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650 Route des Lucioles
F-06921 Sophia Antipolis Cedex - FRANCE

Tel.: +33 4 92 94 42 00 Fax: +33 4 93 65 47 16

Siret N° 348 623 562 00017 - NAF 742 C
Association à but non lucratif enregistrée à la
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Foreword

This Technical Specification has been produced by the 3rd Generation Partnership Project (3GPP).

The contents of the present document are subject to continuing work within the TSG and may change following formal TSG approval. Should the TSG modify the contents of the present document, it will be re-released by the TSG with an identifying change of release date and an increase in version number as follows:

Version x.y.z

where:

- x the first digit:
  - 1 presented to TSG for information;
  - 2 presented to TSG for approval;
  - 3 or greater indicates TSG approved document under change control.
- y the second digit is incremented for all changes of substance, i.e. technical enhancements, corrections, updates, etc.
- z the third digit is incremented when editorial only changes have been incorporated in the document.

1 Scope

The present document specifies the Radio Resource Control protocol for the radio interface between UE and NG-RAN.

The scope of the present document also includes:

- the radio related information transported in a transparent container between source gNB and target gNB upon inter gNB handover;
- the radio related information transported in a transparent container between a source or target gNB and another system upon inter RAT handover.
- the radio related information transported in a transparent container between a source eNB and target gNB during E-UTRA-NR Dual Connectivity.

2 References

The following documents contain provisions which, through reference in this text, constitute provisions of the present document.

- References are either specific (identified by date of publication, edition number, version number, etc.) or non-specific.
- For a specific reference, subsequent revisions do not apply.
- For a non-specific reference, the latest version applies. In the case of a reference to a 3GPP document (including a GSM document), a non-specific reference implicitly refers to the latest version of that document *in the same Release as the present document.*

[1] 3GPP TR 21.905: "Vocabulary for 3GPP Specifications".

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

[3] 3GPP TS 38.321: "NR; Medium Access Control (MAC); Protocol specification".

[4] 3GPP TS 38.322: "NR; Radio Link Control (RLC) protocol specification".

[5] 3GPP TS 38.323: "NR; Packet Data Convergence Protocol (PDCP) protocol specification".

[6] ITU-T Recommendation X.680 (08/2015) "Information Technology - Abstract Syntax Notation One (ASN.1): Specification of basic notation" (Same as the ISO/IEC International Standard 8824-1).

[7] ITU-T Recommendation X.681 (08/2015) "Information Technology - Abstract Syntax Notation One (ASN.1): Information object specification" (Same as the ISO/IEC International Standard 8824-2).

[8] ITU-T Recommendation X.691 (08/2015) "Information technology - ASN.1 encoding rules: Specification of Packed Encoding Rules (PER)" (Same as the ISO/IEC International Standard 8825-2).

[9] 3GPP TS 38.215: "NR; Physical layer measurements".

[10] 3GPP TS 36.331: "Evolved Universal Terrestrial Radio Access (E-UTRA) Radio Resource Control (RRC); Protocol Specification".

[11] 3GPP TS 33.501: "Security Architecture and Procedures for 5G System".

[12] 3GPP TS 38.104: "NR; Base Station (BS) radio transmission and reception".

[13] 3GPP TS 38.213: "NR; Physical layer procedures for control".

[14] 3GPP TS 38.133: "NR; Requirements for support of radio resource management".

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

[16] 3GPP TS 38.211: "NR; Physical channels and modulation".

[17] 3GPP TS 38.212: "NR; Multiplexing and channel coding".

[18] ITU-T Recommendation X.683 (08/2015) "Information Technology - Abstract Syntax Notation One (ASN.1): Parameterization of ASN.1 specifications" (Same as the ISO/IEC International Standard 8824-4).

[19] 3GPP TS 38.214: "NR; Physical layer procedures for data".

[20] 3GPP TS 38.304: "NR; User Equipment (UE) procedures in Idle mode and RRC Inactive state".

[21] 3GPP TS 23.003: "Numbering, addressing and identification".

[22] 3GPP TS 36.101: "E-UTRA; User Equipment (UE) radio transmission and reception".

[23] 3GPP TS 24.501: "Non-Access-Stratum (NAS) protocol for 5G System (5GS); Stage 3".

[24] 3GPP TS 37.324: "Service Data Adaptation Protocol (SDAP) specification".

[25] 3GPP TS 22.261: "Service requirements for the 5G System".

[26] 3GPP TS 38.306: "User Equipment (UE) radio access capabilities".

[27] 3GPP TS 36.304: "E-UTRA; User Equipment (UE) procedures in idle mode".

[28] ATIS 0700041: "WEA 3.0: Device-Based Geo-Fencing".

[29] 3GPP TS 23.041: "Technical realization of Cell Broadcast Service (CBS)".

[30] 3GPP TS 33.401: "3GPP System Architecture Evolution (SAE); Security architecture".

[31] 3GPP TS 36.211: "E-UTRA; Physical channels and modulation".

[32] 3GPP TS 23.501: "System Architecture for the 5G System; Stage 2".

[33] 3GPP TS 36.104:"E-UTRA; Base Station (BS) radio transmission and reception".

[34] 3GPP TS 38.101-3 "NR; User Equipment (UE) radio transmission and reception; Part 3: Range 1 and Range 2 Interworking operation with other radios"

3 Definitions, symbols and abbreviations

3.1 Definitions

For the purposes of the present document, the terms and definitions given in 3GPP TR 21.905 [1] and the following apply. A term defined in the present document takes precedence over the definition of the same term, if any, in 3GPP TR 21.905 [1].

Ceil: Mathematical function used to 'round up' i.e. to the nearest integer having a higher or equal value.

Dedicated signalling: Signalling sent on DCCH logical channel between the network and a single UE.

Field: The individual contents of an information element are referred to as fields.

Floor: Mathematical function used to 'round down' i.e. to the nearest integer having a lower or equal value.

Information element: A structural element containing single or multiple fields is referred as information element.

Primary Cell: The MCG cell, operating on the primary frequency, in which the UE either performs the initial connection establishment procedure or initiates the connection re-establishment procedure.

Primary SCG Cell: For dual connectivity operation, the SCG cell in which the UE performs random access when performing the Reconfiguration with Sync procedure.

Primary Timing Advance Group: Timing Advance Group containing the SpCell.

PUCCH SCell: An SCell configured with PUCCH.

RLC bearer configuration: The lower layer part of the radio bearer configuration comprising the RLC and logical channel configurations.

Secondary Cell: For a UE configured with CA, a cell providing additional radio resources on top of Special Cell.

Secondary Cell Group: For a UE configured with dual connectivity, the subset of serving cells comprising of the PSCell and zero or more secondary cells.

Serving Cell: For a UE in RRC_CONNECTED not configured with CA/DC there is only one serving cell comprising of the primary cell. For a UE in RRC_CONNECTED configured with CA/ DC the term 'serving cells' is used to denote the set of cells comprising of the Special Cell(s) and all secondary cells.

Special Cell: For Dual Connectivity operation the term Special Cell refers to the PCell of the MCG or the PSCell of the SCG, otherwise the term Special Cell refers to the PCell.

SSB Frequency: Frequency referring to the position of resource element RE=#0 (subcarrier #0) of resource block RB#10 of the SS block.

UE Inactive AS Context: UE Inactive AS Context is stored when the connection is suspended and restored when the connection is resumed. It includes information as defined in subclause 5.3.8.3.

3.2 Abbreviations

For the purposes of the present document, the abbreviations given in 3GPP 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 3GPP TR 21.905 [1].

5GC	5G Core Network
ACK	Acknowledgement
AM	Acknowledged Mode
ARQ	Automatic Repeat Request
AS	Access Stratum
ASN.1	Abstract Syntax Notation One
BLER	Block Error Rate
BWP	Bandwidth Part
CA	Carrier Aggregation
CCCH	Common Control Channel
CG	Cell Group
CMAS	Commercial Mobile Alert Service
CP	Control Plane
C-RNTI	Cell RNTI
CSI	Channel State Information
DC	Dual Connectivity
DCCH	Dedicated Control Channel
DCI	Downlink Control Information
DL	Downlink
DL-SCH	Downlink Shared Channel
DRB	(user) Data Radio Bearer
DRX	Discontinuous Reception
DTCH	Dedicated Traffic Channel
EN-DC	E-UTRA NR Dual Connectivity
EPC	Evolved Packet Core
EPS	Evolved Packet System
ETWS	Earthquake and Tsunami Warning System
E-UTRA	Evolved Universal Terrestrial Radio Access
E-UTRA/5GC	E-UTRA connected to 5GC
E-UTRA/EPC	E-UTRA connected to EPC

E-UTRAN	Evolved Universal Terrestrial Radio Access Network
FDD	Frequency Division Duplex
FFS	For Further Study
GERAN	GSM/EDGE Radio Access Network
GNSS	Global Navigation Satellite System
GSM	Global System for Mobile Communications
HARQ	Hybrid Automatic Repeat Request
IE	Information element
IMSI	International Mobile Subscriber Identity
kB	Kilobyte (1000 bytes)
L1	Layer 1
L2	Layer 2
L3	Layer 3
MAC	Medium Access Control
MCG	Master Cell Group
MIB	Master Information Block
N/A	Not Applicable
NR/5GC	NR connected to 5GC
PCell	Primary Cell
PDCP	Packet Data Convergence Protocol
PDU	Protocol Data Unit
PLMN	Public Land Mobile Network
PSCell	Primary SCG Cell
PTAG	Primary Timing Advance Group
PWS	Public Warning System
QoS	Quality of Service
RAN	Radio Access Network
RAT	Radio Access Technology
RLC	Radio Link Control
RNA	RAN-based Notification Area
RNTI	Radio Network Temporary Identifier
ROHC	Robust Header Compression
RRC	Radio Resource Control
RS	Reference Signal
SCell	Secondary Cell
SCG	Secondary Cell Group
SFN	System Frame Number
SFTD	SFN and Frame Timing Difference
SI	System Information
SIB	System Information Block
SpCell	Special Cell
SRB	Signalling Radio Bearer
SSB	Synchronization Signal Block
TAG	Timing Advance Group
TDD	Time Division Duplex
TM	Transparent Mode
UE	User Equipment
UL	Uplink
UM	Unacknowledged Mode
UP	User Plane

In the ASN.1, lower case may be used for some (parts) of the above abbreviations e.g. c-RNTI.

4 General

4.1 Introduction

This specification is organised as follows:

- sub-clause 4.2 describes the RRC protocol model;

- sub-clause 4.3 specifies the services provided to upper layers as well as the services expected from lower layers;
- sub-clause 4.4 lists the RRC functions;
- clause 5 specifies RRC procedures, including UE state transitions;
- clause 6 specifies the RRC messages in ASN.1 and description;
- clause 7 specifies the variables (including protocol timers and constants) and counters to be used by the UE;
- clause 8 specifies the encoding of the RRC messages;
- clause 9 specifies the specified and default radio configurations;
- clause 10 specifies generic error handling;
- clause 11 specifies the RRC messages transferred across network nodes;
- clause 12 specifies the UE capability related constraints and performance requirements.

4.2 Architecture

4.2.1 UE states and state transitions including inter RAT

A UE is either in RRC_CONNECTED state or in RRC_INACTIVE state when an RRC connection has been established. If this is not the case, i.e. no RRC connection is established, the UE is in RRC_IDLE state. The RRC states can further be characterised as follows:

- **RRC_IDLE**:
  - A UE specific DRX may be configured by upper layers;
  - UE controlled mobility based on network configuration;
  - The UE:
    - Monitors Short Messages transmitted with P-RNTI over DCI (see clause 6.5);
    - Monitors a Paging channel for CN paging using 5G-S-TMSI;
    - Performs neighbouring cell measurements and cell (re-)selection;
    - Acquires system information and can send SI request (if configured).
- **RRC_INACTIVE**:
  - A UE specific DRX may be configured by upper layers or by RRC layer;
  - UE controlled mobility based on network configuration;
  - The UE stores the UE Inactive AS context;
  - A RAN-based notification area is configured by RRC layer;

  The UE:
    - Monitors Short Messages transmitted with P-RNTI over DCI (see clause 6.5);
    - Monitors a Paging channel for CN paging using 5G-S-TMSI and RAN paging using fullI-RNTI;
    - Performs neighbouring cell measurements and cell (re-)selection;
    - Performs RAN-based notification area updates periodically and when moving outside the configured RAN-based notification area;
    - Acquires system information and can send SI request (if configured).
- **RRC_CONNECTED:**

- The UE stores the AS context;
- Transfer of unicast data to/from UE;
- At lower layers, the UE may be configured with a UE specific DRX;
- For UEs supporting CA, use of one or more SCells, aggregated with the SpCell, for increased bandwidth;
- For UEs supporting DC, use of one SCG, aggregated with the MCG, for increased bandwidth;
- Network controlled mobility within NR and to/from E-UTRA;
- The UE:
    - Monitors Short Messages transmitted with P-RNTI over DCI (see clause 6.5), if configured;
    - Monitors control channels associated with the shared data channel to determine if data is scheduled for it;
    - Provides channel quality and feedback information;
    - Performs neighbouring cell measurements and measurement reporting;
    - Acquires system information.

Figure 4.2.1-1 illustrates an overview of UE RRC state machine and state transitions in NR. A UE has only one RRC state in NR at one time.

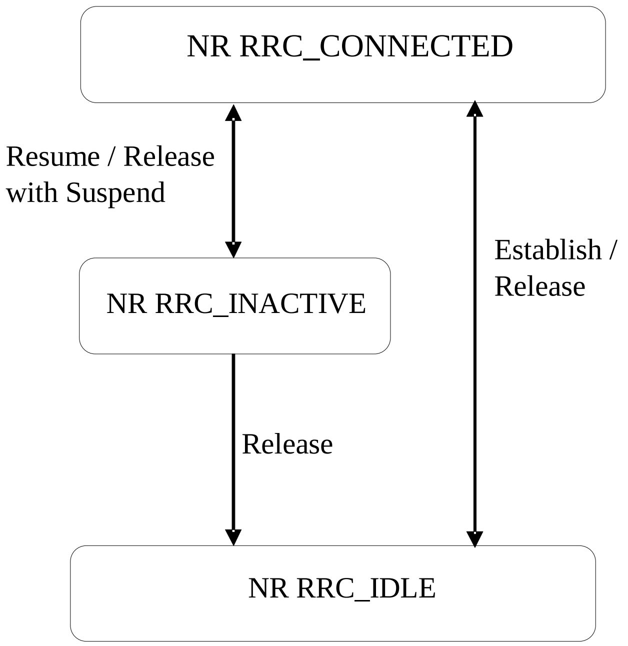

Figure 4.2.1-1: UE state machine and state transitions in NR

Figure 4.2.1-2 illustrates an overview of UE state machine and state transitions in NR as well as the mobility procedures supported between NR/5GC E-UTRA/EPC and E-UTRA/5GC.

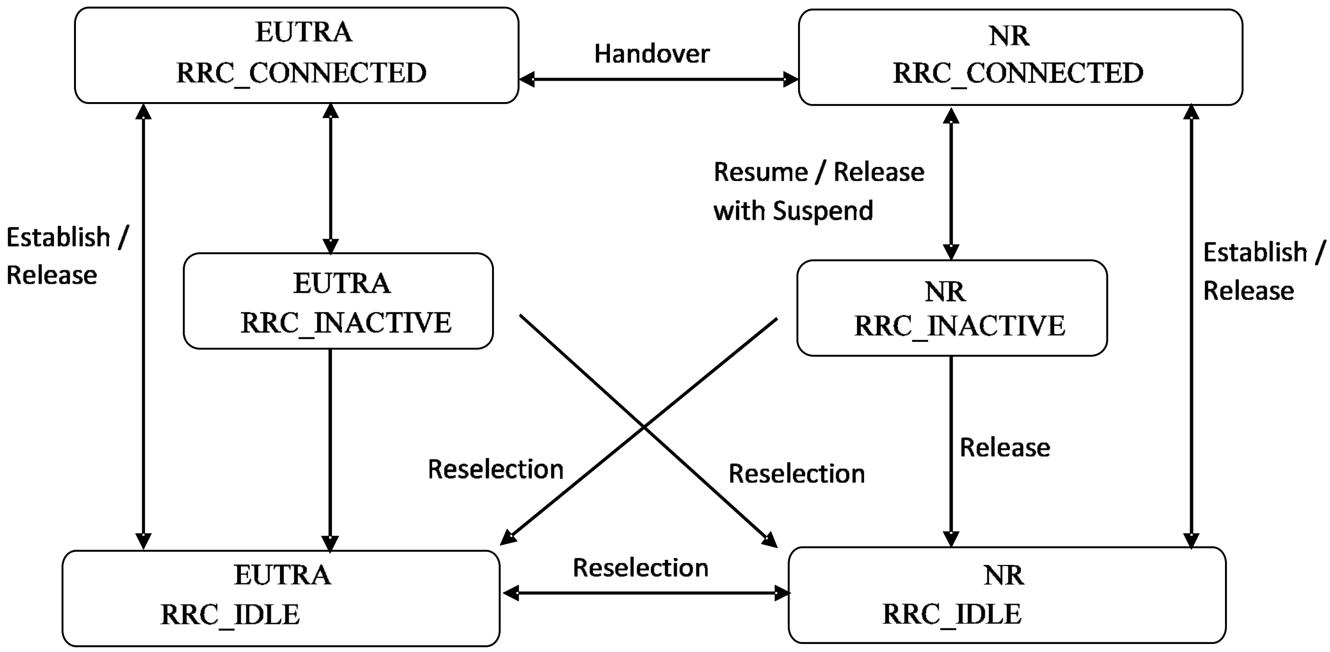

Figure 4.2.1-2: UE state machine and state transitions between NR/5GC, E-UTRA/EPC and E-UTRA/5GC

4.2.2 Signalling radio bearers

"Signalling Radio Bearers" (SRBs) are defined as Radio Bearers (RBs) that are used only for the transmission of RRC and NAS messages. More specifically, the following SRBs are defined:

- SRB0 is for RRC messages using the CCCH logical channel;
- SRB1 is for RRC messages (which may include a piggybacked NAS message) as well as for NAS messages prior to the establishment of SRB2, all using DCCH logical channel;
- SRB2 is for NAS messages, all using DCCH logical channel. SRB2 has a lower-priority than SRB1 and may be configured by the network after security activation;
- SRB3 is for specific RRC messages when UE is in EN-DC, all using DCCH logical channel.

In downlink piggybacking of NAS messages is used only for bearer establishment/modification/release. In uplink piggybacking of NAS message is used only for transferring the initial NAS message during connection setup and connection resume.

NOTE 1: The NAS messages transferred via SRB2 are also contained in RRC messages, which however do not include any RRC protocol control information.

Once security is activated, all RRC messages on SRB1, SRB2 and SRB3, including those containing NAS messages, are integrity protected and ciphered by PDCP. NAS independently applies integrity protection and ciphering to the NAS messages.

Editor's Note: FFS which SRBs are used for NE-DC, NR-NR DC.

4.3 Services

4.3.1 Services provided to upper layers

The RRC protocol offers the following services to upper layers:

- Broadcast of common control information;
- Notification of UEs in RRC_IDLE, e.g. about a terminating call;
- Notification of UEs about ETWS and/or CMAS
- Transfer of dedicated control information, i.e. information for one specific UE.

4.3.2 Services expected from lower layers

In brief, the following are the main services that RRC expects from lower layers:

- Integrity protection, ciphering and loss-less in-sequence delivery of information without duplication;

4.4 Functions

The RRC protocol includes the following main functions:

- Broadcast of system information:
  - Including NAS common information;
  - Information applicable for UEs in RRC_IDLE and RRC_INACTIVE (e.g. cell (re-)selection parameters, neighbouring cell information) and information (also) applicable for UEs in RRC_CONNECTED (e.g. common channel configuration information);
  - Including ETWS notification, CMAS notification.
- RRC connection control:
  - Paging;
  - Establishment/modification/suspension/resumption/release of RRC connection, including e.g. assignment/modification of UE identity (C-RNTI, fullI-RNTI, etc.), establishment/modification/suspension/resumption/release of SRBs (except for SRB0);
  - Access barring;
  - Initial security activation, i.e. initial configuration of AS integrity protection (SRBs, DRBs) and AS ciphering (SRBs, DRBs);
  - RRC connection mobility including e.g. intra-frequency and inter-frequency handover, associated security handling, i.e. key/algorithm change, specification of RRC context information transferred between network nodes;
  - Establishment/modification/suspension/resumption/release of RBs carrying user data (DRBs);
  - Radio configuration control including e.g. assignment/modification of ARQ configuration, HARQ configuration, DRX configuration;
  - In case of DC, cell management including e.g. change of PSCell, addition/modification/release of SCG cell(s);
  - In case of CA, cell management including e.g. addition/modification/release of SCell(s);
  - QoS control including assignment/ modification of semi-persistent scheduling (SPS) configuration and configured grant configuration for DL and UL respectively, assignment/ modification of parameters for UL rate control in the UE, i.e. allocation of a priority and a prioritised bit rate (PBR) for each RB.

- Recovery from radio link failure.

- Inter-RAT mobility including e.g. security activation, transfer of RRC context information;
- Measurement configuration and reporting:
  - Establishment/modification/release of measurement configuration (e.g. intra-frequency, inter-frequency and inter- RAT measurements);
  - Setup and release of measurement gaps;
  - Measurement reporting.
- Other functions including e.g. generic protocol error handling, transfer of dedicated NAS information, transfer of UE radio access capability information.

5 Procedures

5.1 General

5.1.1 Introduction

This section covers the general requirements.

5.1.2 General requirements

The UE shall:

1> process the received messages in order of reception by RRC, i.e. the processing of a message shall be completed before starting the processing of a subsequent message;

NOTE: Network may initiate a subsequent procedure prior to receiving the UE's response of a previously initiated procedure.

1> within a sub-clause execute the steps according to the order specified in the procedural description;

1> consider the term 'radio bearer' (RB) to cover SRBs and DRBs unless explicitly stated otherwise;

1> set the *rrc-TransactionIdentifier* in the response message, if included, to the same value as included in the message received from NR that triggered the response message;

1> upon receiving a choice value set to *setup*:

2> apply the corresponding received configuration and start using the associated resources, unless explicitly specified otherwise;

1> upon receiving a choice value set to *release*:

2> clear the corresponding configuration and stop using the associated resources;

1> in case the size of a list is extended, upon receiving an extension field comprising the entries in addition to the ones carried by the original field (regardless of whether NR signals more entries in total); apply the following generic behaviour unless explicitly stated otherwise:

2> create a combined list by concatenating the additional entries included in the extension field to the original field while maintaining the order among both the original and the additional entries;

2> for the combined list, created according to the previous, apply the same behaviour as defined for the original field.

5.1.3 Requirements for UE in EN-DC

In this specification, the UE considers itself to be in EN-DC if and only if it is configured with nr-SecondaryCellGroupConfig according to TS 36.331[10].

The UE in EN-DC only executes a sub-clause of clause 5 in this specification when the subclause:

- is referred to from a subclause under execution, either in this specification or in TS 36.331 [10]; or
- applies to a message received on SRB3 (if SRB3 is established); or
- applies to field(s), IE(s), UE variable(s) or timer(s) in this specification that the UE is configured with.

When executing a subclause of clause 5 in this specification, the UE follows the requirements in clause 5.1.2 and in all subclauses of this specification applicable to the messages (including processing time requirements), fields, IEs, timers and UE variables indicated in the subclause under execution.

5.2 System information

5.2.1 Introduction

System Information (SI) is divided into the *MIB* and a number of SIBs where:

- the *MIB* is always transmitted on the BCH with a periodicity of 80 ms and repetitions made within 80 ms (TS 38.212 [17], clause 7.1) and it includes parameters that are needed to acquire *SIB1* from the cell. The first transmission of the MIB is scheduled in subframes as defined in TS 38.213 [13], clause 4.1 and repetitions are scheduled according to the period of SSB;
- the *SIB1* is transmitted on the DL-SCH with a periodicity of 160 ms and variable transmission repetition periodicity within 160ms as specified in TS 38.213 [13], clause 13. The default transmission repetition periodicity of *SIB1* is 20 ms but the actual transmission repetition periodicity is up to network implementation. For SSB and CORESET multiplexing pattern 1, *SIB1* repetition transmission period is 20ms. For SSB and CORESET multiplexing pattern 2/3, *SIB1* transmission repetition period is the same as the SSB period (TS 38.213 [13], clause 13). SIB1 includes information regarding the availability and scheduling (e.g. mapping of SIBs to SI message, periodicity, SI-window size) of other SIBs with an indication whether one or more SIBs are only provided on-demand and, in that case, the configuration needed by the UE to perform the SI request. SIB1 is cell-specific SIB;
- SIBs other than *SIB1* are carried in *SystemInformation* (SI) messages, which are transmitted on the DL-SCH. Only SIBs having the same periodicity can be mapped to the same SI message. Each SI message is transmitted within periodically occurring time domain windows (referred to as SI-windows with same length for all SI messages). Each SI message is associated with a SI-window and the SI-windows of different SI messages do not overlap. That is, within one SI-window only the corresponding SI message is transmitted. Any SIB except *SIB1* can be configured to be cell specific or area specific, using an indication in *SIB1*. The cell specific SIB is applicable only within a cell that provides the SIB while the area specific SIB is applicable within an area referred to as SI area, which consists of one or several cells and is identified by s*ystemInformationAreaID*;
- For a UE in RRC_CONNECTED, the network can provide system information through dedicated signalling using the *RRCReconfiguration* message, e.g. if the UE has an active BWP with no common search space configured to monitor system information or paging.
- For PSCell and SCells, the network provides the required SI by dedicated signalling, i.e. within an *RRCReconfiguration* message. Nevertheless, the UE shall acquire MIB of the PSCell to get SFN timing of the SCG (which may be different from MCG). Upon change of relevant SI for SCell, RAN releases and adds the concerned SCell. For PSCell, SI can only be changed with Reconfiguration with Sync.

NOTE: The physical layer imposes a limit to the maximum size a SIB can take. The maximum *SIB1* or *SI message* size is 2976 bits.

5.2.2 System information acquisition

5.2.2.1 General UE requirements

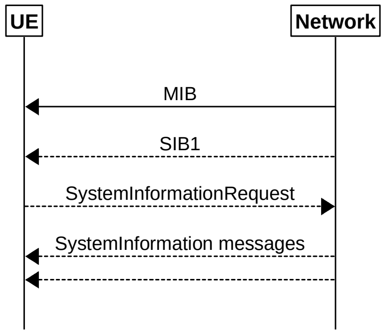

Figure 5.2.2.1-1: System information acquisition

The UE applies the SI acquisition procedure to acquire the AS- and NAS information. The procedure applies to UEs in RRC_IDLE, in RRC_INACTIVE and in RRC_CONNECTED.

The UE in RRC_IDLE and RRC_INACTIVE shall ensure having a valid version of (at least) the *MIB*, *SIB1* through *SIB4* and *SIB5* (if the UE supports E-UTRA).

5.2.2.2 SIB validity and need to (re)-acquire SIB

5.2.2.2.1 SIB validity

The UE shall apply the SI acquisition procedure as defined in clause 5.2.2.3 upon cell selection (e.g. upon power on), cell-reselection, return from out of coverage, after reconfiguration with sync completion, after entering the network from another RAT, upon receiving an indication that the system information has changed, upon receiving a PWS notification; and whenever the UE does not have a valid version of a stored SIB.

When the UE acquires a *MIB* or a *SIB1* or an SI message in a serving cell as described in clause 5.2.2.3, and if the UE stores the acquired SIB then the UE shall store the associated *areaScope*, if present, and the first *PLMN-Identity* in the *PLMN-IdentityInfoList*, *CellIdentity*, *systemInformationAreaID*, if present, and the *valueTag*, if present as indicated in the *si-SchedulingInfo* for the SIB. The UE may use a valid stored version of the SI except *MIB* and *SIB1* e.g. after cell re-selection, upon return from out of coverage or after the reception of SI change indication.

NOTE: The storage and management of the stored SIBs in addition to the SIBs valid for the current serving cell is left to UE implementation.

The UE shall:

1> delete any stored version of a SIB after 3 hours from the moment it was successfully confirmed as valid;

1> for each stored version of a SIB:

2> if the *areaScope* is associated and its value for the stored version of the SIB is the same as the value received in the *si-SchedulingInfo* for that SIB from the serving cell:

3> if the first *PLMN-Identity* included in the *PLMN-IdentityInfoList*, the *systemInformationAreaID* and the v*alueTag* that are included in the *si-SchedulingInfo* for the SIB received from the serving cell are identical to the *PLMN-Identity*, the *systemInformationAreaID* and the *valueTag* associated with the stored version of that SIB;

4> consider the stored SIB as valid for the cell;

2> if the *areaScope* is not present for the stored version of the SIB and the *areaScope* value is not included in the *si-SchedulingInfo* for that SIB from the serving cell:

3> if the first *PLMN-Identity* in the *PLMN-IdentityInfoList, CellIdentity* and *valueTag* that are included in the *si-SchedulingInfo* for the SIB received from the serving cell are identical to the first *PLMN-Identity, CellIdentity* and the *valueTag* associated with the stored version of that SIB;

4> consider the stored SIB as valid for the cell;

5.2.2.2.2 SI change indication and PWS notification

A modification period is used, i.e. updated SI (other than for ETWS and CMAS) is broadcasted in the modification period following the one where SI change indication is transmitted. The modification period boundaries are defined by SFN values for which SFN mod m = 0, where m is the number of radio frames comprising the modification period. The modification period is configured by system information. The UE receives indications about SI modifications and/or PWS notifications using Short Message transmitted with P-RNTI over DCI (see clause 6.5). Repetitions of SI change indication may occur within preceding modification period.

UEs in RRC_IDLE or in RRC_INACTIVE shall monitor for SI change indication in its own paging occasion every DRX cycle. UEs in RRC_CONNECTED shall monitor for SI change indication in any paging occasion at least once per modification period if the UE is provided with common search space on the active BWP to monitor paging, as specified in TS 38.213 [13], clause 13.

ETWS or CMAS capable UEs in RRC_IDLE or in RRC_INACTIVE shall monitor for indications about PWS notification in its own paging occasion every DRX cycle. ETWS or CMAS capable UEs in RRC_CONNECTED shall monitor for indication about PWS notification in any paging occasion at least once per modification period if the UE is provided with common search space on the active BWP to monitor paging.

If the UE receives a Short Message, the UE shall:

1> if the UE is ETWS capable or CMAS capable, and the *etwsAndCmasIndication* bit of Short Message is set:

2> immediately re-acquire the *SIB1*;

2> if the UE is ETWS capable and *si-SchedulingInfo* includes scheduling information for *SIB6*:

3> acquire *SIB6*, as specified in sub-clause 5.2.2.3.2, immediately;

2> if the UE is ETWS capable and *si-SchedulingInfo* includes scheduling information for *SIB7*:

3> acquire *SIB7*, as specified in sub-clause 5.2.2.3.2, immediately;

2> if the UE is CMAS capable and *si-SchedulingInfo* includes scheduling information for *SIB8*:

3> acquire *SIB8*, as specified in sub-clause 5.2.2.3.2, immediately;

1> if the *systemInfoModification* bit of Short Message is set:

2> apply the SI acquisition procedure as defined in sub-clause 5.2.2.3 from the start of the next modification period.

5.2.2.3 Acquisition of System Information

5.2.2.3.1 Acquisition of *MIB* and *SIB1*

The UE shall:

1> apply the specified BCCH configuration defined in 9.1.1.1;

1> if UE is in RRC_IDLE or in RRC_INACTIVE:

2> acquire the *MIB*, which is scheduled as specified in TS 38.213 [13];

2> if the UE is unable to acquire the *MIB*;

3> perform the actions as specified in clause 5.2.2.5;

2> else:

3> perform the actions specified in clause 5.2.2.4.1.

1> if the UE is in RRC_CONNECTED with an active BWP with common search space configured by *searchSpaceSIB1* and *pagingSearchSpace* and has received an indication about change of system information; or

1> if UE is in RRC_IDLE or in RRC_INACTIVE:

2> if *ssb-SubcarrierOffset* indicates *SIB1* is transmitted in the cell (TS 38.213 [13]) and if SIB1 acquisition is required for the UE:

3> acquire the *SIB1,* which is scheduled as specified in TS 38.213 [13];

3> if the UE is unable to acquire the *SIB1*:

4> perform the actions as specified in clause 5.2.2.5;

3> else:

4> upon acquiring *SIB1*, perform the actions specified in clause 5.2.2.4.2.

2> else if SIB1 acquisition is required for the UE and *ssb-SubcarrierOffset* indicates that *SIB1* is not scheduled in the cell:

3> perform the actions as specified in clause 5.2.2.5.

NOTE: The UE in RRC_CONNECTED is only required to acquire broadcasted *SIB1* if the UE can acquire it without disrupting unicast data reception, i.e. the broadcast and unicast beams are quasi co-located.

5.2.2.3.2 Acquisition of an SI message

For SI message acquisition PDCCH monitoring occasion(s) are determined according to *searchSpaceOtherSystemInformation*. If *searchSpaceOtherSystemInformation* is set to zero, PDCCH monitoring occasions for SI message reception in SI-window are same as PDCCH monitoring occasions for SIB1 where the mapping between PDCCH monitoring occasions and SSBs is specified in TS 38.213[13]. If *searchSpaceOtherSystemInformation* is not set to zero, PDCCH monitoring occasions for SI message are determined based on search space indicated by *searchSpaceOtherSystemInformation*. PDCCH monitoring occasions for SI message which are not overlapping with UL symbols (determined according to *tdd-UL-DL-ConfigurationCommon*) are sequentially numbered from one in the SI window. The $[x*N+K]^{th}$ PDCCH monitoring occasion (s) for SI message in SI-window corresponds to the K^{th} transmitted SSB, where x = 0, 1, ...X-1, K = 1, 2, …N, N is the number of actual transmitted SSBs determined according to *ssb-PositionsInBurst* in *SIB1* and X is equal to 'CEIL(number of PDCCH monitoring occasions in SI-window/N).

When acquiring an SI message, the UE shall:

1> determine the start of the SI-window for the concerned SI message as follows:

2> for the concerned SI message, determine the number *n* which corresponds to the order of entry in the list of SI messages configured by *schedulingInfoList* in *si-SchedulingInfo* in *SIB1*;

2> determine the integer value *x = (n – 1) * w*, where *w* is the *si-WindowLength*;

2> the SI-window starts at the slot #*a*, where *a* = *x* mod N, in the radio frame for which SFN mod *T* = FLOOR(*x*/N), where *T* is the *si-Periodicity* of the concerned SI message and N is the number of slots in a radio frame as specified in TS 38.213 [13];

1> receive the PDCCH containing the scheduling RNTI, i.e. SI-RNTI in the PDCCH monitoring occasion(s) for SI message acquisition, from the start of the SI-window and continue until the end of the SI-window whose absolute length in time is given by si-WindowLength, or until the SI message was received;

1> if the SI message was not received by the end of the SI-window, repeat reception at the next SI-window occasion for the concerned SI message in the current modification period;

NOTE 1: The UE is only required to acquire broadcasted SI message if the UE can acquire it without disrupting unicast data reception, i.e. the broadcast and unicast beams are quasi co-located.

NOTE 2: The UE is not required to monitor PDCCH monitoring occasion(s) corresponding to each transmitted SSB in SI-window.

NOTE 3: If the concerned SI message was not received in the current modification period, handling of SI message acquisition is left to UE implementation.

1> perform the actions for the acquired SI message as specified in sub-clause 5.2.2.4.

5.2.2.3.3 Request for on demand system information

The UE shall:

1> if *SIB1* includes *si-SchedulingInfo* containing *si-RequestConfig* or *si-RequestConfigSUL*:

2> trigger the lower layer to initiate the Random Access procedure in accordance with [3] using the PRACH preamble(s) and PRACH resource(s) in *si-RequestConfig* or *si-RequestConfigSUL* corresponding to the SI message(s) that the UE requires to operate within the cell, and for which *si-BroadcastStatus* is set to *notBroadcasting*;

2> if acknowledgement for SI request is received from lower layers:

3> acquire the requested SI message(s) as defined in sub-clause 5.2.2.3.2, immediately;

1> else

2> apply the *timeAlignmentTimerCommon* included in *SIB1*;

2> apply the CCCH configuration as specified in 9.1.1.2;

2> initiate transmission of the *RRCSystemInfoRequest* message in accordance with 5.2.2.3.4;

2> if acknowledgement for *RRCSystemInfoRequest* message is received from lower layers:

3> acquire the requested SI message(s) as defined in sub-clause 5.2.2.3.2, immediately;

1> if cell reselection occurs while waiting for the acknowledgment for SI request from lower layers:

2> reset MAC;

2> if SI request is based on RRCSystemInfoRequest message:

3> release RLC entity for SRB0.

NOTE: After RACH failure for SI request it is UE implementation when to retry the SI request.

5.2.2.3.4 Actions related to transmission of *RRCSystemInfoRequest* message

The UE shall set the contents of *RRCSystemInfoRequest* message as follows:

1> set the *requested-SI-List* to indicate the SI message(s) that the UE requires to operate within the cell, and for which *si-BroadcastStatus* is set to *notBroadcasting*.

The UE shall submit the *RRCSystemInfoRequest* message to lower layers for transmission.

5.2.2.4 Actions upon receipt of System Information

5.2.2.4.1 Actions upon reception of the *MIB*

Upon receiving the *MIB* the UE shall:

1> store the acquired *MIB*;

1> if the UE is in RRC_IDLE or in RRC_INACTIVE or if the UE is in RRC_CONNECTED while *T311* is running:

2> if the *cellBarred* in the acquired *MIB* is set to *barred*:

3> consider the cell as barred in accordance with TS 38.304 [20];

3> if *intraFreqReselection* is set to *notAllowed*:

4> consider cell re-selection to other cells on the same frequency as the barred cell as not allowed, as specified in TS 38.304 [20].

3> else:

4> consider cell re-selection to other cells on the same frequency as the barred cell as allowed, as specified in TS 38.304 [20].

2> else:

3> apply the received *pdcch-ConfigSIB1*, *subCarrierSpacingCommon*, *ssb-SubcarrierOffset* and *dmrs-TypeA-Position*.

5.2.2.4.2 Actions upon reception of the *SIB1*

Upon receiving the *SIB1* the UE shall:

1> store the acquired *SIB1*;

1> if the *cellAccessRelatedInfo* contains an entry with the *PLMN-Identity* of the selected PLMN:

2> in the remainder of the procedures use *plmn-IdentityList*, *trackingAreaCode*, and *cellIdentity* for the cell as received in the corresponding *PLMN-IdentityInfo* containing the selected PLMN;

1> if in RRC_CONNECTED while T311 is not running:

2> disregard the *frequencyBandList*, if received, while in RRC_CONNECTED;

2> forward the *cellIdentity* to upper layers;

2> forward the *trackingAreaCode* to upper layers;

2> apply the configuration included in the *servingCellConfigCommonSIB*;

1> else:

2> if the UE supports one or more of the frequency bands indicated in the *frequencyBandList* for downlink and one or more of the frequency bands indicated in the *frequencyBandList* for uplink or one or more of the frequency bands indicated in the *frequencyBandList* for supplementary uplink, if configured, and they are not downlink only bands, and

2> if the UE supports at least one *additionalSpectrumEmission* in the *NR-NS-PmaxList* within the *frequencyBandList* of *FrequencyInfoUL-SIB* for FDD or of *FrequencyInfoDL-SIB* for TDD for the frequency band selected by the UE (for the downlink and uplink or supplementary uplink, if configured), and

2> if the UE supports the bandwidth of the initial uplink BWP and of the initial downlink BWPs indicated in the *locationAndBandwidth* fields:

3> forward the *cellIdentity* to upper layers;

3> forward the *trackingAreaCode* to upper layers;

3> if in RRC_INACTIVE and the forwarded *trackingAreaCode* does not trigger message transmission by upper layers:

4> if the serving cell does not belong to the configured *ran-NotificationAreaInfo*:

5> initiate an RNA update as specified in 5.3.13.8;

3> forward the *ims-EmergencySupport* to upper layers, if present;

3> forward the *eCallOverIMS-Support* to upper layers, if present;

3> apply the configuration included in the *servingCellConfigCommon*;

3> apply the specified PCCH configuration defined in 9.1.1.3;

3> if the UE has a stored valid version of a SIB, in accordance with sub-clause 5.2.2.2.1, that the UE requires to operate within the cell in accordance with sub-clause 5.2.2.1:

4> use the stored version of the required SIB;

3> if the UE has not stored a valid version of a SIB, in accordance with sub-clause 5.2.2.2.1, of one or several required SIB(s), in accordance with sub-clause 5.2.2.1:

4> for the SI message(s) that, according to the *si-SchedulingInfo*, contain at least one required SIB and for which *si-BroadcastStatus* is set to broadcasting:

5> acquire the SI message(s) as defined in sub-clause 5.2.2.3.2;

4> for the SI message(s) that, according to the *si-SchedulingInfo*, contain at least one required SIB and for which *si-BroadcastStatus* is set to *notBroadcasting*:

5> trigger a request to acquire the SI message(s) as defined in sub-clause 5.2.2.3.3;

3> apply the first listed *additionalSpectrumEmission* which it supports among the values included in *NR-NS-PmaxList* within *frequencyBandList*;

3> if the *additionalPmax* is present in the same entry of the selected *additionalSpectrumEmission* within *NR-NS-PmaxList*:

4> apply the *additionalPmax*;

3> else:

4> apply the *p-Max*;

2> else:

3> consider the cell as barred in accordance with TS 38.304 [20]; and

3> perform barring as if *intraFreqReselection* is set to *notAllowed*;

Editor's Note: To be further updated when content of the *SIB1* has been completed.

5.2.2.4.3 Actions upon reception of *SIB2*

Upon receiving *SIB2*, the UE shall:

1> if in RRC_IDLE or in RRC_INACTIVE or in RRC_CONNECTED while T311 is running:

2> if, for the frequency band selected by the UE (from the procedure in Clause 5.2.2.4.2) to represent the serving cell's carrier frequency, the *frequencyBandList* is present in *SIB2*, the *frequencyBandListSUL* is present in *SIB2* for supplementary uplink, if configured, and the UE supports at least one *additionalSpectrumEmission* in the *NR-NS-PmaxList* within the *frequencyBandList*:

3> apply the first listed *additionalSpectrumEmission* which it supports among the values included in *NR-NS-PmaxList* within *frequencyBandList*;

3> if the *additionalPmax* is present in the same entry of the selected *additionalSpectrumEmission* within *NR-NS-PmaxList*:

4> apply the *additionalPmax*;

3> else:

4> apply the *p-Max*;

2> else:

3> apply the *p-Max*;

5.2.2.4.4 Actions upon reception of *SIB3*

No UE requirements related to the contents of this *SIB3* apply other than those specified elsewhere e.g. within procedures using the concerned system information, and/ or within the corresponding field descriptions.

5.2.2.4.5 Actions upon reception of *SIB4*

Upon receiving *SIB4* the UE shall:

1> if in RRC_IDLE, or in RRC_INACTIVE or in RRC_CONNECTED while T311 is running:

2> if, for the frequency band selected by the UE to represent a non-serving NR carrier frequency is not a downlink only band:

3> if, for the selected frequency band, the *frequencyBandList* is present in *SIB4*, the *frequencyBandListSUL* is present in *SIB4* for supplementary uplink, if configured, and the UE supports at least one *additionalSpectrumEmission* in the *NR-NS-PmaxList* within the *frequencyBandList*:

4> apply the first listed *additionalSpectrumEmission* which it supports among the values included in *NR-NS-PmaxList* within *frequencyBandList*;

4> if the *additionalPmax* is present in the same entry of the selected *additionalSpectrumEmission* within *NR-NS-PmaxList*:

5> apply the *additionalPmax*;

4> else:

5> apply the *p-Max*;

3> else:

4> apply the *p-Max*;

5.2.2.4.6 Actions upon reception of *SIB5*

No UE requirements related to the contents of this *SIB5* apply other than those specified elsewhere e.g. within procedures using the concerned system information, and/ or within the corresponding field descriptions.

5.2.2.4.7 Actions upon reception of *SIB6*

Upon receiving the *SIB6* the UE shall:

1> forward the received *warningType*, *messageIdentifier* and *serialNumber* to upper layers;

5.2.2.4.8 Actions upon reception of *SIB7*

Upon receiving the *SIB7* the UE shall:

1> if there is no current value for *messageIdentifier* and *serialNumber* for *SIB7*; or

1> if either the received value of *messageIdentifier* or of s*erialNumber* or of both are different from the current values of *messageIdentifier* and *serialNumber* for *SIB7*:

2> use the received values of *messageIdentifier* and *serialNumber* for *SIB7* as the current values of *messageIdentifier* and *serialNumber* for *SIB7*;

2> discard any previously buffered *warningMessageSegment*;

2> if all segments of a warning message have been received:

3> assemble the warning message from the received *warningMessageSegment*;

3> forward the received warning message, *messageIdentifier*, *serialNumber* and *dataCodingScheme* to upper layers;

3> stop reception of *SIB7*;

3> discard the current values of *messageIdentifier* and *serialNumber* for *SIB7*;

2> else:

3> store the received *warningMessageSegment*;

3> continue reception of *SIB7*;

1> else if all segments of a warning message have been received:

2> assemble the warning message from the received *warningMessageSegment*;

2> forward the received complete warning message, *messageIdentifier*, *serialNumber* and *dataCodingScheme* to upper layers;

2> stop reception of *SIB7*;

2> discard the current values of *messageIdentifier* and *serialNumber* for *SIB7*;

1> else:

2> store the received *warningMessageSegment*;

2> continue reception of *SIB7*;

The UE should discard any stored *warningMessageSegment* and the current value of *messageIdentifier* and *serialNumber* for *SIB7* if the complete warning message has not been assembled within a period of 3 hours.

5.2.2.4.9 Actions upon reception of *SIB8*

Upon receiving the *SIB8* the UE shall:

1> if the *SIB8* contains a complete warning message and the complete geographical area coordinates (if any):

2> forward the received warning message, *messageIdentifier*, *serialNumber*, *dataCodingScheme* and the geographical area coordinates (if any) to upper layers;

2> continue reception of *SIB8*;

1> else:

2> if the received values of *messageIdentifier* and *serialNumber* are the same (each value is the same) as a pair for which a warning message and the geographical area coordinates (if any) are currently being assembled:

3> store the received *warningMessageSegment*;

3> store the received *warningAreaCoordinatesSegment* (if any);

3> if all segments of a warning message and geographical area coordinates (if any) have been received:

4> assemble the warning message from the received *warningMessageSegment*;

4> assemble the geographical area coordinates from the received *warningAreaCoordinatesSegment* (if any);

4> forward the received warning message, *messageIdentifier*, *serialNumber*, *dataCodingScheme* and geographical area coordinates (if any) to upper layers;

4> stop assembling a warning message and geographical area coordinates (if any) for this *messageIdentifier* and *serialNumber* and delete all stored information held for it;

3> continue reception of *SIB8*;

2> else if the received values of *messageIdentifier* and/or *serialNumber* are not the same as any of the pairs for which a warning message is currently being assembled:

3> start assembling a warning message for this *messageIdentifier* and *serialNumber* pair;

3> start assembling the geographical area coordinates (if any) for this *messageIdentifier* and *serialNumber* pair;

3> store the received *warningMessageSegment*;

3> store the received *warningAreaCoordinatesSegment* (if any);

3> continue reception of *SIB8*;

The UE should discard *warningMessageSegment* and *warningAreaCoordinatesSegment* (if any) and the associated values of *messageIdentifier* and *serialNumber* for *SIB8* if the complete warning message and the geographical area coordinates (if any) have not been assembled within a period of 3 hours.

NOTE: The number of warning messages that a UE can re-assemble simultaneously is a function of UE implementation.

5.2.2.4.10 Actions upon reception of *SIB9*

No UE requirements related to the contents of this *SIB9* apply other than those specified elsewhere e.g. within procedures using the concerned system information, and/ or within the corresponding field descriptions.

5.2.2.5 Essential system information missing

The UE shall:

1> if in RRC_IDLE or in RRC_INACTIVE or in RRC_CONNECTED while T311 is running:

2> if the UE is unable to acquire the *MIB*:

3> consider the cell as barred in accordance with TS 38.304 [20]; and

3> perform barring as if *intraFreqReselection* is set to allowed;

2> else if the UE is unable to acquire the *SIB1*:

3> consider the cell as barred in accordance with TS 38.304 [20].

3> if *intraFreqReselection* in MIB is set to *notAllowed*:

4> consider cell re-selection to other cells on the same frequency as the barred cell as not allowed, as specified in TS 38.304 [20].

3> else:

4> consider cell re-selection to other cells on the same frequency as the barred cell as allowed, as specified in TS 38.304 [20].

5.3 Connection control

5.3.1 Introduction

5.3.1.1 RRC connection control

RRC connection establishment involves the establishment of SRB1. The network completes RRC connection establishment prior to completing the establishment of the NG connection, i.e. prior to receiving the UE context information from the 5GC. Consequently, AS security is not activated during the initial phase of the RRC connection. During this initial phase of the RRC connection, the network may configure the UE to perform measurement reporting, but the UE only sends the corresponding measurement reports after successful security activation. However, the UE only accepts a re-configuration with sync message when security has been activated.

Upon receiving the UE context from the 5GC, the RAN activates AS security (both ciphering and integrity protection) using the initial security activation procedure. The RRC messages to activate security (command and successful response) are integrity protected, while ciphering is started only after completion of the procedure. That is, the response to the message used to activate security is not ciphered, while the subsequent messages (e.g. used to establish SRB2 and DRBs) are both integrity protected and ciphered. After having initiated the initial security activation procedure, the network may initiate the establishment of SRB2 and DRBs, i.e. the network may do this prior to receiving the confirmation of the initial security activation from the UE. In any case, the network will apply both ciphering and integrity protection for the RRC reconfiguration messages used to establish SRB2 and DRBs. The network should release the RRC connection if the initial security activation and/ or the radio bearer establishment fails.

The release of the RRC connection normally is initiated by the network. The procedure may be used to re-direct the UE to an NR frequency or an E-UTRA carrier frequency.

The suspension of the RRC connection is initiated by the network. When the RRC connection is suspended, the UE stores the UE AS context and any configuration received from the network, and transits to RRC_INACTIVE state. The RRC message to suspend the RRC connection is integrity protected and ciphered.

The resumption of a suspended RRC connection is initiated by upper layers when the UE needs to transit from RRC_INACTIVE state to RRC_CONNECTED state or by RRC layer to perform a RNA update or by RAN paging from NG-RAN. When the RRC connection is resumed, network configures the UE according to the RRC connection resume procedure based on the stored UE AS context and any RRC configuration received from the network. The RRC connection resume procedure re-activates security and re-establishes SRB(s) and DRB(s).

In response to a request to resume the RRC connection, the network may resume the suspended RRC connection and send UE to RRC_CONNECTED, or reject the request to resume and send UE to RRC_INACTIVE (with a wait timer), or directly re-suspend the RRC connection and send UE to RRC_INACTIVE, or directly release the RRC connection and send UE to RRC_IDLE, or instruct the UE to initiate NAS level recovery (in this case the network sends an RRC setup message).

Editor's Note FFS NE-DC, NR-NR-DC related aspects.

5.3.1.2 Security

AS security comprises of the integrity protection and ciphering of RRC signalling (SRBs) and user data (DRBs).

RRC handles the configuration of the security parameters which are part of the AS configuration: the integrity protection algorithm, the ciphering algorithm, if integrity and/or ciphering is enabled for a DRB and two parameters, namely the *keySetChangeIndicator* and the *nextHopChainingCount*, which are used by the UE to determine the AS security keys upon reconfiguration with sync (with key change), connection re-establishment and/or connection resume.

The integrity protection and ciphering algorithm is common for signalling radio bearers SRB1 and SRB2. When not configured with any kind of DC, the ciphering and integrity protection algorithm is common for all radio bearers (i.e. SRB1, SRB2 and DRBs). All DRBs related to the same PDU session have the same security configuration. Neither integrity protection nor ciphering applies for SRB0.

Editor's Note: FFS NE-DC, NR-NR-DC related security parameters such as *SK-counter* and *S-KgNB*.

RRC integrity and ciphering are always activated together, i.e. in one message/procedure. RRC integrity and ciphering for SRBs are never de-activated. However, it is possible to switch to a '*NULL*' ciphering algorithm (nea0).

The '*NULL'* integrity protection algorithm (*nia0*) is used only for SRBs and for the UE in limited service mode [11]. In case the *'NULL*' integrity protection algorithm is used, '*NULL*' ciphering algorithm is also used.

NOTE 1: Lower layers discard RRC messages for which the integrity check has failed and indicate the integrity verification check failure to RRC.

The AS applies four different security keys: one for the integrity protection of RRC signalling (K_{RRCint}), one for the ciphering of RRC signalling (K_{RRCenc}), one for integrity protection of user data (K_{UPint}) and one for the ciphering of user data (K_{UPenc}). All four AS keys are derived from the K_{gNB} key. The K_{gNB} is based on the K_{AMF} key (as specified in TS 33.501 [11]), which is handled by upper layers.

The integrity and ciphering algorithms can only be changed with reconfiguration with sync. The AS keys (K_{gNB}, K_{RRCint}, K_{RRCenc}, K_{UPint} and K_{UPenc}) change upon reconfiguration with sync (if *masterKeyUpdate* is included), and upon connection re-establishment and connection resume.

For each radio bearer an independent counter (*COUNT*, as specified in TS 38.323 [5]) is maintained for each direction. For each radio bearer, the *COUNT* is used as input for ciphering and integrity protection. It is not allowed to use the same *COUNT* value more than once for a given security key. In order to limit the signalling overhead, individual messages/ packets include a short sequence number (PDCP SN, as specified in TS 38.323 [5]). In addition, an overflow counter mechanism is used: the hyper frame number (*TX_HFN* and *RX_HFN*, as specified in TS 38.323 [5]). The HFN needs to be synchronized between the UE and the network. The network is responsible for avoiding reuse of the *COUNT* with the same RB identity and with the same key, e.g. due to the transfer of large volumes of data, release and establishment of new RBs, and multiple termination point changes for RLC-UM bearers. In order to avoid such re-use, the network may e.g. use different RB identities for RB establishments, change the security key, or an RRC_CONNECTED to RRC_IDLE/RRC_INACTIVE and then to RRC_CONNECTED transition.

For each SRB, the value provided by RRC to lower layers to derive the 5-bit BEARER parameter used as input for ciphering and for integrity protection is the value of the corresponding *srb-Identity* with the MSBs padded with zeroes.

Editor's Note: FFS Handling of keys in NE-DC and NR-NR-DC.

5.3.2 Paging

5.3.2.1 General

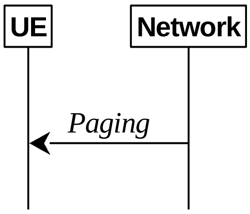

Figure 5.3.2.1-1: Paging

The purpose of this procedure is:

- to transmit paging information to a UE in RRC_IDLE or RRC_INACTIVE.

5.3.2.2 Initiation

The network initiates the paging procedure by transmitting the *Paging* message at the UE's paging occasion as specified in TS 38.304 [20]. The network may address multiple UEs within a *Paging* message by including one *PagingRecord* for each UE.

5.3.2.3 Reception of the *Paging message* by the UE

Upon receiving the *Paging* message, the UE shall:

1> if in RRC_IDLE, for each of the *PagingRecord*, if any, included in the *Paging* message:

2> if the *ue-Identity* included in the *PagingRecord* matches the UE identity allocated by upper layers:

3> forward the *ue-Identity* and *accessType* (if present) to the upper layers;

1> if in RRC_INACTIVE, for each of the *PagingRecord*, if any, included in the *Paging* message:

2> if the *ue-Identity* included in the *PagingRecord* matches the UE's stored *fullI-RNTI*:

3> if the UE is configured by upper layers with access identity 1:

4> initiate the RRC connection resumption procedure according to 5.3.13 with *resumeCause* set to *MPS-PriorityAccess*;

3> else if the UE is configured by upper layers with access identity 2:

4> initiate the RRC connection resumption procedure according to 5.3.13 with *resumeCause* set to *MCS-PriorityAccess*;

3> else if the UE is configured by upper layers with one or more access identities equal to 11-15:

4> initiate the RRC connection resumption procedure according to 5.3.13 with *resumeCause* set to *highPriorityAccess*;

3> else:

4> initiate the RRC connection resumption procedure according to 5.3.13 with *resumeCause* set to *mt-Access*;

2> else if the *ue-Identity* included in the *PagingRecord* matches the UE identity allocated by upper layers:

3> forward the *ue-Identity* to upper layers and *accessType* (if present) to the upper layers;

3> perform the actions upon going to RRC_IDLE as specified in 5.3.11 with release cause 'other'.

5.3.3 RRC connection establishment

5.3.3.1 General

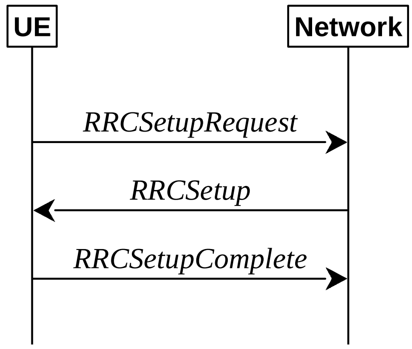

Figure 5.3.3.1-1: RRC connection establishment, successful

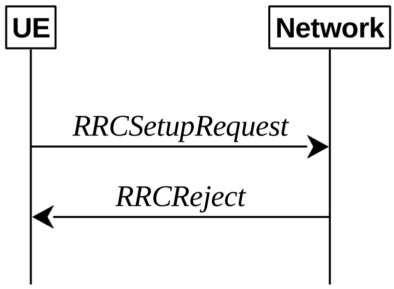

Figure 5.3.3.1-2: RRC connection establishment, network reject

The purpose of this procedure is to establish an RRC connection. RRC connection establishment involves SRB1 establishment. The procedure is also used to transfer the initial NAS dedicated information/ message from the UE to the network.

The network applies the procedure as follows:

- When establishing an RRC connection;
- When UE is resuming or re-establishing an RRC connection, and the network is not able to retrieve or verify the UE context. In this case, UE receives *RRCSetup* and responds with *RRCSetupComplete*.

5.3.3.2 Initiation

The UE initiates the procedure when upper layers request establishment of an RRC connection while the UE is in RRC_IDLE and it has acquired essential system information as described in 5.2.2.1.

The UE shall ensure having valid and up to date essential system information as specified in clause 5.2.2.2 before initiating this procedure.

Upon initiation of the procedure, the UE shall:

1> if the upper layers provide an Access Category and one or more Access Identities upon requesting establishment of an RRC connection:

2> perform the unified access control procedure as specified in 5.3.14 using the Access Category and Access Identities provided by upper layers;

3> if the access attempt is barred, the procedure ends;

1> apply the default L1 parameter values as specified in corresponding physical layer specifications except for the parameters for which values are provided in *SIB1*;

1> apply the default MAC Cell Group configuration as specified in 9.2.2;

1> apply the CCCH configuration as specified in 9.1.1.2;

1> apply the *timeAlignmentTimerCommon* included in *SIB1*;

1> start timer T300;

1> initiate transmission of the *RRCSetupRequest* message in accordance with 5.3.3.3;

5.3.3.3 Actions related to transmission of *RRCSetupRequest* message

The UE shall set the contents of *RRCSetupRequest* message as follows:

1> set the *ue-Identity* as follows:

2> if upper layers provide an *5G-S-TMSI*:

3> set the *ue-Identity* to *ng-5G-S-TMSI-Part1*;

2> else:

3> draw a 39-bit random value in the range $0..2^{39}-1$ and set the *ue-Identity* to this value;

NOTE 1: Upper layers provide the *5G-S-TMSI* if the UE is registered in the TA of the current cell.

1> set the *establishmentCause* in accordance with the information received from upper layers;

The UE shall submit the *RRCSetupRequest* message to lower layers for transmission.

The UE shall continue cell re-selection related measurements as well as cell re-selection evaluation. If the conditions for cell re-selection are fulfilled, the UE shall perform cell re-selection as specified in 5.3.3.6.

5.3.3.4 Reception of the *RRCSetup* by the UE

The UE shall perform the following actions upon reception of the *RRCSetup*:

1> if the *RRCSetup* is received in response to an *RRCReestablishmentRequest*; or

1> if the *RRCSetup* is received in response to an *RRCResumeRequest* or *RRCResumeRequest1*:

2> discard any stored UE Inactive AS context and *suspendConfig*;

2> discard any current AS security context including the K_{RRCenc} key, the K_{RRCint} key, the K_{UPint} key and the K_{UPenc} key;

2> release radio resources for all established RBs except SRB0, including release of the RLC entities, of the associated PDCP entities and of SDAP;

2> release the RRC configuration except for the default MAC Cell Group configuration and CCCH configuration;

2> indicate to upper layers fallback of the RRC connection;

2> stop timer T380, if running;

1> perform the cell group configuration procedure in accordance with the received *masterCellGroup* and as specified in 5.3.5.5;

1> perform the radio bearer configuration procedure in accordance with the received *radioBearerConfig* and as specified in 5.3.5.6;

1> if stored, discard the cell reselection priority information provided by the *cellReselectionPriorities* or inherited from another RAT;

1> stop timer T300, T301 or T319 if running;

1> if T390 is running:

2> stop timer T390 for all access categories;

2> perform the actions as specified in 5.3.14.4.

1> stop timer T302, if running;

1> stop timer T320, if running;

1> if the *RRCSetup* is received in response to an *RRCResumeRequest*, *RRCResumeRequest1* or *RRCSetupRequest*:

2> enter RRC_CONNECTED;

2> stop the cell re-selection procedure;

1> consider the current cell to be the PCell;

1> set the content of *RRCSetupComplete* message as follows:

2> if upper layers provide an *5G-S-TMSI*:

3> if the *RRCSetup* is received in response to an *RRCSetupRequest*:

4> set the *ng-5G-S-TMSI-Value* to *ng-5G-S-TMSI-Part2*;

3> else:

4> set the *ng-5G-S-TMSI-Value* to *ng-5G-S-TMSI*;

2> set the *selectedPLMN-Identity* to the PLMN selected by upper layers (TS 24.501 [23]) from the PLMN(s) included in the *plmn-IdentityList* in *SIB1*;

2> if upper layers provide the 'Registered AMF':

3> include and set the *registeredAMF* as follows:

4> if the PLMN identity of the 'Registered AMF' is different from the PLMN selected by the upper layers:

5> include the *plmnIdentity* in the *registeredAMF* and set it to the value of the PLMN identity in the 'Registered AMF' received from upper layers;

4> set the *amf-Identifier* to the value received from upper layers;

3> include and set the *guami-Type* to the value provided by the upper layers;

2> if upper layers provide one or more S-NSSAI (see TS 23.003 [21]):

3> include the *s-nssai-List* and set the content to the values provided by the upper layers;

2> set the *dedicatedNAS-Message* to include the information received from upper layers;

1> submit the *RRCSetupComplete* message to lower layers for transmission, upon which the procedure ends

5.3.3.5 Reception of the *RRCReject* by the UE

The UE shall:

1> perform the actions as specified in 5.3.15;

5.3.3.6 Cell re-selection or cell selection while T390, T300 or T302 is running (UE in RRC_IDLE)

The UE shall:

1> if cell reselection occurs while T300 or T302 is running:

2> perform the actions upon going to RRC_IDLE as specified in 5.3.11 with release cause 'RRC connection failure';

1> else if cell selection or reselection occurs while T390 is running:

2> stop T390 for all access categories;

2> perform the actions as specified in 5.3.14.4.

5.3.3.7 T300 expiry

The UE shall:

1> if timer T300 expires:

2> reset MAC, release the MAC configuration and re-establish RLC for all RBs that are established;

2> if the T300 has expired a consecutive *connEstFailCount* times on the same cell for which *connEstFailureControl* is included in *SIB1*:

3> for a period as indicated by *connEstFailOffsetValidity*:

4> use *connEstFailOffset* for the parameter *Qoffsettemp* for the concerned cell when performing cell selection and reselection according to TS 38.304 [20] and TS 36.304 [27];

NOTE: When performing cell selection, if no suitable or acceptable cell can be found, it is up to UE implementation whether to stop using *connEstFailOffset* for the parameter *Qoffsettemp* during *connEstFailOffsetValidity* for the concerned cell.

2> inform upper layers about the failure to establish the RRC connection, upon which the procedure ends;

5.3.3.8 Abortion of RRC connection establishment

If upper layers abort the RRC connection establishment procedure, due to a NAS procedure being aborted as specified in TS 37.324 [24], while the UE has not yet entered RRC_CONNECTED, the UE shall:

1> stop timer T300, if running;

1> reset MAC, release the MAC configuration and re-establish RLC for all RBs that are established;

5.3.4 Initial security activation

5.3.4.1 General

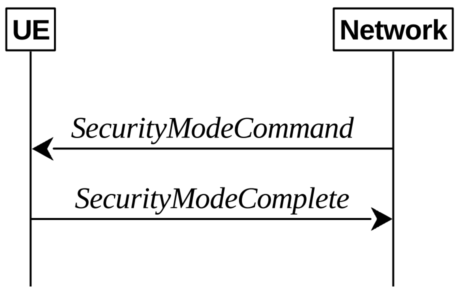

Figure 5.3.4.1-1: Security mode command, successful

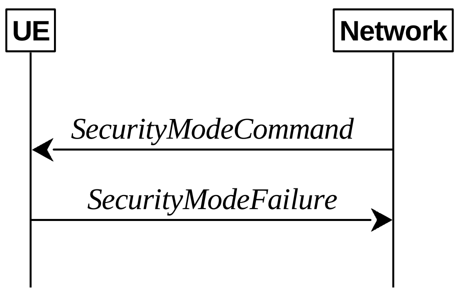

Figure 5.3.4.1-2: Security mode command, failure

The purpose of this procedure is to activate AS security upon RRC connection establishment.

5.3.4.2 Initiation

The network initiates the security mode command procedure to a UE in RRC_CONNECTED. Moreover, the network applies the procedure as follows:

- when only SRB1, is established, i.e. prior to establishment of SRB2 and/ or DRBs.

5.3.4.3 Reception of the *SecurityModeCommand* by the UE

The UE shall:

1> derive the K_{gNB} key, as specified in TS 33.501 [11];

1> derive the K_{RRCint} key associated with the *integrityProtAlgorithm* indicated in the *SecurityModeCommand* message, as specified in TS 33.501 [11];

1> request lower layers to verify the integrity protection of the *SecurityModeCommand* message, using the algorithm indicated by the *integrityProtAlgorithm* as included in the *SecurityModeCommand* message and the K_{RRCint} key;

1> if the *SecurityModeCommand* message passes the integrity protection check:

2> derive the K_{RRCenc} key and the K_{UPenc} key associated with the *cipheringAlgorithm* indicated in the *SecurityModeCommand* message, as specified in TS 33.501 [11];

2> derive the K_{UPint} key associated with the *integrityProtAlgorithm* indicated in the *SecurityModeCommand* message, as specified in TS 33.501 [11];

2> configure lower layers to apply SRB integrity protection using the indicated algorithm and the K_{RRCint} key immediately, i.e. integrity protection shall be applied to all subsequent messages received and sent by the UE, including the *SecurityModeComplete* message;

2> configure lower layers to apply SRB ciphering using the indicated algorithm, the K_{RRCenc} keyafter completing the procedure, i.e. ciphering shall be applied to all subsequent messages received and sent by the UE, except for the *SecurityModeComplete* message which is sent unciphered;

2> consider AS security to be activated;

2> submit the *SecurityModeComplete* message to lower layers for transmission, upon which the procedure ends;

1> else:

2> continue using the configuration used prior to the reception of the *SecurityModeCommand* message, i.e. neither apply integrity protection nor ciphering.

2> submit the *SecurityModeFailure* message to lower layers for transmission, upon which the procedure ends.

5.3.5 RRC reconfiguration

5.3.5.1 General

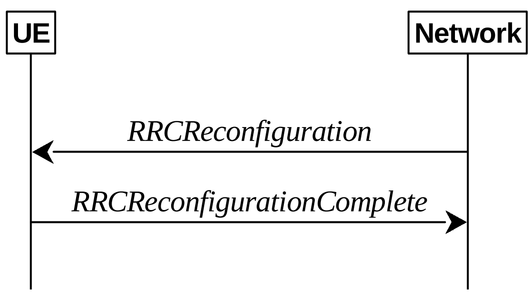

Figure 5.3.5.1-1: RRC reconfiguration, successful

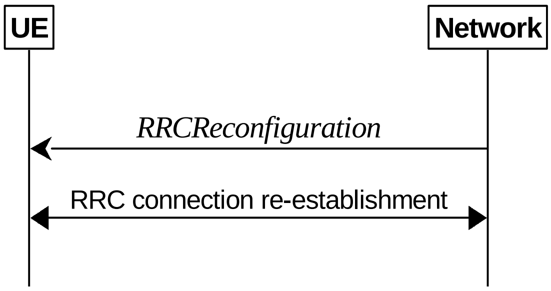

Figure 5.3.5.1-2: RRC reconfiguration, failure

The purpose of this procedure is to modify an RRC connection, e.g. to establish/modify/release RBs, to perform reconfiguration with sync, to setup/modify/release measurements, to add/modify/release SCells and cell groups. As part of the procedure, NAS dedicated information may be transferred from the Network to the UE.

In EN-DC, SRB3 can be used for measurement configuration and reporting, to (re-)configure MAC, RLC, physical layer and RLF timers and constants of the SCG configuration, and to reconfigure PDCP for DRBs associated with the S-K_{gNB} or SRB3, provided that the (re-)configuration does not require any MeNB involvement.

5.3.5.2 Initiation

The Network may initiate the RRC reconfiguration procedure to a UE in RRC_CONNECTED. The Network applies the procedure as follows:

- the establishment of RBs (other than SRB1, that is established during RRC connection establishment) is performed only when AS security has been activated;
- the addition of Secondary Cell Group and SCells is performed only when AS security has been activated;
- the *reconfigurationWithSync* is included in *secondaryCellGroup* only when at least one DRB is setup in SCG;
- the *reconfigurationWithSync* is included in *masterCellGroup* only when AS-security has been activated, and SRB2 with at least one DRB are setup and not suspended.

5.3.5.3 Reception of an *RRCReconfiguration* by the UE

The UE shall perform the following actions upon reception of the *RRCReconfiguration*:

1> if the *RRCReconfiguration* includes the *fullConfig*:

2> perform the full configuration procedure as specified in 5.3.5.11;

1> if the *RRCReconfiguration* includes the *masterCellGroup*:

2> perform the cell group configuration for the received *masterCellGroup* according to 5.3.5.5;

1> if the *RRCReconfiguration* includes the *masterKeyUpdate*:

2> perform security key update procedure as specified in 5.3.5.7;

1> if the *RRCReconfiguration* includes the *secondaryCellGroup*:

2> perform the cell group configuration for the SCG according to 5.3.5.5;

1> if the *RRCReconfiguration* message contains the *radioBearerConfig*:

2> perform the radio bearer configuration according to 5.3.5.6;

1> if the *RRCReconfiguration* message includes the *measConfig*:

2> perform the measurement configuration procedure as specified in 5.5.2;

1> if the *RRCReconfiguration* message includes the *dedicatedNAS-MessageList*:

2> forward each element of the *dedicatedNAS-MessageList* to upper layers in the same order as listed;

1> if the *RRCReconfiguration* message includes the *dedicatedSIB1-Delivery*:

2> perform the action upon reception of *SIB1* as specified in 5.2.2.4.2;

1> if the *RRCReconfiguration* message includes the *dedicatedSystemInformationDelivery*:

2> perform the action upon reception of System Information as specified in 5.2.2.4;

1> if the *RRCReconfiguration* message includes the *otherConfig*:

2> perform the other configuration procedure as specified in 5.3.5.9;

1> set the content of *RRCReconfigurationComplete* message as follows:

2> if the *RRCReconfiguration* includes the *masterCellGroup* containing the *reportUplinkTxDirectCurrent*, or;

2> if the *RRCReconfiguration* includes the *secondaryCellGroup* containing the *reportUplinkTxDirectCurrent*:

3> include the *uplinkTxDirectCurrentList*;

1> if the UE is configured with E-UTRA *nr-SecondaryCellGroupConfig* (MCG is E-UTRA):

2> if *RRCReconfiguration* was received via SRB1:

3> submit the *RRCReconfigurationComplete* via the E-UTRA MCG embedded in E-UTRA RRC message *RRCConnectionReconfigurationComplete* as specified in TS 36.331 [10];

3> if *reconfigurationWithSync* was included in *spCellConfig* of an SCG:

4> initiate the random access procedure on the SpCell, as specified in TS 38.321 [3];

3> else:

4> the procedure ends;

NOTE: The order the UE sends the *RRCConnectionReconfigurationComplete* message and performs the Random Access procedure towards the SCG is left to UE implementation.

2> else (*RRCReconfiguration* was received via SRB3):

3> submit the *RRCReconfigurationComplete* message via SRB3 to lower layers for transmission using the new configuration;

NOTE: For EN-DC, in the case *RRCReconfiguration* is received via SRB1, the random access is triggered by RRC layer itself as there is not necessarily other UL transmission. In the case *RRCReconfiguration* is received via SRB3, the random access is triggered by the MAC layer due to arrival of *RRCReconfigurationComplete*.

1> else:

2> submit the *RRCReconfigurationComplete* message via SRB1 to lower layers for transmission using the new configuration;

2> if this is the first *RRCReconfiguration* message after successful completion of the RRC re-establishment procedure:

3> resume SRB2 and DRBs that are suspended;

1> if *reconfigurationWithSync* was included in *spCellConfig* of an MCG or SCG, and when MAC of an NR cell group successfully completes a random access procedure triggered above;

2> stop timer T304 for that cell group;

2> apply the parts of the CQI reporting configuration, the scheduling request configuration and the sounding RS configuration that do not require the UE to know the SFN of the respective target SpCell, if any;

2> apply the parts of the measurement and the radio resource configuration that require the UE to know the SFN of the respective target SpCell (e.g. measurement gaps, periodic CQI reporting, scheduling request configuration, sounding RS configuration), if any, upon acquiring the SFN of that target SpCell;

2> if the *reconfigurationWithSync* was included in *spCellConfig* of an MCG:

3> if T390 is running:

4> stop timer T390 for all access categories;

4> perform the actions as specified in 5.3.14.4.

3> if *RRCReconfiguration* does not include *dedicatedSIB1-Delivery* and

3> if the active downlink BWP, which is indicated by the *firstActiveDownlinkBWP-Id* for the target SpCell of the MCG, has a common search space configured by *searchSpaceSIB1*:

4> acquire the *SIB1*, which is scheduled as specified in TS 38.213 [13], of the target SpCell of the MCG;

4> upon acquiring *SIB1*, perform the actions specified in clause 5.2.2.4.2;

2> the procedure ends.

NOTE: The UE is only required to acquire broadcasted *SIB1* if the UE can acquire it without disrupting unicast data reception, i.e. the broadcast and unicast beams are quasi co-located.

5.3.5.4 Secondary cell group release

The UE shall:

1> as a result of SCG release triggered by E-UTRA:

2> reset SCG MAC, if configured;

2> for each RLC bearer that is part of the SCG configuration:

3> perform RLC bearer release procedure as specified in 5.3.5.5.3;

2> release the SCG configuration;

2> stop timer T310 for the corresponding SpCell, if running;

2> stop timer T304 for the corresponding SpCell, if running.

NOTE: Release of cell group means only release of the lower layer configuration of the cell group but the *RadioBearerConfig* may not be released.

5.3.5.5 Cell Group configuration

5.3.5.5.1 General

The network configures the UE with Master Cell Group (MCG), and zero or one Secondary Cell Group (SCG). For EN-DC, the MCG is configured as specified in TS 36.331 [10]. The network provides the configuration parameters for a cell group in the *CellGroupConfig* IE.

The UE performs the following actions based on a received *CellGroupConfig* IE:

1> if the *CellGroupConfig* contains the *spCellConfig* with *reconfigurationWithSync*:

2> perform Reconfiguration with sync according to 5.3.5.5.2;

2> resume all suspended radio bearers and resume SCG transmission for all radio bearers, if suspended;

1> if the *CellGroupConfig* contains the *rlc-BearerToReleaseList*:

2> perform RLC bearer release as specified in 5.3.5.5.3;

1> if the *CellGroupConfig* contains the *rlc-BearerToAddModList*:

2> perform the RLC bearer addition/modification as specified in 5.3.5.5.4;

1> if the *CellGroupConfig* contains the mac-*CellGroupConfig*:

2> configure the MAC entity of this cell group as specified in 5.3.5.5.5;

1> if the *CellGroupConfig* contains the *sCellToReleaseList*:

2> perform SCell release as specified in 5.3.5.5.8;

1> if the *CellGroupConfig* contains the *spCellConfig*:

2> configure the SpCell as specified in 5.3.5.5.7;

1> if the *CellGroupConfig* contains the *sCellToAddModList*:

2> perform SCell addition/modification as specified in 5.3.5.5.9.

5.3.5.5.2 Reconfiguration with sync

The UE shall perform the following actions to execute a reconfiguration with sync.

1> if the security is not activated, perform the actions upon going to RRC_IDLE as specified in 5.3.11 with the release cause '*other*' upon which the procedure ends;

1> stop timer T310 for the corresponding SpCell, if running;

1> start timer T304 for the corresponding SpCell with the timer value set to *t304*, as included in the *reconfigurationWithSync*;

1> if the *frequencyInfoDL* is included:

2> consider the target SpCell to be one on the SSB frequency indicated by the *frequencyInfoDL* with a physical cell identity indicated by the *physCellId*;

1> else:

2> consider the target SpCell to be one on the SSB frequency of the source SpCell with a physical cell identity indicated by the *physCellId*;

1> start synchronising to the DL of the target SpCell;

1> apply the specified BCCH configuration defined in 9.1.1.1;

1> acquire the *MIB*, which is scheduled as specified in TS 38.213 [13];

1> perform the actions specified in clause 5.2.2.4.1;

NOTE 1: The UE should perform the reconfiguration with sync as soon as possible following the reception of the RRC message triggering the reconfiguration with sync, which could be before confirming successful reception (HARQ and ARQ) of this message.

NOTE 2: The UE may omit reading the MIB if the UE already has the required timing information, or the timing information is not needed for random access.

1> reset the MAC entity of this cell group;

1> consider the SCell(s) of this cell group, if configured, to be in deactivated state;

1> apply the value of the *newUE-Identity* as the C-RNTI for this cell group;

Editor's Note: Verify that this does not configure some common parameters which are later discarded due to e.g. SCell release or due to LCH release.

1> configure lower layers in accordance with the received s*pCellConfigCommon*;

1> configure lower layers in accordance with any additional fields, not covered in the previous, if included in the received *reconfigurationWithSync.*

5.3.5.5.3 RLC bearer release

The UE shall:

1> for each *logicalChannelIdentity* value included in the *rlc-BearerToReleaseList* that is part of the current UE configuration (LCH release); or

1> for each *logicalChannelIdentity* value that is to be released as the result of an SCG release according to 5.3.5.4:

2> release the RLC entity or entities as specified in TS 38.322 [4], clause 5.1.3;

2> release the corresponding logical channel.

5.3.5.5.4 RLC bearer addition/modification

For each *RLC-BearerConfig* received in the *rlc-BearerToAddModList* IE the UE shall:

1> if the UE's current configuration contains a RLC bearer with the received *logicalChannelIdentity*:

2> if *reestablishRLC* is received:

3> re-establish the RLC entity as specified in TS 38.322 [4];

2> reconfigure the RLC entity or entities in accordance with the received *rlc-Config*;

2> reconfigure the logical channel in accordance with the received *mac-LogicalChannelConfig*;

NOTE: The network does not re-associate an already configured logical channel with another radio bearer. Hence *servedRadioBearer* is not present in this case.

1> else (a logical channel with the given *logicalChannelIdentity* was not configured before):

2> if the *logicalChannelIdentity* corresponds to an SRB and *rlc-Config* is not included:

3> establish an RLC entity in accordance with the default configuration defined in 9.2 for the corresponding SRB;

2> else:

3> establish an RLC entity in accordance with the received *rlc-Config*;

2> if the *logicalChannelIdentity* corresponds to an SRB and if *mac-LogicalChannelConfig* is not included:

3> configure this MAC entity with a logical channel in accordance to the default configuration defined in 9.2 for the corresponding SRB;

2> else:

3> configure this MAC entity with a logical channel in accordance to the received *mac-LogicalChannelConfig*;

2> associate this logical channel with the PDCP entity identified by *servedRadioBearer*.

5.3.5.5.5 MAC entity configuration

The UE shall:

1> if MCG MAC is not part of the current UE configuration (i.e. MCG establishment):

2> create an MCG MAC entity;

1> if SCG MAC is not part of the current UE configuration (i.e. SCG establishment):

2> create an SCG MAC entity;

1> reconfigure the MAC main configuration of the cell group in accordance with the received *mac-CellGroupConfig* other than *tag-ToReleaseList* and *tag-ToAddModList*;

1> if the received *mac-CellGroupConfig* includes the *tag-ToReleaseList*:

2> for each *TAG-Id* value included in the *tag-ToReleaseList* that is part of the current UE configuration:

3> release the TAG indicated by *TAG-Id*;

1> if the received mac-CellGroupConfig includes the *tag-ToAddModList*:

2> for each *tag-Id* value included in *tag-ToAddModList* that is not part of the current UE configuration (TAG addition):

3> add the TAG, corresponding to the *tag-Id*, in accordance with the received *timeAlignmentTimer*;

2> for each *tag-Id* value included in *tag-ToAddModList* that is part of the current UE configuration (TAG modification):

3> reconfigure the TAG, corresponding to the *tag-Id*, in accordance with the received *timeAlignmentTimer*.

5.3.5.5.6 RLF Timers & Constants configuration

The UE shall:

1> if the received *rlf-TimersAndConstants* is set to release:

2> use values for timers T301, T310, T311 and constants N310, N311, as included in *ue-TimersAndConstants* received in *SIB1*;

1> else:

2> (re-)configure the value of timers and constants in accordance with received *rlf-TimersAndConstants*.

2> stop timer T310 for this cell group, if running, and

2> reset the counters N310 and N311

5.3.5.5.7 SPCell Configuration

The UE shall:

1> if the *SpCellConfig* contains the *rlf-TimersAndConstants*:

2> configure the RLF timers and constants for this cell group as specified in 5.3.5.5.6;

1> else if *rlf-TimersAndConstants* is not configured for this cell group:

2> use values for timers T301, T310, T311 and constants N310, N311, as included in *ue-TimersAndConstants* received in *SIB1*;

1> if the *SpCellConfig* contains *spCellConfigDedicated*:

2> configure the SpCell in accordance with the *spCellConfigDedicated*;

2> consider the bandwidth part indicated in *firstActiveUplinkBWP-Id* if configured to be the active uplink bandwidth part;

2> consider the bandwidth part indicated in *firstActiveDownlinkBWP-Id* if configured to be the active downlink bandwidth part;

2> if the any of the reference signal(s) that are used for radio link monitoring are reconfigured by the received *spCellConfigDedicated*:

3> stop timer T310 for the corresponding SpCell, if running;

3> reset the counters N310 and N311.

5.3.5.5.8 SCell Release

The UE shall:

1> if the release is triggered by reception of the *sCellToReleaseList*:

2> for each *sCellIndex* value included in the *sCellToReleaseList*:

3> if the current UE configuration includes an SCell with value *sCellIndex*:

4> release the SCell.

5.3.5.5.9 SCell Addition/Modification

The UE shall:

1> for each *sCellIndex* value included in the *sCellToAddModList* that is not part of the current UE configuration (SCell addition):

2> add the SCell, corresponding to the *sCellIndex*, in accordance with the *sCellConfigCommon* and *sCellConfigDedicated*;

2> configure lower layers to consider the SCell to be in deactivated state;

Editor's Note: FFS Check automatic measurement handling for SCells.

2> for each *measId* included in the *measIdList* within *VarMeasConfig*:

3> if SCells are not applicable for the associated measurement; and

3> if the concerned SCell is included in *cellsTriggeredList* defined within the *VarMeasReportList* for this *measId*:

4> remove the concerned SCell from *cellsTriggeredList* defined within the *VarMeasReportList* for this *measId*;

1> for each *sCellIndex* value included in the *sCellToAddModList* that is part of the current UE configuration (SCell modification):

2> modify the SCell configuration in accordance with the *sCellConfigDedicated*.

5.3.5.6 Radio Bearer configuration

5.3.5.6.1 General

The UE shall perform the following actions based on a received *RadioBearerConfig* IE:

1> if the *RadioBearerConfig* includes the *srb3-ToRelease*:

2> perform the SRB release as specified in 5.3.5.6.2;

1> if the *RadioBearerConfig* includes the *srb-ToAddModList*:

2> perform the SRB addition or reconfiguration as specified in 5.3.5.6.3;

1> if the *RadioBearerConfig* includes the *drb-ToReleaseList*:

2> perform DRB release as specified in 5.3.5.6.4;

1> if the *RadioBearerConfig* includes the *drb-ToAddModList*:

2> perform DRB addition or reconfiguration as specified in 5.3.5.6.5.

1> release all SDAP entities, if any, that have no associated DRB as specified in TS 37.324 [24] clause 5.1.2, and indicate the release of the user plane resources for PDU Sessions associated with the released SDAP entities to upper layers.

5.3.5.6.2 SRB release

The UE shall:

1> release the PDCP entity and the *srb-Identity* of the SRB3.

5.3.5.6.3 SRB addition/modification

The UE shall:

1> for each *srb-Identity* value included in the *srb-ToAddModList* that is not part of the current UE configuration (SRB establishment or reconfiguration from E-UTRA PDCP to NR PDCP):

2> establish a PDCP entity;

2> if AS security has been activated:

3> if target RAT of handover is E-UTRA/5GC, or;

3> if the UE is only connected to E-UTRA/5GC:

4> configure the PDCP entity with the security algorithms and keys (K_{RRCenc} and K_{RRCint}) configured/derived as specified in TS 36.331 [10];

3> else:

4> configure the PDCP entity with the security algorithms according to *securityConfig* and apply the keys (K_{RRCenc} and K_{RRCint}) associated with the master key (K_{eNB}/ K_{gNB}) or secondary key (S-K_{gNB}) as indicated in *keyToUse*, if applicable;

2> if the current UE configuration as configured by E-UTRA in TS 36.331 [10] includes an SRB identified with the same *srb-Identity* value:

3> associate the E-UTRA RLC entity and DCCH of this SRB with the NR PDCP entity;

3> release the E-UTRA PDCP entity of this SRB;

2> if the *pdcp-Config* is included:

3> configure the PDCP entity in accordance with the received *pdcp-Config*;

2> else:

3> configure the PDCP entity in accordance with the default configuration defined in 9.2.1 for the corresponding SRB;

1> for each *srb-Identity* value included in the *srb-ToAddModList* that is part of the current UE configuration:

2> if the *reestablishPDCP* is set:

3> if target RAT of handover is E-UTRA/5GC, or;

3> if the UE is only connected to E-UTRA/5GC:

4> configure the PDCP entity to apply the integrity protection algorithm and K_{RRCint} key configured/derived as specified in TS 36.331 [10], i.e. the integrity protection configuration shall be applied to all subsequent messages received and sent by the UE, including the message used to indicate the successful completion of the procedure;

4> configure the PDCP entity to apply the ciphering algorithm and K_{RRCenc} key configured/derived as specified in TS 36.331 [10], i.e. the ciphering configuration shall be applied to all subsequent messages received and sent by the UE, including the message used to indicate the successful completion of the procedure;

3> else:

4> configure the PDCP entity to apply the integrity protection algorithm and K_{RRCint} key associated with the master key (K_{eNB}/K_{gNB}) or secondary key (S-K_{gNB}), as indicated in *keyToUse* , i.e. the integrity protection configuration shall be applied to all subsequent messages received and sent by the UE, including the message used to indicate the successful completion of the procedure;

4> configure the PDCP entity to apply the ciphering algorithm and K_{RRCenc} key associated with the master key (K_{eNB}/K_{gNB}) or secondary key (S-K_{gNB}) as indicated in *keyToUse*, i.e. the ciphering configuration shall be applied to all subsequent messages received and sent by the UE, including the message used to indicate the successful completion of the procedure;

4> re-establish the PDCP entity of this SRB as specified in TS 38.323 [5];

2> else, if the *discardOnPDCP* is set:

3> trigger the PDCP entity to perform SDU discard as specified in TS 38.323 [5];

2> if the *pdcp-Config* is included:

3> reconfigure the PDCP entity in accordance with the received *pdcp-Config*.

5.3.5.6.4 DRB release

Editor's Note: FFS / TODO: Add handling for the new QoS concept (mapping of flows; configuration of QFI-to-DRB mapping; reflective QoS...) but keep also EPS-Bearer handling for the EN-DC case

The UE shall:

1> for each *drb-Identity* value included in the *drb-ToReleaseList* that is part of the current UE configuration; or

1> for each *drb-Identity* value that is to be released as the result of full configuration according to 5.3.5.11:

2> release the PDCP entity and the *drb-Identity*;

2> if SDAP entity associated with this DRB is configured:

3> indicate the release of the DRB to SDAP entity associated with this DRB (TS 37.324 [24], clause 5.3.3);

2> if the UE is operating in EN-DC:

3> if a new bearer is not added either with NR or E-UTRA with same *eps-BearerIdentity*:

4> indicate the release of the DRB and the *eps-BearerIdentity* of the released DRB to upper layers.

NOTE 1: The UE does not consider the message as erroneous if the *drb-ToReleaseList* includes any *drb-Identity* value that is not part of the current UE configuration.

NOTE 2: Whether or not the RLC and MAC entities associated with this PDCP entity are reset or released is determined by the *CellGroupConfig*.

5.3.5.6.5 DRB addition/modification

The UE shall:

1> for each *drb-Identity* value included in the *drb-ToAddModList* that is not part of the current UE configuration (DRB establishment including the case when full configuration option is used):

2> establish a PDCP entity and configure it in accordance with the received *pdcp-Config*;

2> if the PDCP entity of this DRB is not configured with *cipheringDisabled:*

3> if target RAT of handover is E-UTRA/5GC, or;

3> if the UE is only connected to E-UTRA/5GC:

4> configure the PDCP entity with the ciphering algorithm and K_{UPenc} key configured/derived as specified in TS 36.331 [10];

3> else:

4> configure the PDCP entity with the ciphering algorithms according to *securityConfig* and apply the K_{UPenc} key associated with the master key (K_{eNB}/K_{gNB}) or the secondary key (S-K_{gNB}) as indicated in keyToUse;

2> if the PDCP entity of this DRB is configured with *integrityProtection*:

3> configure the PDCP entity with the integrity algorithms according to *securityConfig* and apply the K_{UPint} key associated with the master (K_{eNB}/K_{gNB}) or the secondary key (S-K_{gNB}) as indicated in *keyToUse*;

2> if an *sdap-Config* is included:

3> if an SDAP entity with the received *pdu-Session* does not exist:

4> establish an SDAP entity as specified in TS 37.324 [24] clause 5.1.1;

4> If an SDAP entity with the received *pdu-Session* did not exist prior to receiving this reconfiguration:

5> indicate the establishment of the user plane resources for the *pdu-Session* to upper layers;

3> configure the SDAP entity in accordance with the received *sdap-Config* as specified in TS 37.324 [24] and associate the DRB with the SDAP entity;

2> if the UE is operating in EN-DC:

3> if the DRB was configured with the same *eps-BearerIdentity* either by NR or E-UTRA prior to receiving this reconfiguration:

4> associate the established DRB with the corresponding *eps-BearerIdentity;*

3> else:

4> indicate the establishment of the DRB(s) and the *eps-BearerIdentity* of the established DRB(s) to upper layers;

1> for each *drb-Identity* value included in the *drb-ToAddModList* that is part of the current UE configuration:

2> if the *reestablishPDCP* is set:

3> if target RAT of handover is E-UTRA/5GC, or;

3> if the UE is only connected to E-UTRA/5GC:

4> if the PDCP entity of this DRB is not configured with *cipheringDisabled:*

5> configure the PDCP entity with the ciphering algorithm and K_{UPenc} key configured/derived as specified in TS 36.331 [10], clause 5.4.2.3, i.e. the ciphering configuration shall be applied to all subsequent PDCP PDUs received and sent by the UE;

3> else:

4> if the PDCP entity of this DRB is not configured with *cipheringDisabled:*

5> configure the PDCP entity with the ciphering algorithm and K_{UPenc} key associated with the master key (K_{eNB}/ K_{gNB}) or the secondary key (S-K_{gNB}), as indicated in *keyToUse*, i.e. the ciphering configuration shall be applied to all subsequent PDCP PDUs received and sent by the UE;

4> if the PDCP entity of this DRB is configured with *integrityProtection*:

5> configure the PDCP entity with the integrity algorithms according to *securityConfig* and apply the K_{UPint} key associated with the master key (K_{eNB}/K_{gNB}) or the secondary key (S-K_{gNB}) as indicated in *keyToUse*;

3> re-establish the PDCP entity of this DRB as specified in TS 38.323 [5], clause 5.1.2;

2> else, if the *recoverPDCP* is set:

3> trigger the PDCP entity of this DRB to perform data recovery as specified in TS 38.323 [5];

2> if the *pdcp-Config* is included:

3> reconfigure the PDCP entity in accordance with the received *pdcp-Config*.

2> if an *sdap-Config* is included,

3> reconfigure the SDAP entity in accordance with the received sdap-Config as specified in TS37.324 [24];

3> for each QFI value added in *mappedQoS-FlowsToAdd*, if the QFI value is previously configured, the QFI value is released from the old DRB;

NOTE 1: Void.

NOTE 2: When determining whether a drb-Identity value is part of the current UE configuration, the UE does not distinguish which *RadioBearerConfig* and *DRB-ToAddModList* that DRB was originally configured in. To re-associate a DRB with a different key (K_{eNB} to S-K_{eNB} or vice versa), the network provides the *drb-Identity* value in the (target) *drb-ToAddModList* and sets the *reestablishPDCP* flag. The network does not list the *drb-Identity* in the (source) *drb-ToReleaseList*.

NOTE 3: When setting the *reestablishPDCP* flag for a radio bearer, the network ensures that the RLC receiver entities do not deliver old PDCP PDUs to the re-established PDCP entity. It does that e.g. by triggering a reconfiguration with sync of the cell group hosting the old RLC entity or by releasing the old RLC entity.

NOTE 4: In this specification, UE configuration refers to the parameters configured by NR RRC unless otherwise stated.

NOTE 5: Ciphering and integrity protection can be enabled or disabled for a DRB. The enabling/disabling of ciphering or integrity protection can be changed only by releasing and adding the DRB.

5.3.5.7 Security key update

The UE shall:

1> if the UE is operating in EN-DC:

2> upon reception of *sk-Counter* as specified in TS 36.331 [10]:

3> update the S-K_{gNB} key based on the K_{eNB} key and using the received *sk-Counter* value, as specified in TS 33.401 [30];

3> derive K_{RRCenc} and K_{UPenc} key as specified in TS 33.401 [30];

3> derive the K_{RRCint} and K_{UPint} key as specified in TS 33.401 [30].

1> else:

2> if the *nas-Container* is included in the received *masterKeyUpdate*:

3> forward the *nas-Container* to the upper layers;

2> if the *keySetChangeIndicator* is set to TRUE:

3> derive or update the K_{gNB} key based on the K_{AMF} key, as specified in TS 33.501 [11];

2> else:

3> derive or update the K_{gNB} key based on the current K_{gNB} or the NH, using the *nextHopChainingCount* value indicated in the received *masterKeyUpdate*, as specified in TS 33.501 [11];

2> store the *nextHopChainingCount* value;

2> derive the keys associated with K_{gNB} as follows:

2> if the *securityAlgorithmConfig* is included in *SecurityConfig*:

3> derive K_{RRCenc} and K_{UPenc} key associated with the *cipheringAlgorithm* indicated in the *securityAlgorithmConfig,* as specified in TS 33.501 [11];

3> derive the K_{RRCint} and K_{UPint} key associated with the *integrityProtAlgorithm* indicated in the *securityAlgorithmConfig,* as specified in TS 33.501 [11];

2> else:

3> derive K_{RRCenc} and K_{UPenc} key associated with the current *cipheringAlgorithm,* as specified in TS 33.501 [11];

3> derive the K_{RRCint} and K_{UPint} key associated with the current *integrityProtAlgorithm,* as specified in TS 33.501 [11].

NOTE: Ciphering and integrity protection are optional to configure for the DRBs.

5.3.5.8 Reconfiguration failure

5.3.5.8.1 Void

5.3.5.8.2 Inability to comply with RRCReconfiguration

The UE shall:

1> if the UE is operating in EN-DC:

2> if the UE is unable to comply with (part of) the configuration included in the *RRCReconfiguration* message received over SRB3;

3> continue using the configuration used prior to the reception of *RRCReconfiguration* message;

3> initiate the SCG failure information procedure as specified in subclause 5.7.3 to report SCG reconfiguration error, upon which the connection reconfiguration procedure ends;

2> else, if the UE is unable to comply with (part of) the configuration included in the *RRCReconfiguration* message received over SRB1;

3> continue using the configuration used prior to the reception of *RRCReconfiguration* message;

3> initiate the connection re-establishment procedure as specified in TS 36.331 [10], clause 5.3.7, upon which the connection reconfiguration procedure ends.

1> else if *RRCReconfiguration* is received via NR:

2> if the UE is unable to comply with (part of) the configuration included in the *RRCReconfiguration* message;

3> continue using the configuration used prior to the reception of *RRCReconfiguration* message;

3> if security has not been activated:

4> perform the actions upon going to RRC_IDLE as specified in 5.3.11, with release cause 'other'

3> else if AS security has been activated but SRB2 and at least one DRB have not been setup:

4> perform the actions upon going to RRC_IDLE as specified in 5.3.11, with release cause 'RRC connection failure';

3> else:

4> initiate the connection re-establishment procedure as specified in 5.3.7, upon which the reconfiguration procedure ends;

1> else if *RRCReconfiguration* is received via other RAT (Handover to NR failure):

2> if the UE is unable to comply with any part of the configuration included in the *RRCReconfiguration* message:

3> perform the actions defined for this failure case as defined in the specifications applicable for the other RAT.

NOTE 1: The UE may apply above failure handling also in case the *RRCReconfiguration* message causes a protocol error for which the generic error handling as defined in 10 specifies that the UE shall ignore the message.

NOTE 2: If the UE is unable to comply with part of the configuration, it does not apply any part of the configuration, i.e. there is no partial success/failure.

5.3.5.8.3 T304 expiry (Reconfiguration with sync Failure)

The UE shall:

1> if T304 of the MCG expires:

2> release dedicated preambles provided in *rach-ConfigDedicated* if configured;

2> revert back to the UE configuration used in the source PCell;

2> initiate the connection re-establishment procedure as specified in subclause 5.3.7.

NOTE 1: In the context above, "the UE configuration" includes state variables and parameters of each radio bearer.

1> else if T304 of a secondary cell group expires:

2> release dedicated preambles provided in *rach-ConfigDedicated*, if configured;

2> initiate the SCG failure information procedure as specified in subclause 5.7.3 to report SCG reconfiguration with sync failure, upon which the RRC reconfiguration procedure ends;

1> else if T304 expires when *RRCReconfiguration* is received via other RAT (HO to NR failure):

2> reset MAC;

2> perform the actions defined for this failure case as defined in the specifications applicable for the other RAT.

5.3.5.9 Other configuration

The UE shall:

1> if the received *otherConfig* includes the *delayBudgetReportingConfig*:

2> if *delayBudgetReportingConfig* is set to *setup*:

3> consider itself to be configured to send delay budget reports in accordance with 5.7.4;

2> else:

3> consider itself not to be configured to send delay budget reports and stop timer T342, if running.

1> if the received *otherConfig* includes the *overheatingAssistanceConfig*:

2> if *overheatingAssistanceConfig* is set to *setup*:

3> consider itself to be configured to provide overheating assistance information in accordance with 5.7.4;

2> else:

3> consider itself not to be configured to provide overheating assistance information and stop timer T345, if running;

5.3.5.10 EN-DC release

The UE shall:

1> as a result of EN-DC release triggered by E-UTRA:

2> release SRB3 (configured according to *radioBearerConfig*), if present;

2> release *measConfig*;

2> release the SCG configuration as specified in clause 5.3.5.4.

5.3.5.11 Full configuration

The UE shall:

1> release/ clear all current dedicated radio configurations except the MCG C-RNTI and the security configurations associated with the master key;

NOTE 1: Radio configuration is not just the resource configuration but includes other configurations like *MeasConfig*. The radio configuration does not include SRB configurations and DRB configurations as configured by *radioBearerConfig*.

1> if the *spCellConfig* in the *masterCellGroup* includes the *reconfigurationWithSync* (handover):

2> release/ clear all current common radio configurations;

2> use the default values specified in 9.2.3 for timers T310, T311 and constants N310, N311;

1> else (full configuration after re-establishment or during RRC resume):

2> if *ue-TimersAndConstants* are included in the *SIB1*:

3> use values for timers T301, T310, T311 and constants N310, N311, as included in *ue-TimersAndConstants* received in *SIB1*

2> else:

3> use the default values specified in 9.2.3 for timers T310, T311 and constants N310, N311;

1> apply the default L1 parameter values as specified in corresponding physical layer specifications except for the parameters for which values are provided in *SIB1*;

1> apply the default MAC Cell Group configuration as specified in 9.2.2;

1> for each *srb-Identity* value included in the *srb-ToAddModList* (SRB reconfiguration):

2> apply the default SRB configuration defined in 9.2.1 for the corresponding SRB;

NOTE 2: This is to get the SRBs (SRB1 and SRB2 for handover and SRB2 for reconfiguration after re-establishment) to a known state from which the reconfiguration message can do further configuration.

1> for each *pdu-Session* that is part of the current UE configuration:

2> release the SDAP entity (clause 5.1.2 in TS 37.324 [24]);

2> release each DRB associated to the *pdu-Session* as specified in 5.3.5.6.4;

NOTE 3: This will retain the *pdu-Session* but remove the DRBs including *drb-identity* of these bearers from the current UE configuration and trigger the setup of the DRBs within the AS in clause 5.3.10.3 using the new configuration. The *pdu-Session* acts as the anchor for associating the released and re-setup DRB. In the AS the DRB re-setup is equivalent with a new DRB setup (including new PDCP and logical channel configurations).

1> for each *pdu-Session* that is part of the current UE configuration but not added with same *pdu-Session* in the *drb-ToAddModList*:

2> indicate the release of the user plane resources for the *pdu-Session* to upper layers;

5.3.6 Counter check

5.3.6.1 General

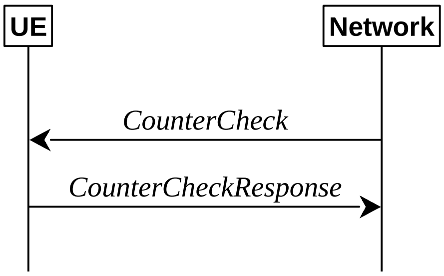

Figure 5.3.6.1-1: Counter check procedure

The counter check procedure is used by the network to request the UE to verify the amount of data sent/ received on each DRB. More specifically, the UE is requested to check if, for each DRB, the most significant bits of the COUNT match with the values indicated by the network.

NOTE: The procedure enables the network to detect packet insertion by an intruder (a 'man in the middle').

5.3.6.2 Initiation

The network initiates the procedure by sending a *CounterCheck* message.

NOTE: The network may initiate the procedure when any of the COUNT values reaches a specific value.

5.3.6.3 Reception of the *CounterCheck* message by the UE

Upon receiving the *CounterCheck* message, the UE shall:

1> for each DRB that is established:

2> if no COUNT exists for a given direction (uplink or downlink) because it is a uni-directional bearer configured only for the other direction:

3> assume the COUNT value to be 0 for the unused direction;

2> if the *drb-Identity* is not included in the *drb-CountMSB-InfoList*:

3> include the DRB in the *drb-CountInfoList* in the *CounterCheckResponse* message by including the *drb-Identity*, the *count-Uplink* and the *count-Downlink* set to the value of TX_NEXT – 1 and RX_NEXT – 1 (specified in TS 38.323 [5]), respectively;

2> else if, for at least one direction, the most significant bits of the COUNT are different from the value indicated in the *drb-CountMSB-InfoList*:

3> include the DRB in the *drb-CountInfoList* in the *CounterCheckResponse* message by including the *drb-Identity*, the *count-Uplink* and the *count-Downlink* set to the value of TX_NEXT – 1 and RX_NEXT – 1 (specified in TS 38.323 [5]), respectively;

1> for each DRB that is included in the *drb-CountMSB-InfoList* in the *CounterCheck* message that is not established:

2> include the DRB in the *drb-CountInfoList* in the *CounterCheckResponse* message by including the *drb-Identity*, the *count-Uplink* and the *count-Downlink* with the most significant bits set identical to the corresponding values in the *drb-CountMSB-InfoList* and the least significant bits set to zero;

1> submit the *CounterCheckResponse* message to lower layers for transmission upon which the procedure ends.

5.3.7 RRC connection re-establishment

5.3.7.1 General

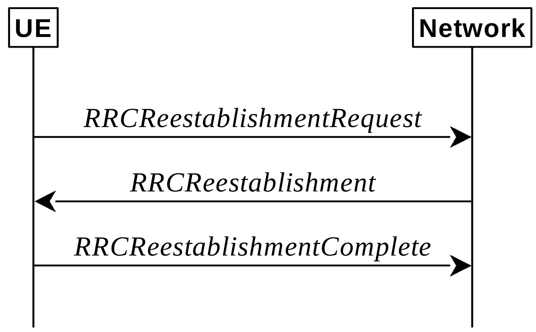

Figure 5.3.7.1-1: RRC connection re-establishment, successful

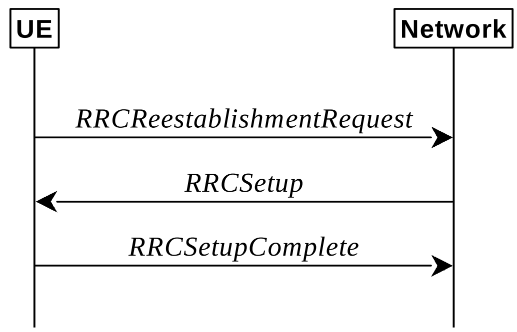

Figure 5.3.7.1-2: RRC re-establishment, fallback to RRC establishment, successful

The purpose of this procedure is to re-establish the RRC connection. A UE in RRC_CONNECTED, for which security has been activated with SRB2 and at least one DRB setup, may initiate the procedure in order to continue the RRC connection. The connection re-establishment succeeds if the network is able to find and verify a valid UE context or, if the UE context cannot be retrieved, and the network responds with an *RRCSetup* according to clause 5.3.3.4. If AS security has not been activated, the UE does not initiate the procedure but instead moves to RRC_IDLE directly, with release cause 'other'. If AS security has been activated, but SRB2 and at least one DRB are not setup, the UE does not initiate the procedure but instead moves to RRC_IDLE directly, with release cause 'RRC connection failure'.

The network applies the procedure as follows:

- When AS security has been activated and the network retrieves or verifies the UE context:
    - to re-activate AS security without changing algorithms;
    - to re-establish and resume the SRB1;
- When UE is re-establishing an RRC connection, and the network is not able to retrieve or verify the UE context:
    - to discard the stored AS Context and release all RB;
    - fallback to establish a new RRC connection.

5.3.7.2 Initiation

The UE initiates the procedure when one of the following conditions is met:

1> upon detecting radio link failure of the MCG, in accordance with 5.3.10; or

1> upon re-configuration with sync failure of the MCG, in accordance with sub-clause 5.3.5.8.3; or

1> upon mobility from NR failure, in accordance with sub-clause 5.4.3.5; or

1> upon integrity check failure indication from lower layers concerning SRB1 or SRB2, except if the integrity check failure is detected on the *RRCReestablishment* message; or

1> upon an RRC connection reconfiguration failure, in accordance with sub-clause 5.3.5.8.2.

Upon initiation of the procedure, the UE shall:

1> stop timer T310, if running;

1> stop timer T304, if running;

1> start timer T311;

1> suspend all RBs, except SRB0;

1> reset MAC;

1> release the MCG SCell(s), if configured;

1> release the current dedicated ServingCell configuration;

1> release *delayBudgetReportingConfig*, if configured, and stop timer T342, if running;

1> release *overheatingAssistanceConfig*, if configured and stop timer T345, if running;

1> perform cell selection in accordance with the cell selection process as specified in TS 38.304 [20], clause 5.2.6.

5.3.7.3 Actions following cell selection while T311 is running

Upon selecting a suitable NR cell, the UE shall:

1> ensure having valid and up to date essential system information as specified in clause 5.2.2.2;

1> stop timer T311;

1> start timer T301;

1> if T390 is running:

2> stop timer T390 for all access categories;

2> perform the actions as specified in 5.3.14.4;

1> apply the default L1 parameter values as specified in corresponding physical layer specifications except for the parameters for which values are provided in *SIB1*;

1> apply the default MAC Cell Group configuration as specified in 9.2.2;

1> apply the *timeAlignmentTimerCommon* included in *SIB1*;

1> initiate transmission of the *RRCReestablishmentRequest* message in accordance with 5.3.7.4;

NOTE: This procedure applies also if the UE returns to the source PCell.

Upon selecting an inter-RAT cell, the UE shall:

1> perform the actions upon going to RRC_IDLE as specified in 5.3.11, with release cause 'RRC connection failure'.

5.3.7.4 Actions related to transmission of *RRCReestablishmentRequest* message

The UE shall set the contents of *RRCReestablishmentRequest* message as follows:

1> set the *ue-Identity* as follows:

2> set the *c-RNTI* to the C-RNTI used in the source PCell (reconfiguration with sync or mobility from NR failure) or used in the PCell in which the trigger for the re-establishment occurred (other cases);

2> set the *physCellId* to the physical cell identity of the source PCell (reconfiguration with sync or mobility from NR failure) or of the PCell in which the trigger for the re-establishment occurred (other cases);

2> set the *shortMAC-I* to the 16 least significant bits of the MAC-I calculated:

3> over the ASN.1 encoded as per clause 8 (i.e., a multiple of 8 bits) *VarShortMAC-Input*;

3> with the K_{RRCint} key and integrity protection algorithm that was used in the source PCell (reconfiguration with sync or mobility from NR failure) or of the PCell in which the trigger for the re-establishment occurred (other cases); and

3> with all input bits for COUNT, BEARER and DIRECTION set to binary ones;

1> set the *reestablishmentCause* as follows:

2> if the re-establishment procedure was initiated due to reconfiguration failure as specified in 5.3.5.8.2:

3> set the *reestablishmentCause* to the value *reconfigurationFailure*;

2> else if the re-establishment procedure was initiated due to reconfiguration with sync failure as specified in 5.3.5.8.3 (intra-NR handover failure) or 5.4.3.5 (inter-RAT mobility from NR failure):

3> set the *reestablishmentCause* to the value *handoverFailure*;

2> else:

3> set the *reestablishmentCause* to the value *otherFailure*;

1> re-establish PDCP for SRB1;

1> re-establish RLC for SRB1;

1> apply the specified configuration defined in 9.2.1 for SRB1;

1> configure lower layers to suspend integrity protection and ciphering for SRB1;

NOTE: Ciphering is not applied for the subsequent *RRCReestablishment* message used to resume the connection. An integrity check is performed by lower layers, but merely upon request from RRC.

1> resume SRB1;

1> submit the *RRCReestablishmentRequest* message to lower layers for transmission.

5.3.7.5 Reception of the *RRCReestablishment* by the UE

The UE shall:

1> stop timer T301;

1> consider the current cell to be the PCell;

1> store the *nextHopChainingCount* value indicated in the *RRCReestablishment* message;

1> update the K_{gNB} key based on the current K_{gNB} or the NH, using the stored *nextHopChainingCount* value, as specified in TS 33.501 [11];

1> derive K_{RRCenc} and K_{UPenc} key associated with the previously configured *cipheringAlgorithm*, as specified in TS 33.501 [11];

1> derive the K_{RRCint} and K_{UPint} key associated with the previously configured *integrityProtAlgorithm*, as specified in TS 33.501 [11].

1> request lower layers to verify the integrity protection of the *RRCReestablishment* message, using the previously configured algorithm and the K_{RRCint} key;

1> if the integrity protection check of the *RRCReestablishment* message fails:

2> perform the actions upon going to RRC_IDLE as specified in 5.3.11, with release cause 'RRC connection failure', upon which the procedure ends;

1> configure lower layers to resume integrity protection for SRB1 using the previously configured algorithm and the KRRCint key immediately, i.e., integrity protection shall be applied to all subsequent messages received and sent by the UE, including the message used to indicate the successful completion of the procedure;

1> configure lower layers to resume ciphering for SRB1 using the previously configured algorithm and, the K_{RRCenc} key immediately, i.e., ciphering shall be applied to all subsequent messages received and sent by the UE, including the message used to indicate the successful completion of the procedure;

1> release the measurement gap configuration indicated by the *measGapConfig*, if configured;

1> submit the *RRCReestablishmentComplete* message to lower layers for transmission;

1> the procedure ends.

5.3.7.6 T311 expiry

Upon T311 expiry, the UE shall:

1> perform the actions upon going to RRC_IDLE as specified in 5.3.11, with release cause 'RRC connection failure'.

5.3.7.7 T301 expiry or selected cell no longer suitable

The UE shall:

1> if timer T301 expires; or

1> if the selected cell becomes no longer suitable according to the cell selection criteria as specified in TS 38.304 [20]:

2> perform the actions upon going to RRC_IDLE as specified in 5.3.11, with release cause 'RRC connection failure'.

5.3.7.8 Reception of the *RRCSetup* by the UE

The UE shall:

1> perform the RRC connection establishment procedure as specified in 5.3.3.4.

5.3.8 RRC connection release

5.3.8.1 General

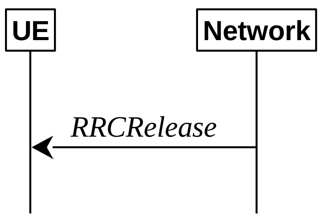

Figure 5.3.8.1-1: RRC connection release, successful

The purpose of this procedure is:

- to release the RRC connection, which includes the release of the established radio bearers as well as all radio resources; or

- to suspend the RRC connection only if SRB2 and at least one DRB is setup, which includes the suspension of the established radio bearers.

5.3.8.2 Initiation

The network initiates the RRC connection release procedure to transit a UE in RRC_CONNECTED to RRC_IDLE; or to transit a UE in RRC_CONNECTED to RRC_INACTIVE only if SRB2 and at least one DRB is setup in RRC_CONNECTED; or to transit a UE in RRC_INACTIVE back to RRC_INACTIVE when the UE tries to resume; or to transit a UE in RRC_INACTIVE to RRC_IDLE when the UE tries to resume. The procedure can also be used to release and redirect a UE to another frequency.

5.3.8.3 Reception of the *RRCRelease* by the UE

The UE shall:

1> delay the following actions defined in this sub-clause 60 ms from the moment the *RRCRelease* message was received or optionally when lower layers indicate that the receipt of the *RRCRelease* message has been successfully acknowledged, whichever is earlier;

1> stop timer T380, if running;

1> stop timer T320, if running;

1> stop timer T390, if running;

1> if the security is not activated, perform the actions upon going to RRC_IDLE as specified in 5.3.11 with the release cause 'other' upon which the procedure ends;

1> if the *RRCRelease* message includes *redirectedCarrierInfo* indicating redirection to *eutra*:

2> if *cnType* is included:

3> after the cell selection, indicate the available CN Type(s) and the received *cnType* to upper layers;

NOTE: Handling the case if the E-UTRA cell selected after the redirection does not support the core network type specified by the *cnType*, is up to UE implementation.

1> if the *RRCRelease* message includes the *cellReselectionPriorities*:

2> store the cell reselection priority information provided by the *cellReselectionPriorities*;

2> if the *t320* is included:

3> start timer T320, with the timer value set according to the value of *t320*;

1> else:

2> apply the cell reselection priority information broadcast in the system information;

1> if *deprioritisationReq* is included:

2> start or restart timer T325 with the timer value set to the *deprioritisationTimer* signalled;

2> store the *deprioritisationReq* until T325 expiry;

1> if the *RRCRelease* includes *suspendConfig*:

2> apply the received *suspendConfig*;

2> reset MAC and release the default MAC Cell Group configuration, if any;

2> re-establish RLC entities for SRB1;

2> if the *RRCRelease* message with *suspendConfig* was received in response to an *RRCResumeRequest* or an *RRCResumeRequest1*:

3> stop the timer T319 if running;

3> in the stored UE Inactive AS context:

4> replace the K_{gNB} and K_{RRCint} keys with the current K_{gNB} and K_{RRCint} keys;

4> replace the C-RNTI with the temporary C-RNTI in the cell the UE has received the *RRCRelease* message;

4> replace the *cellIdentity* with the *cellIdentity* of the cell the UE has received the *RRCRelease* message;

4> replace the physical cell identity with the physical cell identity of the cell the UE has received the *RRCRelease* message;

4> replace the *suspendConfig* with the current *suspendConfig*;

2> else:

3> store in the UE Inactive AS Context the received *suspendConfig*, all current parameters configured with *RRCReconfiguration* or *RRCResume*, the current K_{gNB} and K_{RRCint} keys, the ROHC state, the C-RNTI used in the source PCell, the *cellIdentity* and the physical cell identity of the source PCell;

2> suspend all SRB(s) and DRB(s), except SRB0;

2> indicate PDCP suspend to lower layers of all DRBs;

2> if the *t380* is included:

3> start timer T380, with the timer value set to *t380*;

2> if the *RRCRelease* message is including the *waitTime*:

3> start timer T302 with the value set to the *waitTime*;

3> inform the upper layer that access barring is applicable for all access categories except categories '0' and '2';

2> indicate the suspension of the RRC connection to upper layers;

2> enter RRC_INACTIVE and perform cell selection as specified in TS 38.304 [20];

1> else

2> perform the actions upon going to RRC_IDLE as specified in 5.3.11, with the release cause 'other'.

5.3.8.4 T320 expiry

The UE shall:

1> if T320 expires:

2> if stored, discard the cell reselection priority information provided by the *cellReselectionPriorities* or inherited from another RAT;

2> apply the cell reselection priority information broadcast in the system information.

5.3.8.5 UE actions upon the expiry of *DataInactivityTimer*

Upon receiving the expiry of *DataInactivityTimer* from lower layers while in RRC_CONNECTED, the UE shall:

1> perform the actions upon going to RRC_IDLE as specified in 5.3.11, with release cause 'RRC connection failure'.

5.3.9 RRC connection release requested by upper layers

5.3.9.1 General

The purpose of this procedure is to release the RRC connection. Access to the current PCell may be barred as a result of this procedure.

5.3.9.2 Initiation

The UE initiates the procedure when upper layers request the release of the RRC connection as specified in TS 24.501 [23]. The UE shall not initiate the procedure for power saving purposes.

The UE shall:

1> if the upper layers indicate barring of the PCell:

2> treat the PCell used prior to entering RRC_IDLE as barred according to TS 38.304 [20];

1> perform the actions upon going to RRC_IDLE as specified in 5.3.11, with release cause 'other'.

5.3.10 Radio link failure related actions

5.3.10.1 Detection of physical layer problems in RRC_CONNECTED

The UE shall:

1> upon receiving N310 consecutive "out-of-sync" indications for the SpCell from lower layers while neither T300, T301, T304, T311 nor T319 are running:

2> start timer T310 for the corresponding SpCell.

5.3.10.2 Recovery of physical layer problems

Upon receiving N311 consecutive "in-sync" indications for the SpCell from lower layers while T310 is running, the UE shall:

1> stop timer T310 for the corresponding SpCell.

NOTE 1: In this case, the UE maintains the RRC connection without explicit signalling, i.e. the UE maintains the entire radio resource configuration.

NOTE 2: Periods in time where neither "in-sync" nor "out-of-sync" is reported by layer 1 do not affect the evaluation of the number of consecutive "in-sync" or "out-of-sync" indications.

5.3.10.3 Detection of radio link failure

The UE shall:

1> upon T310 expiry in PCell; or

1> upon random access problem indication from MCG MAC while neither T300, T301, T304, T311 nor T319 are running; or

1> upon indication from MCG RLC that the maximum number of retransmissions has been reached:

2> if CA duplication is configured and activated; and for the corresponding logical channel *allowedServingCells* only includes SCell(s):

3> initiate the failure information procedure as specified in 5.7.5 to report RLC failure.

2> else:

3> consider radio link failure to be detected for the MCG i.e. RLF;

3> if AS security has not been activated:

4> perform the actions upon going to RRC_IDLE as specified in 5.3.11, with release cause 'other';

3> else if AS security has been activated but SRB2 and at least one DRB have not been setup:

4> perform the actions upon going to RRC_IDLE as specified in 5.3.11, with release cause 'RRC connection failure';

3> else:

4> initiate the connection re-establishment procedure as specified in 5.3.7.

The UE shall:

1> upon T310 expiry in PSCell; or

1> upon random access problem indication from SCG MAC; or

1> upon indication from SCG RLC that the maximum number of retransmissions has been reached:

2> if CA duplication is configured and activated; and for the corresponding logical channel *allowedServingCells* only includes SCell(s):

3> initiate the failure information procedure as specified in 5.7.5 to report RLC failure.

2> else:

3> consider radio link failure to be detected for the SCG i.e. SCG-RLF;

3> initiate the SCG failure information procedure as specified in 5.7.3 to report SCG radio link failure.

5.3.11 UE actions upon going to RRC_IDLE

UE shall:

1> reset MAC;

1> if T302 is running:

2> stop timer T302;

2> perform the actions as specified in 5.3.14.4;

1> stop all timers that are running except T320 and T325;

1> discard the UE Inactive AS context;

1> set the variable *pendingRnaUpdate* to *false*, if that is set to *true*;

1> discard the K_{gNB}, the K_{RRCenc} key, the K_{RRCint}, the K_{UPint} key and the K_{UPenc} key, if any;

1> release all radio resources, including release of the RLC entity, the MAC configuration and the associated PDCP entity and SDAP for all established RBs;

1> indicate the release of the RRC connection to upper layers together with the release cause;

1> enter RRC_IDLE and perform cell selection as specified in TS 38.304 [20], except if going to RRC_IDLE was triggered by selecting an inter-RAT cell while T311 was running;

1> if going to RRC_IDLE was triggered by reception of the *RRCRelease* message including a *waitTime*:

2> start timer T302 with the value set to the *waitTime*;

2> inform the upper layer that access barring is applicable for all access categories except categories '0' and '2'.

5.3.12 UE actions upon PUCCH/SRS release request

Upon receiving a PUCCH release request from lower layers, for all bandwidth parts of an indicated serving cell the UE shall:

1> release PUCCH-CSI-Resources configured in *CSI-ReportConfig*;

1> release *SchedulingRequestResourceConfig* instances configured in *PUCCH-Config*.

Upon receiving an SRS release request from lower layers, for all bandwidth parts of an indicated serving cell the UE shall:

1> release *SRS-Resource* instances configured in *SRS-Config*.

5.3.13 RRC connection resume

5.3.13.1 General

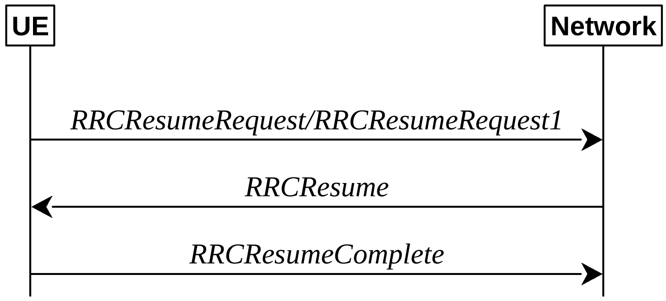

Figure 5.3.13.1-1: RRC connection resume, successful

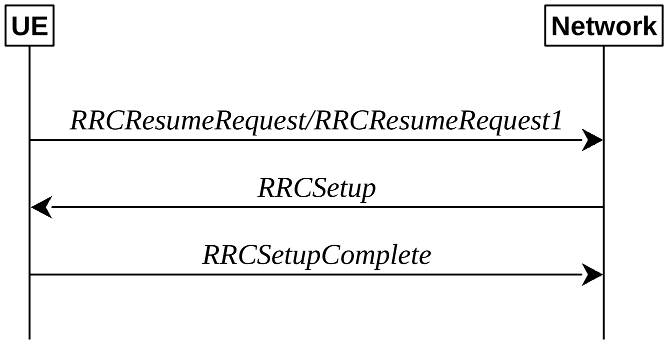

Figure 5.3.13.1-2: RRC connection resume fallback to RRC connection establishment, successful

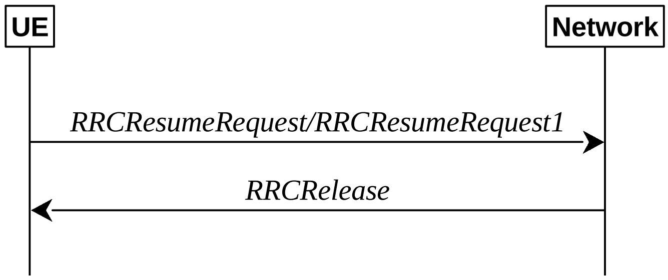

Figure 5.3.13.1-3: RRC connection resume followed by network release, successful

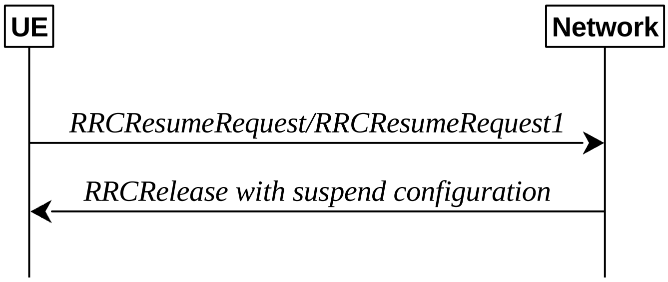

Figure 5.3.13.1-4: RRC connection resume followed by network suspend, successful

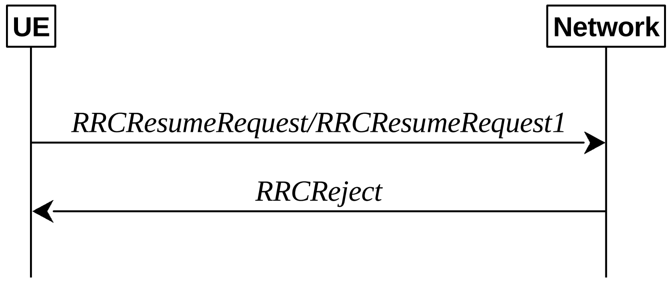

Figure 5.3.13.1-5: RRC connection resume, network reject

The purpose of this procedure is to resume a suspended RRC connection, including resuming SRB(s) and DRB(s) or perform an RNA update.

5.3.13.2 Initiation

The UE initiates the procedure when upper layers or AS (when responding to RAN paging or upon triggering RNA updates while the UE is in RRC_INACTIVE) requests the resume of a suspended RRC connection.

The UE shall ensure having valid and up to date essential system information as specified in clause 5.2.2.2 before initiating this procedure.

Upon initiation of the procedure, the UE shall:

Editor's Note: FFS Whether SCG configuration should be released or whether that should be treated as any other configuration (i.e. with delta signalling).

1> if the resumption of the RRC connection is triggered by response to NG-RAN paging:

2> select '0' as the Access Category;

2> perform the unified acccess control procedure as specified in 5.3.14 using the selected Access Category and one or more Access Identities provided by upper layers;

3> if the access attempt is barred, the procedure ends;

1> else if the upper layers provide an Access Category and one or more Access Identities upon requesting the resumption of an RRC connection:

2> perform the unified access control procedure as specified in 5.3.14 using the Access Category and Access Identities provided by upper layers;

2> set the *resumeCause* in accordance with the information received from upper layers;

3> if the access attempt is barred, the procedure ends;

1> else if the resumption of the RRC connection is triggered due to an RNA update as specified in 5.3.13.8:

2> if an emergency service is ongoing:

NOTE: How the RRC layer in the UE is aware of an ongoing emergency service is up to UE implementation.

3> select '2' as the Access Category;

2> else:

3> select '8' as the Access Category;

2> perform the unified access control procedure as specified in 5.3.14 using the selected Access Category and one or more Access Identities to be applied as specified in TS 24.501 [23];

3> if the access attempt is barred:

4> set the variable *pendingRnaUpdate* to *true*;

4> the procedure ends;

1> release the current dedicated Serving Cell configuration;

1> apply the default L1 parameter values as specified in corresponding physical layer specifications, except for the parameters for which values are provided in *SIB1*;

1> apply the default SRB1 configuration as specified in 9.2.1;

1> apply the default MAC Cell Group configuration as specified in 9.2.2;

1> release *delayBudgetReportingConfig*, if configured and stop timer T342, if running;

1> release *overheatingAssistanceConfig*, if configured and stop timer T345, if running;

1> apply the CCCH configuration as specified in 9.1.1.2;

1> apply the *timeAlignmentTimerCommon* included in *SIB1*;

1> start timer T319;

1> set the variable *pendingRnaUpdate* to *false*;

1> initiate transmission of the *RRCResumeRequest* message or *RRCResumeRequest1* in accordance with 5.3.13.3.

5.3.13.3 Actions related to transmission of *RRCResumeRequest* or *RRCResumeRequest1* message

The UE shall set the contents of *RRCResumeRequest* or *RRCResumeRequest1* message as follows:

1> if field *useFullResumeID* is signalled in *SIB1*:

2> select *RRCResumeRequest1* as the message to use;

2> set the *resumeIdentity* to the stored *fullI-RNTI* value;

1> else:

2> select *RRCResumeRequest* as the message to use;

2> set the *shortResumeIdentity* to the stored *shortI-RNTI* value;

1> restore the RRC configuration and security context from the stored UE AS context except the *cellGroupConfig*;

1> set the *resumeMAC-I* to the 16 least significant bits of the MAC-I calculated:

2> over the ASN.1 encoded as per clause 8 (i.e., a multiple of 8 bits) *VarResumeMAC-Input*;

2> with the K_{RRCint} key in the UE Inactive AS Context and the previously configured integrity protection algorithm; and

2> with all input bits for COUNT, BEARER and DIRECTION set to binary ones;

Editor's Note: FFS Additional input to *VarResumeMAC-Input* (replay attacks mitigation).

1> restore the RRC configuration and the K_{gNB} and K_{RRCint} keys from the UE Inactive AS context except the *cellGroupConfig* and *pdcp-Config*;

1> derive the K_{gNB} key based on the current K_{gNB} or the NH, using the stored *nextHopChainingCount* value, as specified in TS 33.501 [11];

1> derive the K_{RRCenc} key, the K_{RRCint} key, the K_{UPint} key and the K_{UPenc} key;

1> configure lower layers to apply integrity protection for all radio bearers except SRB0 using the configured algorithm and the K_{RRCint} key and K_{UPint} key derived in this subclause immediately, i.e., integrity protection shall be applied to all subsequent messages received and sent by the UE;

NOTE 1: Only DRBs with previously configured UP integrity protection shall resume integrity protection.

1> configure lower layers to apply ciphering for all radio bearers except SRB0 and to apply the configured ciphering algorithm, the K_{RRCenc} key and the K_{UPenc} key derived in this subclause, i.e. the ciphering configuration shall be applied to all subsequent messages received and sent by the UE;

1> re-establish PDCP entities for SRB1;

1> resume SRB1;

1> submit the selected message *RRCResumeRequest* or *RRCResumeRequest1* for transmission to lower layers.

NOTE 2: Only DRBs with previously configured UP ciphering shall resume ciphering.

If lower layers indicate an integrity check failure while T319 is running, perform actions specified in 5.3.13.5.

The UE shall continue cell re-selection related measurements as well as cell re-selection evaluation.

5.3.13.4 Reception of the *RRCResume* by the UE

The UE shall:

1> stop timer T319;

1> stop timer T380, if running;

1> if the *RRCResume* includes the *fullConfig*:

2> perform the full configuration procedure as specified in 5.3.5.11;

1> else:

2> if *drb-ContinueROHC* is included:

3> indicate to lower layers that *drb-ContinueROHC* is configured;

2> restore the *masterCellGroup* and *pdcp-Config* from the UE Inactive AS context;

1> discard the UE Inactive AS context except the *ran-NotificationAreaInfo*;

1> if the *RRCResume* includes the *masterCellGroup*:

2> perform the cell group configuration for the received *masterCellGroup* according to 5.3.5.5;

1> if the *RRCResume* includes the *radioBearerConfig*:

2> perform the radio bearer configuration according to 5.3.5.6;

1> resume SRB2 and all DRBs;

1> if stored, discard the cell reselection priority information provided by the *cellReselectionPriorities* or inherited from another RAT;

1> stop timer T320, if running;

1> if the *RRCResume* message includes the *measConfig*:

2> perform the measurement configuration procedure as specified in 5.5.2;

1> resume measurements if suspended;

1> if T390 is running:

2> stop timer T390 for all access categories;

2> perform the actions as specified in 5.3.14.4.

1> stop timer T302, if running;

1> enter RRC_CONNECTED;

1> indicate to upper layers that the suspended RRC connection has been resumed;

1> stop the cell re-selection procedure;

1> consider the current cell to be the PCell;

1> set the content of the of *RRCResumeComplete* message as follows:

2> if the upper layer provides NAS PDU, set the *dedicatedNAS-Message* to include the information received from upper layers;

2> if the upper layer provides a PLMN, set the *selectedPLMN-Identity* to PLMN selected by upper layers (TS 24.501 [23]) from the PLMN(s) included in the *plmn-IdentityList* in *SIB1;*

2> if the *masterCellGroup* contains the *reportUplinkTxDirectCurrent*:

3> include the uplinkTxDirectCurrentList;

1> submit the *RRCResumeComplete* message to lower layers for transmission;

1> the procedure ends.

5.3.13.5 T319 expiry or Integrity check failure from lower layers while T319 is running

The UE shall:

1> if timer T319 expires or upon receiving Integrity check failure indication from lower layers while T319 is running:

2> perform the actions upon going to RRC_IDLE as specified in 5.3.11 with release cause 'RRC Resume failure'.

5.3.13.6 Cell re-selection or cell selection while T390, T319 or T302 is running (UE in RRC_INACTIVE)

The UE shall:

1> if cell reselection occurs while T319 or T302 is running:

2> perform the actions upon going to RRC_IDLE as specified in 5.3.11 with release cause 'RRC Resume failure';

1> else if cell selection or reselection occurs while T390 is running:

2> stop T390 for all access categories;

2> perform the actions as specified in 5.3.14.4.

5.3.13.7 Reception of the *RRCSetup* by the UE

The UE shall:

1> perform the RRC connection setup procedure as specified in 5.3.3.4.

5.3.13.8 RNA update

In RRC_INACTIVE state, the UE shall:

1> if T380 expires; or

1> if RNA Update is triggered at reception of SIB1, as specified in 5.2.2.4.2:

2> initiate RRC connection resume procedure in 5.3.13.2 with *resumeCause* set to *rna-Update*;

1> if barring is alleviated for Access Category '8', as specified in 5.3.14.4:

2> if upper layers do not request RRC the resumption of an RRC connection, and

2> if the variable *pendingRnaUpdate* is set to *true*:

3> initiate RRC connection resume procedure in 5.3.13.2 with *resumeCause* value set to *rna-Update*.

If the UE in RRC_INACTIVE state fails to find a suitable cell and camps on the acceptable cell to obtain limited service as defined in TS 38.304 [20], the UE shall:

1> perform the actions upon going to RRC_IDLE as specified in 5.3.11 with release cause 'other'.

5.3.13.9 Reception of the *RRCRelease* by the UE

The UE shall:

1> perform the actions as specified in 5.3.8.

5.3.13.10 Reception of the *RRCReject* by the UE

The UE shall:

1> perform the actions as specified in 5.3.15.

5.3.13.11 Inability to comply with *RRCResume*

The UE shall:

1> if the UE is unable to comply with (part of) the configuration included in the *RRCResume* message;

2> perform the actions upon going to RRC_IDLE as specified in 5.3.11 with release cause ′RRC Resume failure′.

NOTE 1: The UE may apply above failure handling also in case the *RRCResume* message causes a protocol error for which the generic error handling as defined in 10 specifies that the UE shall ignore the message.

NOTE 2: If the UE is unable to comply with part of the configuration, it does not apply any part of the configuration, i.e. there is no partial success/failure.

5.3.13.12 Inter RAT cell reselection

Upon reselecting to an inter-RAT cell, the UE shall:

1> perform the actions upon going to RRC_IDLE as specified in 5.3.11, with release cause 'other'.

5.3.14 Unified Access Control

5.3.14.1 General

The purpose of this procedure is to perform access barring check for an access attempt associated with a given Access Category and one or more Access Identities upon request from upper layers according to TS 24.501 [23] or the RRC layer.

After a handover resulting in change of PCell in RRC_CONNECTED the UE shall defer access barring checks until it has obtained valid UAC information (from SIB1) from the target cell.

5.3.14.2 Initiation

Upon initiation of the procedure, the UE shall:

1> if timer T390 is running for the Access Category:

2> consider the access attempt as barred;

1> if timer T302 is running and the Access Category is neither '2' nor '0':

2> consider the access attempt as barred;

1> else:

2> if the Access Category is '0':

3> consider the access attempt as allowed;

2> else:

3> if *SIB1* includes *uac-BarringPerPLMN-List* and the *uac-BarringPerPLMN-List* contains an *UAC-BarringPerPLMN* entry with the *plmn-IdentityIndex* corresponding to the PLMN selected by upper layers (see TS 24.501 [23]):

4> select the *UAC-BarringPerPLMN* entry with the *plmn-IdentityIndex* corresponding to the PLMN selected by upper layers;

4> in the remainder of this procedure, use the selected *UAC-BarringPerPLMN* entry (i.e. presence or absence of access barring parameters in this entry) irrespective of the *uac-BarringForCommon* included in *SIB1*;

3> else if SIB1 includes *uac-BarringForCommon*:

4> in the remainder of this procedure use the *uac-BarringForCommon* (i.e. presence or absence of these parameters) included in *SIB1*;

3> else:

4> consider the access attempt as allowed;

3> if *uac-BarringForCommon* is applicable or the *uac-ACBarringListType* indicated that *uac-ExplicitACBarringList* is used:

4> if the corresponding *UAC-BarringPerCatList* contains a *UAC-BarringPerCat* entry corresponding to the Access Category:

5> select the *UAC-BarringPerCat* entry;

5> if the *uac-BarringInfoSetList* contain a *UAC-BarringInfoSet* entry corresponding to the selected *uac-barringInfoSetIndex* in the *UAC-BarringPerCat*:

6> select the *UAC-BarringInfoSet* entry;

6> perform access barring check for the Access Category as specified in 5.3.14.5, using the selected *UAC-BarringInfoSet* as "UAC barring parameter";

5> else:

6> consider the access attempt as allowed;

4> else:

5> consider the access attempt as allowed;

3> else if the *uac-ACBarringListType* indicated that *uac-ImplicitACBarringList* is indicated:

4> select the *uac-BarringInfoSetIndex* corresponding to the Access Category in the *uac-ImplicitACBarringList*;

4> if the *uac-BarringInfoSetList* contain the *UAC-BarringInfoSet* entry corresponding to the selected *uac-BarringInfoSetIndex*:

5> select the *UAC-BarringInfoSet* entry;

5> perform access barring check for the Access Category as specified in 5.3.14.5, using the selected *UAC-BarringInfoSet* as "UAC barring parameter";

4> else:

5> consider the access attempt as allowed;

3> else:

4> consider the access attempt as allowed;

1> if the access barring check was requested by upper layers:

2> if the access attempt is considered as barred:

3> if timer T302 is running:

4> inform the upper layer that access barring is applicable for all access categories except categories '0' and '2', upon which the procedure ends;

3> else:

4> inform upper layers that the access attempt for the Access Category is barred, upon which the procedure ends;

2> else:

3> inform upper layers that the access attempt for the Access Category is allowed, upon which the procedure ends;

1> else:

2> the procedure ends.

5.3.14.3 Void

5.3.14.4 T302, T390 expiry or stop (Barring alleviation)

The UE shall:

1> if timer T302 expires or is stopped, and if timer T390 corresponding to an Access Category is not running; or

1> if timer T390 corresponding to an Access Category other than '2' expires or is stopped, and if timer T302 is not running; or

1> if timer T390 corresponding to the Access Category '2' expires or is stopped:

2> consider the barring for this Access Category to be alleviated;

1> when barring for an access category is considered being alleviated:

2> if the Access Category was informed to upper layers as barred:

3> inform upper layers about barring alleviation for the Access Category.

2> if barring is alleviated for Access Category '8':

3> perform actions specified in 5.3.13.8;

5.3.14.5 Access barring check

The UE shall:

1> if one or more Access Identities are indicated according to TS 24.501 [23], and

1> if for at least one of these Access Identities the corresponding bit in the *uac-BarringForAccessIdentity* contained in "UAC barring parameter" is set to *zero*:

2> consider the access attempt as allowed;

1> else:

2> draw a random number '*rand*' uniformly distributed in the range: $0 \leq rand < 1$;

2> if '*rand*' is lower than the value indicated by *uac-BarringFactor* included in "UAC barring parameter":

3> consider the access attempt as allowed;

2> else:

3> consider the access attempt as barred;

1> if the access attempt is considered as barred:

2> draw a random number '*rand*' that is uniformly distributed in the range $0 \leq rand < 1$;

2> start timer T390 for the Access Category with the timer value calculated as follows, using the *uac-BarringTime* included in "AC barring parameter":

$$T390 = (0.7+ 0.6 * rand) * uac\text{-}BarringTime.$$

5.3.15 RRC connection reject

5.3.15.1 Initiation

The UE initiates the procedure upon the reception of *RRCReject* when the UE tries to establish or resume an RRC connection.

5.3.15.2 Reception of the *RRCReject* by the UE

The UE shall:

1> stop timer T300, if running;

1> stop timer T319, if running;

1> stop timer T302, if running;

1> reset MAC and release the default MAC Cell Group configuration;

1> if *waitTime* is configured in the *RRCReject*:

2> start timer T302, with the timer value set to the *waitTime*;

1> if *RRCReject* is received in response to a request from upper layers:

2> inform the upper layer that access barring is applicable for all access categories except categories '0' and '2';

1> if *RRCReject* is received in response to an *RRCSetupRequest*:

2> inform upper layers about the failure to setup the RRC connection, upon which the procedure ends;

1> else if *RRCReject* is received in response to an *RRCResumeRequest* or an *RRCResumeRequest1*:

2> if resume is triggered by upper layers:

3> inform upper layers about the failure to resume the RRC connection;

Editor's Note: FFS In which cases upper layers are informed that a resume failure occurred upon the reception of RRC Reject.

2> if resume is triggered due to an RNA update:

3> set the variable *pendingRnaUpdate* to *true*;

2> discard the current K_{gNB}, the K_{RRCenc} key, the K_{RRCint} key, K_{UPint} key and K_{UPenc} key derived in accordance with 5.3.13.3;

2> suspend SRB1, upon which the procedure ends;

The RRC_INACTIVE UE shall continue to monitor paging while the timer T302 is running.

5.4 Inter-RAT mobility

5.4.1 Introduction

NR support network controlled inter-RAT mobility between NR and E-UTRA which can be connected to either EPC or 5GC.

5.4.2 Handover to NR

5.4.2.1 General

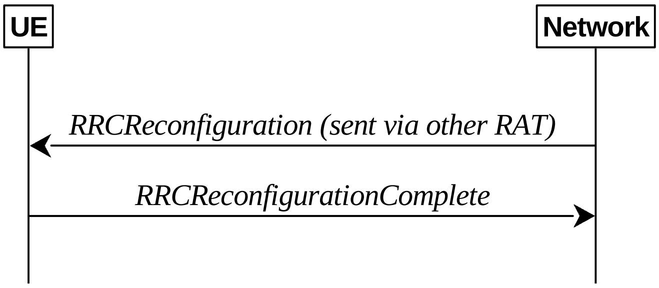

Figure 5.4.2.1-1: Handover to NR, successful

The purpose of this procedure is to, under the control of the network, transfer a connection between the UE and another Radio Access Network (e.g. E-UTRAN) to NR.

The handover to NR procedure applies when SRBs, possibly in combination with DRBs, are established in another RAT. Handover from E-UTRA to NR applies only after integrity has been activated in E-UTRA.

5.4.2.2 Initiation

The RAN using another RAT initiates the handover to NR procedure, in accordance with the specifications applicable for the other RAT, by sending the *RRCReconfiguration* message via the radio access technology from which the inter-RAT handover is performed.

The network applies the procedure as follows:

- to activate ciphering, possibly using NULL algorithm, if not yet activated in the other RAT;
- to re-establish SRBs and one or more DRBs;

5.4.2.3 Reception of the *RRCReconfiguration* by the UE

The UE shall:

1> perform RRC reconfiguration procedure as specified in 5.3.5;

NOTE: If the UE is connected to 5GC of the source E-UTRA cell, the delta configuration for PDCP and SDAP can be used for intra-system inter-RAT handover.

5.4.3 Mobility from NR

5.4.3.1 General

Figure 5.4.3.1-1: Mobility from NR, successful

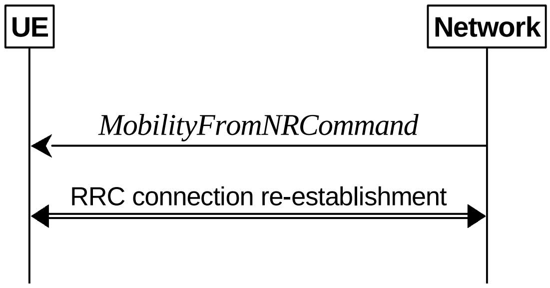

Figure 5.4.3.1-2: Mobility from NR, failure

The purpose of this procedure is to move a UE in RRC_CONNECTED to a cell using other RAT, e.g. E-UTRA. The mobility from NR procedure covers the following type of mobility:

- handover, i.e. the *MobilityFromNRCommand* message includes radio resources that have been allocated for the UE in the target cell;

5.4.3.2 Initiation

The network initiates the mobility from NR procedure to a UE in RRC_CONNECTED, possibly in response to a *MeasurementReport* message, by sending a *MobilityFromNRCommand* message. The network applies the procedure as follows:

- the procedure is initiated only when AS-security has been activated, and SRB2 with at least one DRB are setup and not suspended.

5.4.3.3 Reception of the *MobilityFromNRCommand* by the UE

The UE shall:

1> if T390 is running:

2> stop timer T390 for all access categories;

2> perform the actions as specified in 5.3.14.4;

1> if the *targetRAT-Type* is set to *eutra*:

2> consider inter-RAT mobility as initiated towards E-UTRA;

2> forward the *nas-SecurityParamFromNR* to the upper layers, if included;

1> access the target cell indicated in the inter-RAT message in accordance with the specifications of the target RAT.

5.4.3.4 Successful completion of the mobility from NR

Upon successfully completing the handover, at the source side the UE shall:

1> reset MAC;

1> stop all timers that are running;

1> release *ran-NotificationAreaInfo*, if stored;

1> release the AS security context including the K_{RRCenc} key, the K_{RRCint}, the K_{UPint} key and the K_{UPenc} key, if stored;

1> release all radio resources, including release of the RLC entity and the MAC configuration;

1> if delta configuration is used:

2> maintain source RAT configuration of PDCP and SDAP for applicable RBs which is used for target RAT RBs;

1> else:

2> release the associated PDCP entity and SDAP entity for all established RBs;

1> indicate the release of the RRC connection to upper layers together with the release cause 'other'.

5.4.3.5 Mobility from NR failure

The UE shall:

1> if the UE does not succeed in establishing the connection to the target radio access technology; or

1> if the UE is unable to comply with any part of the configuration included in the *MobilityFromNRCommand* message; or

1> if there is a protocol error in the inter RAT information included in the *MobilityFromNRCommand* message, causing the UE to fail the procedure according to the specifications applicable for the target RAT:

2> revert back to the configuration used in the source PCell;

2> initiate the connection re-establishment procedure as specified in subclause 5.3.7.

5.5 Measurements

5.5.1 Introduction

The network may configure an RRC_CONNECTED UE to perform measurements and report them in accordance with the measurement configuration. The measurement configuration is provided by means of dedicated signalling i.e. using the *RRCReconfiguration.*

The network may configure the UE to perform the following types of measurements:

- NR measurements;
- Inter-RAT measurements of E-UTRA frequencies.

The network may configure the UE to report the following measurement information based on SS/PBCH block(s):

- Measurement results per SS/PBCH block;
- Measurement results per cell based on SS/PBCH block(s);
- SS/PBCH block(s) indexes.

The network may configure the UE to report the following measurement information based on CSI-RS resources:

- Measurement results per CSI-RS resource;
- Measurement results per cell based on CSI-RS resource(s);
- CSI-RS resource measurement identifiers.

The measurement configuration includes the following parameters:

1. **Measurement objects:** A list of objects on which the UE shall perform the measurements.
   - For intra-frequency and inter-frequency measurements a measurement object indicates the frequency/time location and subcarrier spacing of reference signals to be measured. Associated with this measurement object, the network may configure a list of cell specific offsets, a list of 'blacklisted' cells and a list of 'whitelisted' cells. Blacklisted cells are not applicable in event evaluation or measurement reporting. Whitelisted cells are the only ones applicable in event evaluation or measurement reporting.
   - The *measObjectId* of the MO which corresponds to each serving cell is indicated by *servingCellMO* within the serving cell configuration.
   - For inter-RAT E-UTRA measurements a measurement object is a single E-UTRA carrier frequency. Associated with this E-UTRA carrier frequency, the network can configure a list of cell specific offsets, a list of 'blacklisted' cells and a list of 'whitelisted' cells. Blacklisted cells are not applicable in event evaluation or

measurement reporting. Whitelisted cells are the only ones applicable in event evaluation or measurement reporting.

2. **Reporting configurations:** A list of reporting configurations where there can be one or multiple reporting configurations per measurement object. Each reporting configuration consists of the following:

   - Reporting criterion: The criterion that triggers the UE to send a measurement report. This can either be periodical or a single event description.

   - RS type: The RS that the UE uses for beam and cell measurement results (SS/PBCH block or CSI-RS).

   - Reporting format: The quantities per cell and per beam that the UE includes in the measurement report (e.g. RSRP) and other associated information such as the maximum number of cells and the maximum number beams per cell to report.

3. **Measurement identities:** A list of measurement identities where each measurement identity links one measurement object with one reporting configuration. By configuring multiple measurement identities, it is possible to link more than one measurement object to the same reporting configuration, as well as to link more than one reporting configuration to the same measurement object. The measurement identity is also included in the measurement report that triggered the reporting, serving as a reference to the network.

4. **Quantity configurations:** The quantity configuration defines the measurement filtering configuration used for all event evaluation and related reporting, and for periodical reporting of that measurement. For NR measurements, the network may configure up to 2 quantity configurations with a reference in the NR measurement object to the configuration that is to be used. In each configuration, different filter coefficients can be configured for different measurement quantities, for different RS types, and for measurements per cell and per beam.

5. **Measurement gaps:** Periods that the UE may use to perform measurements.

A UE in RRC_CONNECTED maintains a measurement object list, a reporting configuration list, and a measurement identities list according to signalling and procedures in this specification. The measurement object list possibly includes NR measurement object(s) and inter-RAT objects. Similarly, the reporting configuration list includes NR and inter-RAT reporting configurations. Any measurement object can be linked to any reporting configuration of the same RAT type. Some reporting configurations may not be linked to a measurement object. Likewise, some measurement objects may not be linked to a reporting configuration.

The measurement procedures distinguish the following types of cells:

1. The NR serving cell(s) - these are the SpCell and one or more SCells.

2. Listed cells - these are cells listed within the measurement object(s).

3. Detected cells - these are cells that are not listed within the measurement object(s) but are detected by the UE on the SSB frequency(ies) and subcarrier spacing(s) indicated by the measurement object(s).

For NR measurement object(s), the UE measures and reports on the serving cell(s), listed cells and/or detected cells. For inter-RAT measurements object(s) of E-UTRA, the UE measures and reports on listed cells and detected cells.

Whenever the procedural specification, other than contained in sub-clause 5.5.2, refers to a field it concerns a field included in the *VarMeasConfig* unless explicitly stated otherwise i.e. only the measurement configuration procedure covers the direct UE action related to the received *measConfig*.

5.5.2 Measurement configuration

5.5.2.1 General

The network applies the procedure as follows:

- to ensure that, whenever the UE has a *measConfig*, it includes a *measObject* for the SpCell and for each NR SCell to be measured;

- to configure at most one measurement identity using a reporting configuration with the *reportType* set to *reportCGI;*

- to ensure that for all SSB based measurements there is at most one measurement object with the same *ssbFrequency;*
- to ensure that all measurement objects configured in this specification and in TS 36.331 [10] with the same *ssbFrequency* have the same *ssbSubcarrierSpacing*;
- to ensure that a *smtc1* included in any measurement object with the same *ssbFrequency* has the same value, and that a *smtc2* included in any measurement object with the same *ssbFrequency* has the same value;
- to ensure that, if a measurement object has the same *ssbFrequency* as a measurement object configured in TS 36.331 [10]:
  - for that *ssbFrequency*, the measurement window according to the *smtc* configured in TS 36.331 [10] includes the measurement window according to the *smtc1* configured in TS 38.331, or vice-versa, with an accuracy of the maximum receive timing difference specified in TS 38.133 [14].
  - if both measurement objects are used for RSSI measurements, bits in *measurementSlots* in both objects corresponding to the same slot are set to the same value. Also, the *endSymbol* is the same in both objects.

The UE shall:

1> if the received *measConfig* includes the *measObjectToRemoveList*:

2> perform the measurement object removal procedure as specified in 5.5.2.4;

1> if the received *measConfig* includes the *measObjectToAddModList*:

2> perform the measurement object addition/modification procedure as specified in 5.5.2.5;

1> if the received *measConfig* includes the *reportConfigToRemoveList*:

2> perform the reporting configuration removal procedure as specified in 5.5.2.6;

1> if the received *measConfig* includes the *reportConfigToAddModList*:

2> perform the reporting configuration addition/modification procedure as specified in 5.5.2.7;

1> if the received *measConfig* includes the *quantityConfig*:

2> perform the quantity configuration procedure as specified in 5.5.2.8;

1> if the received *measConfig* includes the *measIdToRemoveList*:

2> perform the measurement identity removal procedure as specified in 5.5.2.2;

1> if the received *measConfig* includes the *measIdToAddModList*:

2> perform the measurement identity addition/modification procedure as specified in 5.5.2.3;

1> if the received *measConfig* includes the *measGapConfig*:

2> perform the measurement gap configuration procedure as specified in 5.5.2.9;

1> if the received *measConfig* includes the *measGapSharingConfig*:

2> perform the measurement gap sharing configuration procedure as specified in 5.5.2.11;

1> if the received *measConfig* includes the *s-MeasureConfig*:

2> if *s-MeasureConfig* is set to *ssb-RSRP*, set parameter *ssb-RSRP* of *s-MeasureConfig* within *VarMeasConfig* to the lowest value of the RSRP ranges indicated by the received value of *s-MeasureConfig;*

2> else, set parameter *csi-RSRP* of *s-MeasureConfig* within *VarMeasConfig* to the lowest value of the RSRP ranges indicated by the received value of *s-MeasureConfig*.

5.5.2.2 Measurement identity removal

The UE shall:

1> for each *measId* included in the received *measIdToRemoveList* that is part of the current UE configuration in *VarMeasConfig*:

2> remove the entry with the matching *measId* from the *measIdList* within the *VarMeasConfig*;

2> remove the measurement reporting entry for this *measId* from the *VarMeasReportList*, if included;

2> stop the periodical reporting timer or timer T321, whichever one is running, and reset the associated information (e.g. *timeToTrigger*) for this *measId*.

NOTE: The UE does not consider the message as erroneous if the *measIdToRemoveList* includes any *measId* value that is not part of the current UE configuration.

5.5.2.3 Measurement identity addition/modification

The network applies the procedure as follows:

- configure a *measId* only if the corresponding measurement object, the corresponding reporting configuration and the corresponding quantity configuration, are configured.

The UE shall:

1> for each *measId* included in the received *measIdToAddModList*:

2> if an entry with the matching *measId* exists in the *measIdList* within the *VarMeasConfig*:

3> replace the entry with the value received for this *measId*;

2> else:

3> add a new entry for this *measId* within the *VarMeasConfig*;

2> remove the measurement reporting entry for this *measId* from the *VarMeasReportList*, if included;

2> stop the periodical reporting timer or timer T321, whichever one is running, and reset the associated information (e.g. *timeToTrigger*) for this *measId*.

2> if the *reportType* is set to *reportCGI* in the *reportConfig* associated with this *measId*;

3> if the *measObject* associated with this *measId* concerns E-UTRA:

4> start timer T321 with the timer value set to 1 second for this *measId*;

3> if the *measObject* associated with this *measId* concerns NR:

4> if the measObject associated with this measId concerns FR1:

5> start timer T321 with the timer value set to 2 seconds for this measId;

4> if the measObject associated with this measId concerns FR2:

5> start timer T321 with the timer value set to 16 seconds for this measId;

5.5.2.4 Measurement object removal

The UE shall:

1> for each measObjectId included in the received *measObjectToRemoveList* that is part of *measObjectList* in VarMeasConfig:

2> remove the entry with the matching *measObjectId* from the *measObjectList* within the *VarMeasConfig*;

2> remove all *measId* associated with this *measObjectId* from the *measIdList* within the *VarMeasConfig*, if any;

2> if a *measId* is removed from the *measIdList*:

3> remove the measurement reporting entry for this *measId* from the *VarMeasReportList*, if included;

3> stop the periodical reporting timer or timer T321, whichever is running, and reset the associated information (e.g. *timeToTrigger*) for this *measId*.

NOTE: The UE does not consider the message as erroneous if the *measObjectToRemoveList* includes any *measObjectId* value that is not part of the current UE configuration.

5.5.2.5 Measurement object addition/modification

The UE shall:

1> for each *measObjectId* included in the received *measObjectToAddModList*:

2> if an entry with the matching *measObjectId* exists in the *measObjectList* within the *VarMeasConfig*, for this entry:

3> reconfigure the entry with the value received for this *measObject*, except for the fields *cellsToAddModList*, *blackCellsToAddModList*, *whiteCellsToAddModList*, *cellsToRemoveList*, *blackCellsToRemoveList* and *whiteCellsToRemoveList*;

3> if the received *measObject* includes the *cellsToRemoveList*:

4> for each *physCellId* included in the *cellsToRemoveList*:

5> remove the entry with the matching *physCellId* from the *cellsToAddModList*;

3> if the received *measObject* includes the *cellsToAddModList*:

4> for each *physCellId* value included in the *cellsToAddModList*:

5> if an entry with the matching *physCellId* exists in the *cellsToAddModList*:

6> replace the entry with the value received for this *physCellId*;

5> else:

6> add a new entry for the received *physCellId* to the *cellsToAddModList*;

3> if the received *measObject* includes the *blackCellsToRemoveList*:

4> for each *pci-RangeIndex* included in the *blackCellsToRemoveList*:

5> remove the entry with the matching *pci-RangeIndex* from the *blackCellsToAddModList*;

NOTE: For each *pci-RangeIndex* included in the *blackCellsToRemoveList* that concerns overlapping ranges of cells, a cell is removed from the black list of cells only if all cell indexes containing it are removed.

3> if the received *measObject* includes the *blackCellsToAddModList*:

4> for each pci-RangeIndex included in the blackCellsToAddModList:

5> if an entry with the matching *pci-RangeIndex* is included in the *blackCellsToAddModList*:

6> replace the entry with the value received for this *pci-RangeIndex*;

5> else:

6> add a new entry for the received *pci-RangeIndex* to the *blackCellsToAddModList*;

3> if the received *measObject* includes the *whiteCellsToRemoveList*:

4> for each pci-RangeIndex included in the whiteCellsToRemoveList:

5> remove the entry with the matching *pci-RangeIndex* from the *whiteCellsToAddModList*;

3> if the received *measObject* includes the *whiteCellsToAddModList*:

4> for each pci-RangeIndex included in the *whiteCellsToAddModList*:

5> if an entry with the matching *pci-RangeIndex* is included in the *whiteCellsToAddModList*:

6> replace the entry with the value received for this *pci-RangeIndex*;

5> else:

6> add a new entry for the received *pci-RangeIndex* to the *whiteCellsToAddModList*;

3> for each *measId* associated with this *measObjectId* in the *measIdList* within the *VarMeasConfig*, if any:

4> remove the measurement reporting entry for this *measId* from the *VarMeasReportList*, if included;

4> stop the periodical reporting timer or timer T321, whichever one is running, and reset the associated information (e.g. *timeToTrigger*) for this *measId*;

2> else:

3> add a new entry for the received *measObject* to the *measObjectList* within *VarMeasConfig*.

5.5.2.6 Reporting configuration removal

The UE shall:

1> for each *reportConfigId* included in the received *reportConfigToRemoveList* that is part of the current UE configuration in *VarMeasConfig*:

2> remove the entry with the matching *reportConfigId* from the *reportConfigList* within the *VarMeasConfig*;

2> remove all *measId* associated with the *reportConfigId* from the *measIdList* within the *VarMeasConfig*, if any;

2> if a measId is removed from the *measIdList*:

3> remove the measurement reporting entry for this *measId* from the *VarMeasReportList*, if included;

3> stop the periodical reporting timer or timer T321, whichever one is running, and reset the associated information (e.g. *timeToTrigger*) for this *measId*.

NOTE: The UE does not consider the message as erroneous if the *reportConfigToRemoveList* includes any *reportConfigId* value that is not part of the current UE configuration.

5.5.2.7 Reporting configuration addition/modification

The UE shall:

1> for each *reportConfigId* included in the received *reportConfigToAddModList*:

2> if an entry with the matching *reportConfigId* exists in the *reportConfigList* within the *VarMeasConfig*, for this entry:

3> reconfigure the entry with the value received for this *reportConfig*;

3> for each *measId* associated with this *reportConfigId* included in the *measIdList* within the *VarMeasConfig*, if any:

4> remove the measurement reporting entry for this *measId* from the *VarMeasReportList*, if included;

4> stop the periodical reporting timer or timer T321, whichever one is running, and reset the associated information (e.g. *timeToTrigger*) for this *measId*;

2> else:

3> add a new entry for the received *reportConfig* to the *reportConfigList* within the *VarMeasConfig*.

NOTE: UE does not need to retain the *reportConfig* with the associated *cellForWhichToReportCGI* and *measId* after reporting *cgi-Info*.

5.5.2.8 Quantity configuration

The UE shall:

1> for each RAT for which the received *quantityConfig* includes parameter(s):

2> set the corresponding parameter(s) in *quantityConfig* within *VarMeasConfig* to the value of the received *quantityConfig* parameter(s);

1> for each *measId* included in the *measIdList* within *VarMeasConfig*:

2> remove the measurement reporting entry for this *measId* from the *VarMeasReportList*, if included;

2> stop the periodical reporting timer or timer T321, whichever one is running, and reset the associated information (e.g. *timeToTrigger*) for this *measId*.

5.5.2.9 Measurement gap configuration

The UE shall:

1> if *gapFR1* is set to setup:

2> if an FR1 measurement gap configuration is already setup, release the FR1 measurement gap configuration;

2> setup the FR1 measurement gap configuration indicated by the *measGapConfig* in accordance with the received *gapOffset*, i.e., the first subframe of each gap occurs at an SFN and subframe meeting the following condition:

SFN mod T = FLOOR(*gapOffset*/10);

subframe = *gapOffset* mod 10;

with T = MGRP/10 as defined in TS 38.133 [14];

2> if *mgta* is configured, apply the specified timing advance to the gap occurrences calculated above (i.e. the UE starts the measurement *mgta* ms before the gap subframe occurrences);

1> else if *gapFR1* is set to release:

2> release the FR1 measurement gap configuration;

1> if *gapFR2* is set to setup:

2> if an FR2 measurement gap configuration is already setup, release the FR2 measurement gap configuration;

2> setup the FR2 measurement gap configuration indicated by the *measGapConfig* in accordance with the received *gapOffset*, i.e., the first subframe of each gap occurs at an SFN and subframe meeting the following condition:

SFN mod T = FLOOR(*gapOffset*/10);

subframe = *gapOffset* mod 10;

with T = MGRP/10 as defined in TS 38.133 [14];

2> if *mgta* is configured, apply the specified timing advance to the gap occurrences calculated above (i.e. the UE starts the measurement *mgta* ms before the gap subframe occurrences);

1> else if *gapFR2* is set to release:

2> release the FR2 measurement gap configuration;

1> if *gapUE* is set to setup:

2> if a per UE measurement gap configuration is already setup, release the per UE measurement gap configuration;

2> setup the per UE measurement gap configuration indicated by the *measGapConfig* in accordance with the received *gapOffset*, i.e., the first subframe of each gap occurs at an SFN and subframe meeting the following condition:

SFN mod *T* = FLOOR(*gapOffset*/10);

subframe = *gapOffset* mod 10;

with *T* = MGRP/10 as defined in TS 38.133 [14];

2> if *mgta* is configured, apply the specified timing advance to the gap occurrences calculated above (i.e. the UE starts the measurement *mgta* ms before the gap subframe occurrences);

1> else if *gapUE* is set to release:

2> release the per UE measurement gap configuration.

NOTE 1: For gapFR2 configuration, the SFN and subframe of a serving cell on FR2 frequency is used in the gap calculation

NOTE 2: For *gapFR1* or *gapUE* configuration, the SFN and subframe of the PCell is used in the gap calculation.

5.5.2.10 Reference signal measurement timing configuration

The UE shall setup the first SS/PBCH block measurement timing configuration (SMTC) in accordance with the received *periodicityAndOffset* parameter (providing *Periodicity* and *Offset* value for the following condition) in the *smtc1* configuration. The first subframe of each SMTC occasion occurs at an SFN and subframe of the NR SpCell meeting the following condition:

SFN mod *T* = (FLOOR (*Offset*/10));

if the *Periodicity* is larger than sf5:

subframe = *Offset* mod 10;

else:

subframe = *Offset* or (*Offset* +5);

with *T* = CEIL(*Periodicity*/10).

If *smtc2* is present, for cells indicated in the *pci-List* parameter in *smtc2* in the same *MeasObjectNR*, the UE shall setup an additional SS/PBCH block measurement timing configuration (SMTC) in accordance with the received *periodicity* parameter in the *smtc2* configuration and use the *Offset* (derived from parameter *periodicityAndOffset*) and *duration* parameter from the *smtc1* configuration. The first subframe of each SMTC occasion occurs at an SFN and subframe of the NR SpCell meeting the above condition:

On the indicated *ssbFrequency*, the UE shall not consider SS/PBCH block transmission in subframes outside the SMTC occasion for RRM measurements based on SS/PBCH blocks and for RRM measurements based on CSI-RS.

5.5.2.11 Measurement gap sharing configuration

The UE shall:

1> if *gapSharingFR1* is set to setup:

2> if an FR1 measurement gap sharing configuration is already setup, release the measurement gap sharing configuration;

2> setup the FR1 measurement gap sharing configuration indicated by the *measGapSharingConfig* in accordance with the received *measGapSharingScheme* as defined in TS 38.133 [14];

1> else if *gapSharingFR1* is set to release:

2> release the FR1 measurement gap sharing configuration;

1> if *gapSharingFR2* is set to setup:

2> if an FR2 measurement gap sharing configuration is already setup, release the measurement gap sharing configuration;

2> setup the FR2 measurement gap sharing configuration indicated by the *measGapSharingConfig* in accordance with the received *measGapSharingScheme* as defined in TS 38.133 [14];

1> else if *gapSharingFR2* is set to release:

2> release the FR2 measurement gap sharing configuration.

1> if *gapSharingUE* is set to setup:

2> if a per UE measurement gap sharing configuration is already setup, release the per UE measurement gap sharing configuration;

2> setup the per UE measurement gap sharing configuration indicated by the *measGapSharingConfig* in accordance with the received *measGapSharingScheme* as defined in TS 38.133 [14];

1> else if *gapSharingUE* is set to release:

2> release the per UE measurement gap sharing configuration.

5.5.3 Performing measurements

5.5.3.1 General

An RRC_CONNECTED UE shall derive cell measurement results by measuring one or multiple beams associated per cell as configured by the network, as described in 5.5.3.3. For all cell measurement results in RRC_CONNECTED the UE applies the layer 3 filtering as specified in 5.5.3.2, before using the measured results for evaluation of reporting criteria and measurement reporting. For cell measurements, the network can configure RSRP, RSRQ or SINR as trigger quantity. Reporting quantities can be the same as trigger quantity or combinations of quantities (i.e. RSRP and RSRQ; RSRP and SINR; RSRQ and SINR; RSRP, RSRQ and SINR).

The network may also configure the UE to report measurement information per beam (which can either be measurement results per beam with respective beam identifier(s) or only beam identifier(s)), derived as described in 5.5.3.3a. If beam measurement information is configured to be included in measurement reports, the UE applies the layer 3 beam filtering as specified in 5.5.3.2. On the other hand, the exact layer 1 filtering of beam measurements used to derive cell measurement results is implementation dependent.

The UE shall:

1> whenever the UE has a *measConfig*, perform RSRP and RSRQ measurements for each serving cell for which *servingCellMO* is configured as follows:

2> if at least one *measId* included in the *measIdList* within *VarMeasConfig* contains an *rsType* set to *ssb*:

3> if at least one *measId* included in the *measIdList* within *VarMeasConfig* contains a *reportQuantityRS-Indexes* and *maxNrofRS-IndexesToReport* and contains an *rsType* set to *ssb*:

4> derive layer 3 filtered RSRP and RSRQ per beam for the serving cell based on SS/PBCH block, as described in 5.5.3.3a;

3> derive serving cell measurement results based on SS/PBCH block, as described in 5.5.3.3;

2> if at least one *measId* included in the *measIdList* within *VarMeasConfig* contains an *rsType* set to *csi-rs*:

3> if at least one *measId* included in the *measIdList* within *VarMeasConfig* contains a *reportQuantityRS-Indexes* and *maxNrofRS-IndexesToReport* and contains an *rsType* set to *csi-rs*:

4> derive layer 3 filtered RSRP and RSRQ per beam for the serving cell based on CSI-RS, as described in 5.5.3.3a;

3> derive serving cell measurement results based on CSI-RS, as described in 5.5.3.3;

1> if at least one *measId* included in the *measIdList* within *VarMeasConfig* contains SINR as trigger quantity and/or reporting quantity:

2> if the associated *reportConfig* contains *rsType* set to *ssb*:

3> if the *measId* contains a *reportQuantityRS-Indexes* and *maxNrofRS-IndexesToReport*:

4> derive layer 3 filtered SINR per beam for the serving cell based on SS/PBCH block, as described in 5.5.3.3a;

3> derive serving cell SINR based on SS/PBCH block, as described in 5.5.3.3;

2> if the associated *reportConfig* contains *rsType* set to *csi-rs*:

3> if the *measId* contains a *reportQuantityRS-Indexes* and *maxNrofRS-IndexesToReport*:

4> derive layer 3 filtered SINR per beam for the serving cell based on CSI-RS, as described in 5.5.3.3a;

3> derive serving cell SINR based on CSI-RS, as described in 5.5.3.3;

1> for each *measId* included in the *measIdList* within *VarMeasConfig*:

2> if the *reportType* for the associated *reportConfig* is set to *reportCGI*:

3> perform the corresponding measurements on the frequency and RAT indicated in the associated *measObject* using available idle periods;

3> if the cell indicated by *reportCGI* field for the associated *measObject* is an NR cell and that indicated cell is broadcasting *SIB1* (see TS 38.213 [13], clause 13):

4> try to acquire *SIB1* in the concerned cell;

3> if the cell indicated by *reportCGI* field is an E-UTRA cell:

4> try to acquire *SystemInformationBlockType1* in the concerned cell;

2> if the *reportType* for the associated *reportConfig* is *periodical* or *eventTriggered*:

3> if a measurement gap configuration is setup, or

3> if the UE does not require measurement gaps to perform the concerned measurements:

4> if *s-MeasureConfig* is not configured, or

4> if *s-MeasureConfig* is set to *ssb-RSRP* and the NR SpCell RSRP based on SS/PBCH block, after layer 3 filtering, is lower than *ssb-RSRP*, or

4> if *s-MeasureConfig* is set to *csi-RSRP* and the NR SpCell RSRP based on CSI-RS, after layer 3 filtering, is lower than *csi-RSRP*:

5> if the *measObject* is associated to NR and the *rsType* is set to *csi-rs*:

6> if *reportQuantityRS-Indexes* and *maxNrofRS-IndexesToReport* for the associated *reportConfig* are configured:

7> derive layer 3 filtered beam measurements only based on CSI-RS for each measurement quantity indicated in *reportQuantityRS-Indexes*, as described in 5.5.3.3a;

6> derive cell measurement results based on CSI-RS for each trigger quantity and each measurement quantity indicated in *reportQuantityCell* using parameters from the associated *measObject*, as described in 5.5.3.3;

5> if the *measObject* is associated to NR and the *rsType* is set to *ssb*:

6> if *reportQuantityRS-Indexes* and *maxNrofRS-IndexesToReport* for the associated *reportConfig* are configured:

7> derive layer 3 beam measurements only based on SS/PBCH block for each measurement quantity indicated in *reportQuantityRS-Indexes*, as described in 5.5.3.3a;

6> derive cell measurement results based on SS/PBCH block for each trigger quantity and each measurement quantity indicated in *reportQuantityCell* using parameters from the associated *measObject*, as described in 5.5.3.3;

5> if the *measObject* is associated to E-UTRA:

6> perform the corresponding measurements associated to neighbouring cells on the frequencies indicated in the concerned *measObject*;

2> perform the evaluation of reporting criteria as specified in 5.5.4.

5.5.3.2 Layer 3 filtering

The UE shall:

1> for each cell measurement quantity and for each beam measurement quantity that the UE performs measurements according to 5.5.3.1:

2> filter the measured result, before using for evaluation of reporting criteria or for measurement reporting, by the following formula:

$$F_n = (1 - a)*F_{n-1} + a*M_n$$

where

M_n is the latest received measurement result from the physical layer;

F_n is the updated filtered measurement result, that is used for evaluation of reporting criteria or for measurement reporting;

F_{n-1} is the old filtered measurement result, where F_0 is set to M_1 when the first measurement result from the physical layer is received; and$a = 1/2^{(k_i/4)}$, where k_i is the *filterCoefficient* for the corresponding measurement quantity of the i:th *QuantityConfigNR* in *quantityConfigNR-List*, and *i* is indicated by *quantityConfigIndex* in *MeasObjectNR*;

2> adapt the filter such that the time characteristics of the filter are preserved at different input rates, observing that the *filterCoefficient k* assumes a sample rate equal to X ms; The value of X is equivalent to one intra-frequency L1 measurement period as defined in TS 38.133 [14] assuming non-DRX operation, and depends on frequency range.

NOTE 1: If ***k*** is set to 0, no layer 3 filtering is applicable.

NOTE 2: The filtering is performed in the same domain as used for evaluation of reporting criteria or for measurement reporting, i.e., logarithmic filtering for logarithmic measurements.

NOTE 3: The filter input rate is implementation dependent, to fulfil the performance requirements set in TS 38.133[14]. For further details about the physical layer measurements, see TS 38.133 [14].

5.5.3.3 Derivation of cell measurement results

The network may configure the UE to derive RSRP, RSRQ and SINR measurement results per cell associated to NR measurement objects based on parameters configured in the *measObject* (e.g. maximum number of beams to be averaged and beam consolidation thresholds) and in the *reportConfig* (*rsType* to be measured, SS/PBCH block or CSI-RS).

The UE shall:

1> for each cell measurement quantity to be derived based on SS/PBCH block:

2> if *nrofSS-BlocksToAverage* in the associated *measObject* is not configured; or

2> if *absThreshSS-BlocksConsolidation* in the associated *measObject* is not configured; or

2> if the highest beam measurement quantity value is below or equal to *absThreshSS-BlocksConsolidation*:

3> derive each cell measurement quantity based on SS/PBCH block as the highest beam measurement quantity value, where each beam measurement quantity is described in TS 38.215 [9];

2> else:

3> derive each cell measurement quantity based on SS/PBCH block as the linear power scale average of the highest beam measurement quantity values above *absThreshSS-BlocksConsolidation* where the total number of averaged beams shall not exceed *nrofSS-BlocksToAverage*;

2> apply layer 3 cell filtering as described in 5.5.3.2;

1> for each cell measurement quantity to be derived based on CSI-RS:

2> consider a CSI-RS resource to be applicable for deriving cell measurements when the concerned CSI-RS resource is included in the *csi-rs-CellMobility* including the *physCellId* of the cell in the*CSI-RS-ResourceConfigMobility* in the associated *measObject*;

2> if *nrofCSI-RS-ResourcesToAverage* in the associated *measObject* is not configured; or

2> if *absThreshCSI-RS-Consolidation* in the associated *measObject* is not configured; or

2> if the highest beam measurement quantity value is below or equal to *absThreshCSI-RS-Consolidation*:

3> derive each cell measurement quantity based on applicable CSI-RS resources for the cell as the highest beam measurement quantity value, where each beam measurement quantity is described in TS 38.215 [9];

2> else:

3> derive each cell measurement quantity based on CSI-RS as the linear power scale average of the highest beam measurement quantity values above *absThreshCSI-RS-Consolidation* where the total number of averaged beams shall not exceed *nrofCSI-RS-ResourcesToAverage*;

2> apply layer 3 cell filtering as described in 5.5.3.2.

5.5.3.3a Derivation of layer 3 beam filtered measurement

The UE shall:

1> for each layer 3 beam filtered measurement quantity to be derived based on SS/PBCH block;

2> derive each configured beam measurement quantity based on SS/PBCH block as described in TS 38.215[9], and apply layer 3 beam filtering as described in 5.5.3.2;

1> for each layer 3 beam filtered measurement quantity to be derived based on CSI-RS;

2> derive each configured beam measurement quantity based on CSI-RS as described in TS 38.215 [9], and apply layer 3 beam filtering as described in 5.5.3.2.

5.5.4 Measurement report triggering

5.5.4.1 General

If security has been activated successfully, the UE shall:

1> for each *measId* included in the *measIdList* within *VarMeasConfig*:

2> if the corresponding *reportConfig* includes a *reportType* set to *eventTriggered* or *periodical*;

3> if the corresponding *measObject* concerns NR;

4> if the *eventA1* or *eventA2* is configured in the corresponding *reportConfig*:

5> consider only the serving cell to be applicable;

4> if the *eventA3* or *eventA5* is configured in the corresponding *reportConfig*:

5> if a serving cell is associated with a *measObjectNR* and neighbours are associated with another *measObjectNR*, consider any serving cell associated with the other *measObjectNR* to be a neighbouring cell as well;

4> for measurement events other than *eventA1* or *eventA2*:

5> if *useWhiteCellList* is set to TRUE:

6> consider any neighbouring cell detected based on parameters in the associated *measObjectNR* to be applicable when the concerned cell is included in the *whiteCellsToAddModList* defined within the *VarMeasConfig* for this measId;

5> else:

6> consider any neighbouring cell detected based on parameters in the associated *measObjectNR* to be applicable when the concerned cell is not included in the *blackCellsToAddModList* defined within the *VarMeasConfig* for this measId;

3> else if the corresponding *measObject* concerns E-UTRA;

4> consider any neighbouring cell detected on the associated frequency to be applicable when the concerned cell is not included in the *blackCellsToAddModListEUTRAN* defined within the *VarMeasConfig* for this *measId*;

2> else if the corresponding *reportConfig* includes a *reportType* set to *reportCGI*:

3> consider the cell detected on the associated *measObject* which has a physical cell identity matching the value of the *cellForWhichToReportCGI* included in the corresponding *reportConfig* within the *VarMeasConfig* to be applicable;

2> if the *reportType* is set to *eventTriggered* and if the entry condition applicable for this event, i.e. the event corresponding with the *eventId* of the corresponding *reportConfig* within *VarMeasConfig*, is fulfilled for one or more applicable cells for all measurements after layer 3 filtering taken during *timeToTrigger* defined for this event within the *VarMeasConfig*, while the *VarMeasReportList* does not include a measurement reporting entry for this *measId* (a first cell triggers the event):

3> include a measurement reporting entry within the *VarMeasReportList* for this *measId*;

3> set the *numberOfReportsSent* defined within the *VarMeasReportList* for this *measId* to 0;

3> include the concerned cell(s) in the *cellsTriggeredList* defined within the *VarMeasReportList* for this *measId*;

3> initiate the measurement reporting procedure, as specified in 5.5.5;

2> else if the *reportType* is set to *eventTriggered* and if the entry condition applicable for this event, i.e. the event corresponding with the *eventId* of the corresponding *reportConfig* within *VarMeasConfig*, is fulfilled for one or more applicable cells not included in the *cellsTriggeredList* for all measurements after layer 3 filtering taken during *timeToTrigger* defined for this event within the *VarMeasConfig* (a subsequent cell triggers the event):

3> set the *numberOfReportsSent* defined within the *VarMeasReportList* for this *measId* to 0;

3> include the concerned cell(s) in the *cellsTriggeredList* defined within the *VarMeasReportList* for this *measId*;

3> initiate the measurement reporting procedure, as specified in 5.5.5;

2> else if the *reportType* is set to *eventTriggered* and if the leaving condition applicable for this event is fulfilled for one or more of the cells included in the *cellsTriggeredList* defined within the *VarMeasReportList* for this *measId* for all measurements after layer 3 filtering taken during *timeToTrigger* defined within the *VarMeasConfig* for this event:

3> remove the concerned cell(s) in the *cellsTriggeredList* defined within the *VarMeasReportList* for this *measId*;

3> if *reportOnLeave* is set to *TRUE* for the corresponding reporting configuration:

4> initiate the measurement reporting procedure, as specified in 5.5.5;

3> if the *cellsTriggeredList* defined within the *VarMeasReportList* for this *measId* is empty:

4> remove the measurement reporting entry within the *VarMeasReportList* for this *measId*;

4> stop the periodical reporting timer for this *measId*, if running;

2> if *reportType* is set to *periodical* and if a (first) measurement result is available:

3> include a measurement reporting entry within the *VarMeasReportList* for this *measId*;

3> set the *numberOfReportsSent* defined within the *VarMeasReportList* for this *measId* to 0;

3> if the *reportAmount* exceeds 1:

4> initiate the measurement reporting procedure, as specified in 5.5.5, immediately after the quantity to be reported becomes available for the NR SpCell;

3> else (i.e. the *reportAmount* is equal to 1):

4> initiate the measurement reporting procedure, as specified in 5.5.5, immediately after the quantity to be reported becomes available for the NR SpCell and for the strongest cell among the applicable cells;

2> upon expiry of the periodical reporting timer for this *measId*:

3> initiate the measurement reporting procedure, as specified in 5.5.5.

2> if *reportType* is set to *reportCGI*;

3> if the UE acquired the *SIB1* or *SystemInformationBlockType1* for the requested cell; or

3> if the UE detects that the requested NR cell is not transmitting *SIB1* (see TS 38.213 [13], clause 13):

4> stop timer T321;

4> include a measurement reporting entry within the *VarMeasReportList* for this *measId*;

4> set the *numberOfReportsSent* defined within the *VarMeasReportList* for this *measId* to 0;

4> initiate the measurement reporting procedure, as specified in 5.5.5;

2> upon the expiry of T321 for this *measId*:

3> include a measurement reporting entry within the *VarMeasReportList* for this *measId*;

3> set the *numberOfReportsSent* defined within the *VarMeasReportList* for this *measId* to 0;

3> initiate the measurement reporting procedure, as specified in 5.5.5.

5.5.4.2 Event A1 (Serving becomes better than threshold)

The UE shall:

1> consider the entering condition for this event to be satisfied when condition A1-1, as specified below, is fulfilled;

1> consider the leaving condition for this event to be satisfied when condition A1-2, as specified below, is fulfilled;

1> for this measurement, consider the NR serving cell corresponding to the associated *measObjectNR* associated with this event.

Inequality A1-1 (Entering condition)

$Ms - Hys > Thresh$

Inequality A1-2 (Leaving condition)

Ms + Hys < Thresh

The variables in the formula are defined as follows:

Ms is the measurement result of the serving cell, not taking into account any offsets.

Hys is the hysteresis parameter for this event (i.e. *hysteresis* as defined within *reportConfigNR* for this event).

Thresh is the threshold parameter for this event (i.e. *a1-Threshold* as defined within *reportConfigNR* for this event).

Ms is expressed in dBm in case of RSRP, or in dB in case of RSRQ and RS-SINR.

Hys is expressed in dB.

Thresh is expressed in the same unit as ***Ms***.

5.5.4.3 Event A2 (Serving becomes worse than threshold)

The UE shall:

1> consider the entering condition for this event to be satisfied when condition A2-1, as specified below, is fulfilled;

1> consider the leaving condition for this event to be satisfied when condition A2-2, as specified below, is fulfilled;

1> for this measurement, consider the serving cell indicated by the *measObjectNR* associated to this event.

Inequality A2-1 (Entering condition)

Ms + Hys < Thresh

Inequality A2-2 (Leaving condition)

Ms – Hys > Thresh

The variables in the formula are defined as follows:

Ms is the measurement result of the serving cell, not taking into account any offsets.

Hys is the hysteresis parameter for this event (i.e. *hysteresis* as defined within *reportConfigNR* for this event).

Thresh is the threshold parameter for this event (i.e. *a2-Threshold* as defined within *reportConfigNR* for this event).

Ms is expressed in dBm in case of RSRP, or in dB in case of RSRQ and RS-SINR.

Hys is expressed in dB.

Thresh is expressed in the same unit as ***Ms***.

5.5.4.4 Event A3 (Neighbour becomes offset better than SpCell)

The UE shall:

1> consider the entering condition for this event to be satisfied when condition A3-1, as specified below, is fulfilled;

1> consider the leaving condition for this event to be satisfied when condition A3-2, as specified below, is fulfilled;

1> use the SpCell for *Mp*, *Ofp and Ocp*.

NOTE The cell(s) that triggers the event has reference signals indicated in the *measObjectNR* associated to this event which may be different from the NR SpCell *measObjectNR*.

Inequality A3-1 (Entering condition)

Mn + Ofn + Ocn – Hys > Mp + Ofp + Ocp + Off

Inequality A3-2 (Leaving condition)

Mn + Ofn + Ocn + Hys < Mp + Ofp + Ocp + Off

The variables in the formula are defined as follows:

Mn is the measurement result of the neighbouring cell, not taking into account any offsets.

Ofn is the measurement object specific offset of the reference signal of the neighbour cell (i.e. *offsetMO* as defined within *measObjectNR* corresponding to the neighbour cell).

Ocn is the cell specific offset of the neighbour cell (i.e. *cellIndividualOffset* as defined within *measObjectNR* corresponding to the frequency of the neighbour cell), and set to zero if not configured for the neighbour cell.

Mp is the measurement result of the SpCell, not taking into account any offsets.

Ofp is the measurement object specific offset of the SpCell (i.e. *offsetMO* as defined within *measObjectNR* corresponding to the SpCell).

Ocp is the cell specific offset of the SpCell (i.e. *cellIndividualOffset* as defined within *measObjectNR* corresponding to the SpCell), and is set to zero if not configured for the SpCell.

Hys is the hysteresis parameter for this event (i.e. *hysteresis* as defined within *reportConfigNR* for this event).

Off is the offset parameter for this event (i.e. *a3-Offset* as defined within *reportConfigNR* for this event).

Mn, Mp are expressed in dBm in case of RSRP, or in dB in case of RSRQ and RS-SINR.

Ofn, ***Ocn***, ***Ofp***, ***Ocp***, ***Hys***, ***Off*** are expressed in dB.

5.5.4.5 Event A4 (Neighbour becomes better than threshold)

The UE shall:

1> consider the entering condition for this event to be satisfied when condition A4-1, as specified below, is fulfilled;

1> consider the leaving condition for this event to be satisfied when condition A4-2, as specified below, is fulfilled.

Inequality A4-1 (Entering condition)

Mn + Ofn + Ocn – Hys > Thresh

Inequality A4-2 (Leaving condition)

Mn + Ofn + Ocn + Hys < Thresh

The variables in the formula are defined as follows:

Mn is the measurement result of the neighbouring cell, not taking into account any offsets.

Ofn is the measurement object specific offset of the neighbour cell (i.e. *offsetMO* as defined within *measObjectNR* corresponding to the neighbour cell).

Ocn is the measurement object specific offset of the neighbour cell (i.e. *cellIndividualOffset* as defined within *measObjectNR* corresponding to the neighbour cell), and set to zero if not configured for the neighbour cell.

Hys is the hysteresis parameter for this event (i.e. *hysteresis* as defined within *reportConfigNR* for this event).

Thresh is the threshold parameter for this event (i.e. *a4-Threshold* as defined within *reportConfigNR* for this event).

Mn is expressed in dBm in case of RSRP, or in dB in case of RSRQ and RS-SINR.

Ofn, Ocn, Hys are expressed in dB.

Thresh is expressed in the same unit as ***Mn***.

5.5.4.6 Event A5 (SpCell becomes worse than threshold1 and neighbour becomes better than threshold2)

The UE shall:

1> consider the entering condition for this event to be satisfied when both condition A5-1 and condition A5-2, as specified below, are fulfilled;

1> consider the leaving condition for this event to be satisfied when condition A5-3 or condition A5-4, i.e. at least one of the two, as specified below, is fulfilled;

1> use the SpCell for *Mp*.

NOTE: The parameters of the reference signal(s) of the cell(s) that triggers the event are indicated in the *measObjectNR* associated to the event which may be different from the *measObjectNR* of the NR SpCell.

Inequality A5-1 (Entering condition 1)

Mp + Hys < Thresh1

Inequality A5-2 (Entering condition 2)

Mn + Ofn + Ocn – Hys > Thresh2

Inequality A5-3 (Leaving condition 1)

Mp – Hys > Thresh1

Inequality A5-4 (Leaving condition 2)

Mn + Ofn + Ocn + Hys < Thresh2

The variables in the formula are defined as follows:

Mp is the measurement result of the NR SpCell, not taking into account any offsets.

Mn is the measurement result of the neighbouring cell, not taking into account any offsets.

Ofn is the measurement object specific offset of the neighbour cell (i.e. *offsetMO* as defined within *measObjectNR* corresponding to the neighbour cell).

Ocn is the cell specific offset of the neighbour cell (i.e. *cellIndividualOffset* as defined within *measObjectNR* corresponding to the neighbour cell), and set to zero if not configured for the neighbour cell.

Hys is the hysteresis parameter for this event (i.e. *hysteresis* as defined within *reportConfigNR* for this event).

Thresh1 is the threshold parameter for this event (i.e. *a5-Threshold1* as defined within *reportConfigNR* for this event).

Thresh2 is the threshold parameter for this event (i.e. *a5-Threshold2* as defined within *reportConfigNR* for this event).

Mn, Mp are expressed in dBm in case of RSRP, or in dB in case of RSRQ and RS-SINR.

Ofn, Ocn, Hys are expressed in dB.

Thresh1is expressed in the same unit as ***Mp***.

Thresh2 is expressed in the same unit as ***Mn***.

5.5.4.7 Event A6 (Neighbour becomes offset better than SCell)

The UE shall:

1> consider the entering condition for this event to be satisfied when condition A6-1, as specified below, is fulfilled;

1> consider the leaving condition for this event to be satisfied when condition A6-2, as specified below, is fulfilled;

1> for this measurement, consider the (secondary) cell corresponding to the *measObjectNR* associated to this event to be the serving cell.

NOTE: The reference signal(s) of the neighbour(s) and the reference signal(s) of the SCell are both indicated in the associated *measObjectNR*.

Inequality A6-1 (Entering condition)

Mn + Ocn – Hys > Ms + Ocs + Off

Inequality A6-2 (Leaving condition)

Mn + Ocn + Hys < Ms + Ocs + Off

The variables in the formula are defined as follows:

Mn is the measurement result of the neighbouring cell, not taking into account any offsets.

Ocn is the cell specific offset of the neighbour cell (i.e. *cellIndividualOffset* as defined within the associated *measObjectNR*), and set to zero if not configured for the neighbour cell.

Ms is the measurement result of the serving cell, not taking into account any offsets.

Ocs is the cell specific offset of the serving cell (i.e. *cellIndividualOffset* as defined within the associated *measObjectNR*), and is set to zero if not configured for the serving cell.

Hys is the hysteresis parameter for this event (i.e. *hysteresis* as defined within *reportConfigNR* for this event).

Off is the offset parameter for this event (i.e. *a6-Offset* as defined within *reportConfigNR* for this event).

Mn, Ms are expressed in dBm in case of RSRP, or in dB in case of RSRQ and RS-SINR.

Ocn, Ocs, Hys, Off are expressed in dB.

5.5.4.8 Event B1 (Inter RAT neighbour becomes better than threshold)

The UE shall:

1> consider the entering condition for this event to be satisfied when condition B1-1, as specified below, is fulfilled;

1> consider the leaving condition for this event to be satisfied when condition B1-2, as specified below, is fulfilled;

Inequality B1-1 (Entering condition)

Mn + Ofn + Ocn – Hys > Thresh

Inequality B1-2 (Leaving condition)

Mn + Ofn + Ocn + Hys < Thresh

The variables in the formula are defined as follows:

Mn is the measurement result of the inter-RAT neighbour cell, not taking into account any offsets.

Ofn is the measurement object specific offset of the frequency of the inter-RAT neighbour cell (i.e. *eutra-Q-OffsetRange* as defined within the *measObjectEUTRA* corresponding to the frequency of the neighbour inter-RAT cell).

Ocn is the cell specific offset of the inter-RAT neighbour cell (i.e. *cellIndividualOffset* as defined within the *measObjectEUTRA* corresponding to the neighbour inter-RAT cell), and set to zero if not configured for the neighbour cell.

Hys is the hysteresis parameter for this event (i.e. *hysteresis* as defined within *reportConfigInterRAT* for this event).

Thresh is the threshold parameter for this event (i.e. *b1-ThresholdEUTRA* as defined within *reportConfigInterRAT* for this event).

Mn is expressed in dBm or in dB, depending on the measurement quantity of the inter-RAT neighbour cell.

Ofn, Ocn, Hys are expressed in dB.

Thresh is expressed in the same unit as ***Mn***.

5.5.4.9 Event B2 (PCell becomes worse than threshold1 and inter RAT neighbour becomes better than threshold2)

The UE shall:

1> consider the entering condition for this event to be satisfied when both condition B2-1 and condition B2-2, as specified below, are fulfilled;

1> consider the leaving condition for this event to be satisfied when condition B2-3 or condition B2-4, i.e. at least one of the two, as specified below, is fulfilled;

Inequality B2-1 (Entering condition 1)

Mp + Hys < Thresh1

Inequality B2-2 (Entering condition 2)

Mn + Ofn + Ocn – Hys > Thresh2

Inequality B2-3 (Leaving condition 1)

Mp – Hys > Thresh1

Inequality B2-4 (Leaving condition 2)

Mn + Ofn + Ocn + Hys < Thresh2

The variables in the formula are defined as follows:

Mp is the measurement result of the PCell, not taking into account any offsets.

Mn is the measurement result of the inter-RAT neighbour cell, not taking into account any offsets.

Ofn is the measurement object specific offset of the frequency of the inter-RAT neighbour cell (i.e. *eutra-Q-OffsetRange* as defined within the *measObjectEUTRA* corresponding to the frequency of the inter-RAT neighbour cell).

Ocn is the cell specific offset of the inter-RAT neighbour cell (i.e. *cellIndividualOffset* as defined within the *measObjectEUTRA* corresponding to the neighbour inter-RAT cell), and set to zero if not configured for the neighbour cell.

Hys is the hysteresis parameter for this event (i.e. *hysteresis* as defined within *reportConfigInterRAT* for this event).

Thresh1 is the threshold parameter for this event (i.e. b2-*Threshold1* as defined within *reportConfigInterRAT* for this event).

Thresh2 is the threshold parameter for this event (i.e. *b2-Threshold2EUTRA* as defined within *reportConfigInterRAT* for this event).

Mp is expressed in dBm in case of RSRP, or in dB in case of RSRQ and SINR.

Mn is expressed in dBm or dB, depending on the measurement quantity of the inter-RAT neighbour cell.

Ofn, Ocn, Hys are expressed in dB.

Thresh1 is expressed in the same unit as ***Mp***.

Thresh2 is expressed in the same unit as ***Mn***.

5.5.5 Measurement reporting

5.5.5.1 General

Figure 5.5.5.1-1: Measurement reporting

The purpose of this procedure is to transfer measurement results from the UE to the network. The UE shall initiate this procedure only after successful security activation.

For the *measId* for which the measurement reporting procedure was triggered, the UE shall set the *measResults* within the *MeasurementReport* message as follows:

1> set the *measId* to the measurement identity that triggered the measurement reporting;

1> set the *measResultServingCell* within *measResultServingMOList* to include, for each NR serving cell that is configured with *servingCellMO*, RSRP, RSRQ and the available SINR, derived based on the *rsType* if indicated in the associated *reportConfig*, otherwise based on SSB if available, otherwise based on CSI-RS;

1> set the *servCellId* within *measResultServingMOList* to include each NR serving cell that is configured with *servingCellMO*, if any;

1> if the *reportConfig* associated with the *measId* that triggered the measurement reporting includes *reportQuantityRS-Indexes* and *maxNrofRS-IndexesToReport*:

2> for each serving cell configured with *servingCellMO*, include beam measurement information according to the associated *reportConfig* as described in 5.5.5.2;

1> if the *reportConfig* associated with the *measId* that triggered the measurement reporting includes *reportAddNeighMeas*:

2>for each serving cell *measObjectId* referenced in the *measIdList*, other than the *measObjectId* corresponding with the *measId* that triggered the measurement reporting:

3> set the *measResultBestNeighCell* within *measResultServingMOList* to include the *physCellId* and the available measurement quantities based on the *reportQuantityCell* and *rsType* indicated in *reportConfig* of the non-serving cell corresponding to the concerned *measObjectNR*with the highest measured RSRP if RSRP measurement results are available for cells corresponding to this *measObjectNR*, otherwise with the highest measured RSRQ if RSRQ measurement results are available for cells corresponding to this *measObjectNR*, otherwise with the highest measured SINR;

3> if the *reportConfig* associated with the *measId* that triggered the measurement reporting includes *reportQuantityRS-Indexes* and *maxNrofRS-IndexesToReport:*

4> for each best non-serving cell included in the measurement report:

5>include beam measurement information according to the associated *reportConfig* as described in 5.5.5.2;

1> if there is at least one applicable neighbouring cell to report:

2> if the *reportType* is set to *eventTriggered* or *periodical*:

3> set the *measResultNeighCells* to include the best neighbouring cells up to *maxReportCells* in accordance with the following:

4> if the reportType is set to eventTriggered:

5> include the cells included in the *cellsTriggeredList* as defined within the *VarMeasReportList* for this *measId*;

4> else:

5> include the applicable cells for which the new measurement results became available since the last periodical reporting or since the measurement was initiated or reset;

4> for each cell that is included in the *measResultNeighCells*, include the *physCellId*;

4> if the *reportType* is set to *eventTriggered* or *periodical*:

5> for each included cell, include the layer 3 filtered measured results in accordance with the *reportConfig* for this *measId*, ordered as follows:

6> if the *measObject* associated with this *measId* concerns NR:

7> if *rsType* in the associated *reportConfig* is set to *ssb*:

8> set *resultsSSB-Cell* within the *measResult* to include the SS/PBCH block based quantity(ies) indicated in the *reportQuantityCell* within the concerned *reportConfig*, in decreasing order of the sorting quantity, determined as specified in 5.5.5.3, i.e. the best cell is included first:

9> if *reportQuantityRS-Indexes* and *maxNrofRS-IndexesToReport* are configured, include beam measurement information as described in 5.5.5.2;

7> else if *rsType* in the associated *reportConfig* is set to *csi-rs*:

8> set *resultsCSI-RS-Cell* within the *measResult* to include the CSI-RS based quantity(ies) indicated in the *reportQuantityCell* within the concerned *reportConfig*, in decreasing order of the sorting quantity, determined as specified in 5.5.5.3, i.e. the best cell is included first:

9> if *reportQuantityRS-Indexes* and *maxNrofRS-IndexesToReport* are configured, include beam measurement information as described in 5.5.5.2;

6> if the *measObject* associated with this *measId* concerns E-UTRA:

7> set the *measResult* to include the quantity(ies) indicated in the *reportQuantity* within the concerned *reportConfigInterRAT* in decreasing order of the sorting quantity, determined as specified in 5.5.5.3, i.e. the best cell is included first;

2> else:

3> if the cell indicated by *cellForWhichToReportCGI* is an NR cell:

4> if *plmn-IdentityInfoList* of the *cgi-Info* for the concerned cell has been obtained:

5> include the plmn-IdentityInfoList including plmn-IdentityList, trackingAreaCode (if available), ranac (if available) and cellIdentity for each entry of the plmn-IdentityInfoList;

5> include frequencyBandList if available;

4> else if MIB indicates the SIB1 is not broadcast:

5> include the *noSIB1* including the *ssb-SubcarrierOffset* and *pdcch-ConfigSIB1* obtained from MIB of the concerned cell;

3> if the cell indicated by *cellForWhichToReportCGI* is an E-UTRA cell:

4> if all mandatory fields of the *cgi-Info-EPC* for the concerned cell have been obtained:

5> include in the *cgi-Info-EPC* the fields broadcasted in E-UTRA *SystemInformationBlockType1* associated to EPC;

4> if UE is E-UTRA/5GC capable and all mandatory fields of the *cgi-Info-5GC* for the concerned cell have been obtained:

5> include in the *cgi-Info-5GC* the fields broadcasted in E-UTRA *SystemInformationBlockType1* associated to 5GC;

4> include the *freqBandIndicator*;

4> if the cell broadcasts the *multiBandInfoList*, include the *multiBandInfoList*;

4> if the cell broadcasts the *freqBandIndicatorPriority*, include the *freqBandIndicatorPriority*;

1> increment the *numberOfReportsSent* as defined within the *VarMeasReportList* for this *measId* by 1;

1> stop the periodical reporting timer, if running;

1> if the *numberOfReportsSent* as defined within the *VarMeasReportList* for this *measId* is less than the *reportAmount* as defined within the corresponding *reportConfig* for this *measId*:

2> start the periodical reporting timer with the value of *reportInterval* as defined within the corresponding *reportConfig* for this *measId*;

1> else:

2> if the *reportType* is set to *periodical*:

3> remove the entry within the *VarMeasReportList* for this *measId*;

3> remove this *measId* from the *measIdList* within *VarMeasConfig*;

1> if the UE is configured with EN-DC:

2> if SRB3 is configured:

3> submit the *MeasurementReport* message via SRB3 to lower layers for transmission, upon which the procedure ends;

2> else:

3> submit the *MeasurementReport* message via the E-UTRA MCG embedded in E-UTRA RRC message *ULInformationTransferMRDC* as specified in TS 36.331 [10].

1> else:

2> submit the *MeasurementReport* message to lower layers for transmission, upon which the procedure ends.

5.5.5.2 Reporting of beam measurement information

For beam measurement information to be included in a measurement report the UE shall:

1> if *reportType* is set to *eventTriggered*:

2> consider the trigger quantity as the sorting quantity;

1> if *reportType* is set to *periodical*:

2> if a single reporting quantity is set to TRUE in *reportQuantityRS-Indexes*;

3> consider the configured single quantity as the sorting quantity;

2> else:

3> if *rsrp* is set to TRUE;

4> consider RSRP as the sorting quantity;

3> else:

4> consider RSRQ as the sorting quantity;

1> set *rsIndexResults* to include up to *maxNrofRS-IndexesToReport* SS/PBCH block indexes or CSI-RS indexes in order of decreasing sorting quantity as follows:

2> if the measurement information to be included is based on SS/PBCH block:

3> include within *resultsSSB-Indexes* the index associated to the best beam for that SS/PBCH block sorting quantity and if *absThreshSS-BlocksConsolidation* is included in the *VarMeasConfig* for the *measObject* associated to the cell for which beams are to be reported, the remaining beams whose sorting quantity is above *absThreshSS-BlocksConsolidation*;

3> if *includeBeamMeasurements* is configured, include the SS/PBCH based measurement results for the quantities in *reportQuantityRS-Indexes* set to TRUE for each SS/PBCH blockindex;

2> else if the beam measurement information to be included is based on CSI-RS:

3> include within *resultsCSI-RS-Indexes* the index associated to the best beam for that CSI-RS sorting quantity and, if *absThreshCSI-RS-Consolidation* is included in the *VarMeasConfig* for the *measObject* associated to the cell for which beams are to be reported, the remaining beams whose sorting quantity is above *absThreshCSI-RS-Consolidation*;

3> if *includeBeamMeasurements*is configured, include the CSI-RS based measurement results for the quantities in *reportQuantityRS-Indexes* set to TRUE for each CSI-RS index.

5.5.5.3 Sorting of cell measurement results

The UE shall determine the sorting quantity according to parameters of the reportConfig associated with the measId that triggered the reporting:

1> if the *reportType* is set to *eventTriggered*:

2> for an NR cell, consider the quantity used in the in the *aN-Threshold* (for *eventA1*, *eventA2* and *eventA4*) or in the *a5-Threshold2* (for *eventA5*) or in the *aN-Offset* (for *eventA3* and *eventA6*) as the sorting quantity;

2> for an E-UTRA cell, consider the quantity used in the *bN-ThresholdEUTRA* as the sorting quantity;

1> if the *reportType* is set to *periodical*:

2> determine the sorting quantity according to *reportQuantityCell* for an NR cell, and according to *reportQuantity* for an E-UTRA cell, as below:

3> if a single quantity is set to TRUE:

4> consider this quantity as the sorting quantity;

3> else:

4> if *rsrp* is set to TRUE;

5> consider RSRP as the sorting quantity;

4> else:

5> consider RSRQ as the sorting quantity.

5.5.6 Location measurement indication

5.5.6.1 General

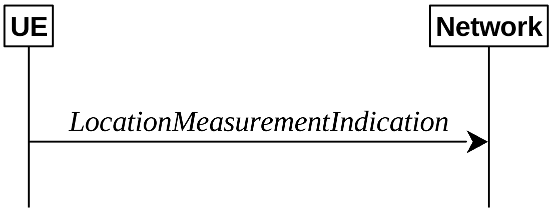

Figure 5.5.5.1-1: Location measurement indication

The purpose of this procedure is to indicate to the network that the UE is going to start/stop location related measurements which require measurement gaps.

NOTE: It is a network decision to configure the measurement gap.

5.5.6.2 Initiation

The UE shall:

1> if and only if upper layers indicate to start performing location measurements and the UE requires measurement gaps for these measurements while measurement gaps are either not configured or not sufficient:

2> initiate the procedure to indicate start;

NOTE 1: The UE verifies the measurement gap situation only upon receiving the indication from upper layers. If at this point in time sufficient gaps are available, the UE does not initiate the procedure. Unless it receives a new indication from upper layers, the UE is only allowed to further repeat the procedure in the same PCell once per frequency of the target RAT if the provided measurement gaps are insufficient.

1> if and only if upper layers indicate to stop performing location measurements:

2> initiate the procedure to indicate stop.

NOTE 2: The UE may initiate the procedure to indicate stop even if it did not previously initiate the procedure to indicate start.

5.5.6.3 Actions related to transmission of *LocationMeasurementIndication* message

The UE shall set the contents of *LocationMeasurementIndication* message as follows:

1> set the *measurementIndication* as follows:

2> if the procedure is initiated to indicate start of location related measurements:

3> set the *measurementIndication* to setup *LocationmeasurementInfo*;

3> if the procedure is initiated for RSTD measurements towards E-UTRA:

4> set the *locationMeasurementInfo*to the value *eutra-RSTD*according to the information received from upper layers;

Editor's Note: Initiation of the procedure to start measurements other than RSTD measurements towards E-UTRA is FFS.

2> else if the procedure is initiated to indicate stop of location related measurements:

3> set the *measurementIndication* to release;

1> submit the *LocationMeasurementIndication* message to lower layers for transmission, upon which the procedure ends.

5.6 UE capabilities

5.6.1 UE capability transfer

5.6.1.1 General

This clause describes how the UE compiles and transfers its UE capability information upon receiving a UECapabilityEnquiry from the network.

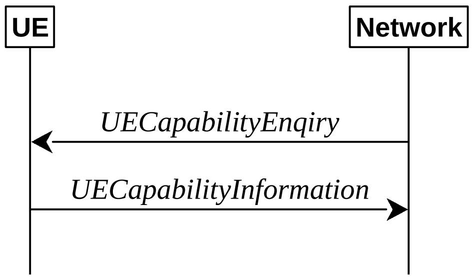

Figure 5.6.1.1-1: UE capability transfer

5.6.1.2 Initiation

The network initiates the procedure to a UE in RRC_CONNECTED when it needs (additional) UE radio access capability information.

5.6.1.3 Reception of the *UECapabilityEnquiry* by the UE

The UE shall set the contents of *UECapabilityInformation* message as follows:

1> if the *ue-CapabilityRAT-RequestList* contains a *UE-CapabilityRAT-Request* with *rat-Type* set to *nr*:

2> include in the *ue-CapabilityRAT-ContainerList* a *UE-CapabilityRAT-Container* of the type *UE-NR-Capability* and with the *rat-Type* set to *nr*;

2> include the *supportedBandCombinationList, featureSets* and *featureSetCombinations* as specified in clause 5.6.1.4;

1> if the *ue-CapabilityRAT-RequestList* contains a *UE-CapabilityRAT-Request* with *rat-Type* set to *eutra-nr*:

2> if the UE supports EN-DC:

3> include in the *ue-CapabilityRAT-ContainerList* a *UE-CapabilityRAT-Container* of the type *UE-MRDC-Capability* and with the *rat-Type* set to *eutra-nr*;

3> include the *supportedBandCombinationList* and *featureSetCombinations* as specified in clause 5.6.1.4;

1> if the *ue-CapabilityRAT-RequestList* contains a *UE-CapabilityRAT-Request* with *rat-Type* set to *eutra*:

2> if the UE supports E-UTRA:

3> include in the *ue-CapabilityRAT-ContainerList* a *ue-CapabilityRAT-Container* of the type *UE-EUTRA-Capability* and with the *rat-Type* set to *eutra* as specified in TS 36.331 [10], clause 5.6.3.3;

1> submit the *UECapabilityInformation* message to lower layers for transmission, upon which the procedure ends.

5.6.1.4 Setting band combinations, feature set combinations and feature sets supported by the UE

The UE invokes the procedures in this clause if the NR or E-UTRA network requests UE capabilities for *nr*, *eutra-nr* or *eutra*. This procedure is invoked once per requested rat-Type (see clause 5.6.1.3 for capability enquiry by the NR network; see TS 36.331 [10], clause 5.6.3.3 for capability enquiry by the E-UTRA network). The UE shall ensure that the feature set IDs and feature set combination IDs are consistent across feature sets, feature set combinations and band combinations in all three UE capability containers that the network queries with the same *FreqBandList* and with the same eutra-nr-only flag (where applicable).

NOTE: For EN-DC, the gNB needs the capabilities for RAT types *nr* and *eutra-nr* and it uses the *featureSets* in the *UE-NR-Capabilities* together with the *featureSetCombinations* in the *UE-MRDC-Capabilities* to determine the NR UE capabilities for the supported MRDC band combinations. Similarly, the eNB needs the capabilities for RAT types *eutra* and *eutra-nr* and it uses the *featureSetsEUTRA-r15* in the *UE-EUTRA-Capabilities* together with the *featureSetCombinations* in the UE-MRDC-Capabilities to determine the E-UTRA UE capabilities for the supported MRDC band combinations. Hence, the IDs used in the *featureSets* must match the IDs referred to in *featureSetCombinations* across all three containers. The requirement on consistency implies that there are no undefined feature sets and feature set combinations.

NOTE: If the UE cannot include all feature sets and feature set combinations due to message size or list size constraints, it is up to UE implementation which feature sets and feature set combinations it prioritizes.

The UE shall:

1> compile a list of "candidate band combinations" only consisting of bands included in *FreqBandList*, and prioritized in the order of *FreqBandList* (i.e. first include band combinations containing the first-listed band, then include remaining band combinations containing the second-listed band, and so on), where for each band in the band combination, the parameters of the band do not exceed *maxBandwidthRequestedDL*, *maxBandwidthRequestedUL*, *maxCarriersRequestedDL*, *maxCarriersRequestedUL*, *ca-BandwidthClassDL-EUTRA* or *ca-BandwidthClassUL-EUTRA*, whichever are received;

1> for each band combination included in the list of "candidate band combinations":

2> if the network (E-UTRA) included the *eutra-nr-only* field, or

2> if the requested *rat-Type* is *eutra*:

3> remove the NR-only band combination from the list of "candidate band combinations";

NOTE: The (E-UTRA) network may request capabilities for *nr* but indicate with the *eutra-nr-only* flag that the UE shall not include any NR band combinations in the *UE-NR-Capabilities*. In this case the procedural text above removes all NR-only band combinations from the candidate list and thereby also avoids inclusion of corresponding feature set combinations and feature sets below.

2> if it is regarded as a fallback band combination with the same capabilities of another band combination included in the list of "candidate band combinations":

3> remove the band combination from the list of "candidate band combinations";

NOTE: Even if the network requests (only) capabilities for *nr*, it may include E-UTRA band numbers in the *FreqBandList* to ensure that the UE includes all necessary feature sets needed for subsequently requested *eutra-nr* capabilities. At this point of the procedure the list of "candidate band combinations" contains all NR- and/or E-UTRA-NR band combinations that match the filter (*FreqBandList*) provided by the NW and that match the *eutra-nr-flag* (if RAT-Type *nr* is requested by E-UTRA). In the following, this candidate list is used to derive the band combinations, feature set combinations and feature sets to be reported in the requested capability container.

1> if *srs-SwitchingTimeRequest* is received:

2> include *srs-CarrierSwitch* for each band combination if SRS carrier switching is supported;

2> set *srs-SwitchingTimeRequested* to true;

1> if the requested *rat-Type* is *nr*:

2> include into *supportedBandCombinationList* as many NR-only band combinations as possible from the list of "candidate band combinations", starting from the first entry;

3> if *srs-SwitchingTimeRequest* is received:

4> if SRS carrier switching is supported;

5> include *srs-SwitchingTimesListNR* and *srs-SwitchingTimesListEUTRA* for each band combination;

4> set *srs-SwitchingTimeRequested* to *true*;

2> include, into *featureSetCombinations*, the feature set combinations referenced from the supported band combinations as included in *supportedBandCombinationList* according to the previous;

2> compile a list of "candidate feature set combinations" referenced from the list of "candidate band combinations" excluding entries (rows in feature set combinations) for fallback band combinations with same or lower capabilities;

NOTE: This list of "candidate feature set combinations" contains the feature set combinations used for NR-only as well as E-UTRA-NR band combinations. It is used to derive a list of NR feature sets referred to from the feature set combinations in the UE-NR-Capabilities and from the feature set combinations in a UE-MRDC-Capabilities container.

2> include into *featureSets* the feature sets referenced from the "candidate feature set combinations" excluding entries (feature sets per CC) for fallback band combinations with same or lower capabilities and where the parameters do not exceed *maxBandwidthRequestedDL*, *maxBandwidthRequestedUL*, *maxCarriersRequestedDL* or *maxCarriersRequestedUL*, whichever are received;

1> else, if the requested *rat-Type* is *eutra-nr*:

2> include into *supportedBandCombinationList* as many E-UTRA-NR band combinations as possible from the list of "candidate band combinations", starting from the first entry;

3> if *srs-SwitchingTimeRequest* is received:

4> if SRS carrier switching is supported;

5> include *srs-SwitchingTimesListNR* and *srs-SwitchingTimesListEUTRA* for each band combination;

4> set *srs-SwitchingTimeRequested* to true;

2> include, into *featureSetCombinations*, the feature set combinations referenced from the supported band combinations as included in *supportedBandCombinationList* according to the previous;

1> else (if the requested *rat-Type* is *eutra*):

2> compile a list of "candidate feature set combinations" referenced from the list of "candidate band combinations" excluding entries (rows in feature set combinations) for fallback band combinations with same or lower capabilities;

NOTE: This list of "candidate feature set combinations" contains the feature set combinations used for E-UTRA-NR band combinations. It is used to derive a list of E-UTRA feature sets referred to from the feature set combinations in a UE-MRDC-Capabilities container.

2> include into *featureSetsEUTRA* the feature sets referenced from the "candidate feature set combinations" excluding entries (feature sets per CC) for fallback band combinations with same or lower capabilities and where the parameters do not exceed *ca-BandwidthClassDL-EUTRA* and *ca-BandwidthClassUL-EUTRA*, whichever are received;

1> include the received *FreqBandList* in the field *appliedFreqBandListFilter* of the requested UE capability;

5.6.1.5 Void

5.7 Other

5.7.1 DL information transfer

5.7.1.1 General

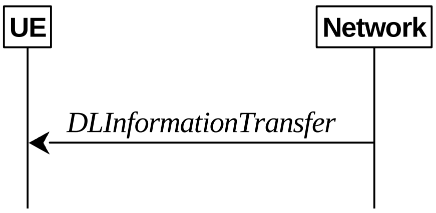

Figure 5.7.1.1-1: DL information transfer

The purpose of this procedure is to transfer NAS dedicated information from NG-RAN to a UE in RRC_CONNECTED.

5.7.1.2 Initiation

The network initiates the DL information transfer procedure whenever there is a need to transfer NAS dedicated information. The network initiates the DL information transfer procedure by sending the *DLInformationTransfer* message.

5.7.1.3 Reception of the *DLInformationTransfer* by the UE

Upon receiving *DLInformationTransfer* message, the UE shall:

1> if *dedicatedNAS-Message* is included:

2> forward *dedicatedNAS-Message* to upper layers.

5.7.2 UL information transfer

Editor's Note: It is assumed that NAS triggers the Unified Access Control specified in 5.3.x before initiating this procedure. UE performs this procedure if the access attempt is allowed according to 5.3.14.

5.7.2.1 General

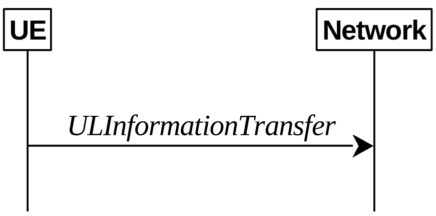

Figure 5.7.2.1-1: UL information transfer

The purpose of this procedure is to transfer NAS dedicated information from the UE to the network.

5.7.2.2 Initiation

A UE in RRC_CONNECTED initiates the UL information transfer procedure whenever there is a need to transfer NAS dedicated information. The UE initiates the UL information transfer procedure by sending the ULInformationTransfer message.

5.7.2.3 Actions related to transmission of ULInformationTransfer message

The UE shall set the contents of the *ULInformationTransfer* message as follows:

1> if the upper layer provides NAS PDU:

2> set the *dedicatedNAS-Message* to include the information received from upper layers

1> submit the *ULInformationTransfer* message to lower layers for transmission, upon which the procedure ends.

5.7.2.4 Failure to deliver *ULInformationTransfer* message

The UE shall:

1> if AS security is not started and radio link failure occurs before the successful delivery of *ULInformationTransfer* messages has been confirmed by lower layers; or

1> if mobility (i.e. handover, RRC connection re-establishment) occurs before the successful delivery of *ULInformationTransfer* messages has been confirmed by lower layers:

2> inform upper layers about the possible failure to deliver the information contained in the concerned *ULInformationTransfer* messages.

5.7.3 SCG failure information

5.7.3.1 General

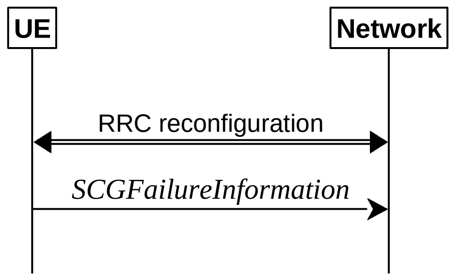

Figure 5.7.3.1-1: SCG failure information

The purpose of this procedure is to inform E-UTRAN or NR MN about an SCG failure the UE has experienced i.e. SCG radio link failure, failure of SCG reconfiguration with sync, SCG configuration failure for RRC message on SRB3, SCG integrity check failure and exceeding the maximum uplink transmission timing difference.

Editor's Note: SCG failure considers the case of exceeding the maximum uplink transmission timing difference if RAN1 decides that EN-DC supports the synchronised operation case. FFS how to capture

Editor's Note: FFS whether to include the handling of SCell Failure in CA duplication case in *SCGfailureinformation* procedure and whether to rename *SCGfailureinformation*.

5.7.3.2 Initiation

A UE initiates the procedure to report SCG failures when SCG transmission is not suspended and when one of the following conditions is met:

1> upon detecting radio link failure for the SCG, in accordance with subclause 5.3.10.3;

1> upon reconfiguration with sync failure of the SCG, in accordance with subclause 5.3.5.8.3;

1> upon SCG configuration failure, in accordance with subclause 5.3.5.8.2;

1> upon integrity check failure indication from SCG lower layers concerning SRB3.

Upon initiating the procedure, the UE shall:

1> suspend SCG transmission for all SRBs and DRBs;

1> reset SCG-MAC;

1> stop T304, if running;

1> if the UE is operating in EN-DC:

2> initiate transmission of the *SCGFailureInformationNR* message as specified in TS 36.331 [10], clause 5.6.13a.

Editor's Note: The section for transmission of SCGFailureInformation in NR RRC entity for SA is FFS_Standalone.

5.7.3.3 Failure type determination

Editor's Note: FFS / TODO: Either use this section also for NR-DC or change section title (add "for EN-DC").

The UE shall set the SCG failure type as follows:

1> if the UE initiates transmission of the *SCGFailureInformationNR* message due to T310 expiry:

2> set the *failureType* as t310-Expiry;

1> else if the UE initiates transmission of the *SCGFailureInformationNR* message to provide reconfiguration with sync failure information for an SCG:

2> set the failureType as *synchReconfigFailure-SCG*;

1> else if the UE initiates transmission of the *SCGFailureInformationNR* message to provide random access problem indication from SCG MAC:

2> set the failureType as randomAccessProblem;

1> else if the UE initiates transmission of the *SCGFailureInformationNR* message to provide indication from SCG RLC that the maximum number of retransmissions has been reached:

2> set the failureType as rlc-MaxNumRetx;

1> else if the UE initiates transmission of the *SCGFailureInformationNR* message due to SRB3 IP check failure:

2> set the failureType as srb3-IntegrityFailure;

1> else if the UE initiates transmission of the *SCGFailureInformationNR* message due to Reconfiguration failure of NR RRC reconfiguration message:

2> set the failureType as scg-reconfigFailure.

Editor's Note: FFS: whether to include *rrc-TransactionIdentifier* information.

5.7.3.4 Setting the contents of *MeasResultSCG-Failure*

The UE shall set the contents of the *MeasResultSCG-Failure*as follows:

1> for each *MeasOjectNR* for which a *measId* is configured and measurement results are available;

2> include an entry in *measResultsPerMOList*;

2> if there is a *measId* configured with the *MeasObjectNR* and a *reportConfig* which has *rsType* set to *ssb*:

3> set *ssbFrequency* to the value indicated by *ssbFrequency* as included in the *MeasObjectNR*;

2> if there is a *measId* configured with the *MeasObjectNR* and a *reportConfig* which has *rsType* set to *csi-rs*:

3> set *refFreqCSI-RS* to the value indicated by *refFreqCSI-RS* as included in the associated measurement object;

2> if a serving cell is associated with the *MeasObjectNR*:

3> set *measResultServingCell* to include the available quantities of the concerned cell and in accordance with the performance requirements in [FFS_Ref];

2> set the *measResultNeighCellList* to include the best measured cells, ordered such that the best cell is listed first, and based on measurements collected up to the moment the UE detected the failure, and set its fields as follows;

3> ordering the cells with sorting as follows:

4> based on SS/PBCH block if SS/PBCH block measurement results are available and otherwise based on CSI-RS,

4> using RSRP if RSRP measurement results are available, otherwise using RSRQ if RSRQ measurement results are available, otherwise using SINR,

3> for each neighbour cell included:

4> include the optional fields that are available.

NOTE: The measured quantities are filtered by the L3 filter as configured in the mobility measurement configuration. The measurements are based on the time domain measurement resource restriction, if configured. Blacklisted cells are not required to be reported.

5.7.4 UE Assistance Information

5.7.4.1 General

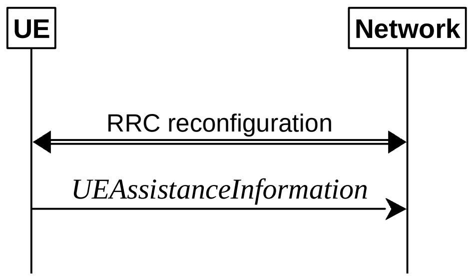

Figure 5.7.4.1-1: UE Assistance Information

The purpose of this procedure is to inform the network of the UE's delay budget report carrying desired increment/decrement in the Uu air interface delay, connected mode DRX cycle length or overheating assistance information.

5.7.4.2 Initiation

A UE capable of providing delay budget report in RRC_CONNECTED may initiate the procedure in several cases, including upon being configured to provide delay budget report and upon change of delay budget preference.

A UE capable of providing overheating assistance information in RRC_CONNECTED may initiate the procedure if it was configured to do so, upon detecting internal overheating, or upon detecting that it is no longer experiencing an overheating condition.

Upon initiating the procedure, the UE shall:

1> if configured to provide delay budget report:

2> if the UE did not transmit a *UEAssistanceInformation* message with *delayBudgetReport* since it was configured to provide delay budget report; or

2> if the current delay budget is different from the one indicated in the last transmission of the *UEAssistanceInformation* message and timer T342 is not running:

3> initiate transmission of the *UEAssistanceInformation* message in accordance with 5.7.4.3;

1> if configured to provide overheating assistance information:

2> if the overheating condition has been detected and T345 is not running; or

2> if the current overheating assistance information is different from the one indicated in the last transmission of the *UEAssistanceInformation* message and timer T345 is not running:

3> initiate transmission of the *UEAssistanceInformation* message in accordance with 5.7.4.3;

5.7.4.3 Actions related to transmission of *UEAssistanceInformation* message

The UE shall set the contents of the *UEAssistanceInformation* message for delay budget report as follows:

1> if configured to provide delay budget report:

2> if the UE prefers an adjustment in the connected mode DRX cycle length:

3> set *delayBudgetReport* to *type1* according to a desired value;

2> start or restart timer T342 with the timer value set to the *delayBudgetReportingProhibitTimer*.

The UE shall set the contents of the *UEAssistanceInformation* message for overheating assistance indication:

1> if the UE experiences internal overheating:

2> if the UE prefers to temporarily reduce the number of maximum secondary component carriers:

3> include *reducedMaxCCs* in the *OverheatingAssistance* IE;

3> set *reducedCCsDL* to the number of maximum SCells the UE prefers to be temporarily configured in downlink;

3> set *reducedCCsUL* to the number of maximum SCells the UE prefers to be temporarily configured in uplink;

2> if the UE prefers to temporarily reduce maximum aggregated bandwidth of FR1:

3> include *reducedMaxBW-FR1* in the *OverheatingAssistance* IE;

3> set *reducedBW-FR1-DL* to the maximum aggregated bandwidth the UE prefers to be temporarily configured across all downlink carriers of FR1;

3> set *reducedBW-FR1-UL* to the maximum aggregated bandwidth the UE prefers to be temporarily configured across all uplink carriers of FR1;

2> if the UE prefers to temporarily reduce maximum aggregated bandwidth of FR2:

3> include *reducedMaxBW-FR2* in the *OverheatingAssistance* IE;

3> set *reducedBW-FR2-DL* to the maximum aggregated bandwidth the UE prefers to be temporarily configured across all downlink carriers of FR2;

3> set *reducedBW-FR2-UL* to the maximum aggregated bandwidth the UE prefers to be temporarily configured across all uplink carriers of FR2;

2> if the UE prefers to temporarily reduce the number of maximum MIMO layers of each serving cell operating on FR1:

3> include *reducedMaxMIMO-LayersFR1* in the *OverheatingAssistance* IE;

3> set *reducedMIMO-LayersFR1-DL* to the number of maximum MIMO layers of each serving cell operating on FR1 the UE prefers to be temporarily configured in downlink;

3> set *reducedMIMO-LayersFR1-UL* to the number of maximum MIMO layers of each serving cell operating on FR1 the UE prefers to be temporarily configured in uplink;

2> if the UE prefers to temporarily reduce the number of maximum MIMO layers of each serving cell operating on FR2:

3> include *reducedMaxMIMO-LayersFR2* in the *OverheatingAssistance* IE;

3> set *reducedMIMO-LayersFR2-DL* to the number of maximum MIMO layers of each serving cell operating on FR2 the UE prefers to be temporarily configured in downlink;

3> set *reducedMIMO-LayersFR2-UL* to the number of maximum MIMO layers of each serving cell operating on FR2 the UE prefers to be temporarily configured in uplink;

2> start timer T345 with the timer value set to the *overheatingIndicationProhibitTimer*;

1> else (if the UE no longer experiences an overheating condition):

2> do not include *reducedMaxCCs, reducedMaxBW-FR1*, *reducedMaxBW-FR2*, *reducedMaxMIMO-LayersFR1* and *reducedMaxMIMO-LayersFR2* in *OverheatingAssistance* IE;

2> start timer T345 with the timer value set to the *overheatingIndicationProhibitTimer*.

5.7.5 Failure information

5.7.5.1 General

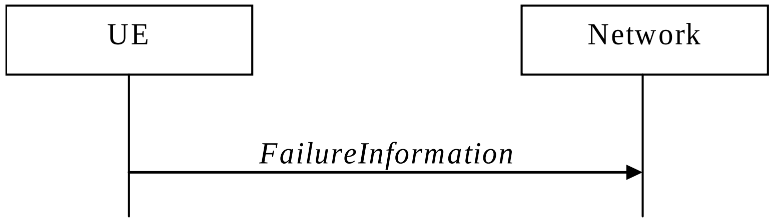

Figure 5.7.5.1-1: Failure information

The purpose of this procedure is to inform the network about a failure detected by the UE.

5.7.5.2 Initiation

A UE initiates the procedure when there is a need inform the network about a failure detected by the UE. In particular, the UE initiates the procedure when the following condition is met:

1> upon detecting failure for an RLC bearer, in accordance with 5.3.10.3;

Upon initiating the procedure, the UE shall:

1> initiate transmission of the *FailureInformation* message as specified in 5.7.5.3;

5.7.5.3 Actions related to transmission of *FailureInformation* message

The UE shall:

1> if initiated to provide RLC failure information:

2> set *logicalChannelIdentity* to the logical channel identity of the failing RLC bearer;

2> set *cellGroupIndication* to the cell group of the failing RLC bearer;

2> set *failureType* to the type of failure that was detected;

1> if used to inform the network about a failure for an MCG RLC bearer:

2> submit the *FailureInformation* message to lower layers for transmission via SRB1;

1> else if used to inform the network about a failure for an SCG RLC bearer: and if the UE is configured with EN-DC:

2> if SRB3 is configured;

3> submit the *FailureInformation* message to lower layers for transmission via SRB3;

2> else;

3> submit the *FailureInformation* message via the E-UTRA MCG embedded in E-UTRA RRC message *ULInformationTransferMRDC* as specified in TS 36.331 [10].

6 Protocol data units, formats and parameters (ASN.1)

6.1 General

6.1.1 Introduction

The contents of each RRC message is specified in sub-clause 6.2 using ASN.1 to specify the message syntax and using tables when needed to provide further detailed information about the fields specified in the message syntax. The syntax of the information elements that are defined as stand-alone abstract types is further specified in a similar manner in sub-clause 6.3.

6.1.2 Need codes and conditions for optional downlink fields

The need for fields to be present in a message or an abstract type, i.e., the ASN.1 fields that are specified as OPTIONAL in the abstract notation (ASN.1), is specified by means of comment text tags attached to the OPTIONAL statement in the abstract syntax. All comment text tags are available for use in the downlink direction only. The meaning of each tag is specified in table 6.1.2-1.

If conditions are used, a conditional presence table is provided for the message or information element specifying the need of the field for each condition case. The table also specifies whether UE maintains or releases the value in case the field is not present. The conditions clarify what the UE may expect regarding the setting of the message by the network. Violation of conditions is regarded as invalid network behaviour, which the UE is not required to cope with. Hence the general error handling defined in 10.4 does not apply in case a field is absent although it is mandatory according to the CondC or CondM condition.

For guidelines on the use of need codes and conditions, see Annex A.6 and A.7.

Table 6.1.2-1: Meaning of abbreviations used to specify the need for fields to be present

Abbreviation	Meaning
CondC conditionTag	Configuration condition Presence of the field is conditional to other configuration settings.
CondM conditionTag	Message condition Presence of the field is conditional to other fields included in the message.
Need S	*Specified* Used for (configuration) fields, whose field description or procedure **specifies** the UE behavior performed upon receiving a message with the field absent (and not if field description or procedure specifies the UE behavior when field is not configured).
Need M	*Maintain* Used for (configuration) fields that are stored by the UE i.e. not one-shot. Upon receiving a message with the field absent, the UE maintains the current value.
Need N	*No action* (one-shot configuration that is not maintained) Used for (configuration) fields that are not stored and whose presence causes a one-time action by the UE. Upon receiving message with the field absent, the UE takes no action.
Need R	*Release* Used for (configuration) fields that are stored by the UE i.e. not one-shot. Upon receiving a message with the field absent, the UE releases the current value.

6.2 RRC messages

6.2.1 General message structure

– *NR-RRC-Definitions*

This ASN.1 segment is the start of the NR RRC PDU definitions.

```
-- ASN1START
-- TAG-NR-RRC-DEFINITIONS-START

NR-RRC-Definitions DEFINITIONS AUTOMATIC TAGS ::=

BEGIN

-- TAG-NR-RRC-DEFINITIONS-STOP
-- ASN1STOP
```

– *BCCH-BCH-Message*

The *BCCH-BCH-Message* class is the set of RRC messages that may be sent from the network to the UE via BCH on the BCCH logical channel.

```
-- ASN1START
-- TAG-BCCH-BCH-MESSAGE-START

BCCH-BCH-Message ::=                SEQUENCE {
    message                             BCCH-BCH-MessageType
}

BCCH-BCH-MessageType ::=            CHOICE {
    mib                                 MIB,
    messageClassExtension               SEQUENCE {}
}

-- TAG-BCCH-BCH-MESSAGE-STOP
-- ASN1STOP
```

– *BCCH-DL-SCH-Message*

The *BCCH-DL-SCH-Message* class is the set of RRC messages that may be sent from the network to the UE via DL-SCH on the BCCH logical channel.

```
-- ASN1START
-- TAG-BCCH-DL-SCH-MESSAGE-START

BCCH-DL-SCH-Message ::=             SEQUENCE {
    message                             BCCH-DL-SCH-MessageType
}
```

```
BCCH-DL-SCH-MessageType ::=     CHOICE {
    c1                              CHOICE {
        systemInformation               SystemInformation,
        systemInformationBlockType1     SIB1
    },
    messageClassExtension           SEQUENCE {}
}

-- TAG-BCCH-DL-SCH-MESSAGE-STOP
-- ASN1STOP
```

– *DL-CCCH-Message*

The *DL-CCCH-Message* class is the set of RRC messages that may be sent from the Network to the UE on the downlink CCCH logical channel.

```
-- ASN1START
-- TAG-DL-CCCH-MESSAGE-START


DL-CCCH-Message ::=             SEQUENCE {
    message                         DL-CCCH-MessageType
}

DL-CCCH-MessageType ::=         CHOICE {
    c1                              CHOICE {
        rrcReject                       RRCReject,
        rrcSetup                        RRCSetup,
        spare2                          NULL,
        spare1                          NULL
    },
    messageClassExtension           SEQUENCE {}
}

-- TAG-DL-CCCH-MESSAGE-STOP
-- ASN1STOP
```

– *DL-DCCH-Message*

The *DL-DCCH-Message* class is the set of RRC messages that may be sent from the network to the UE on the downlink DCCH logical channel.

```
-- ASN1START
-- TAG-DL-DCCH-MESSAGE-START

DL-DCCH-Message ::=              SEQUENCE {
    message                         DL-DCCH-MessageType
}

DL-DCCH-MessageType ::=         CHOICE {
    c1                              CHOICE {
        rrcReconfiguration              RRCReconfiguration,
```

```
        rrcResume                       RRCResume,
        rrcRelease                      RRCRelease,
        rrcReestablishment              RRCReestablishment,
        securityModeCommand             SecurityModeCommand,
        dlInformationTransfer           DLInformationTransfer,
        ueCapabilityEnquiry             UECapabilityEnquiry,
        counterCheck                    CounterCheck,
        mobilityFromNRCommand           MobilityFromNRCommand,
        spare7 NULL,
        spare6 NULL, spare5 NULL, spare4 NULL,
        spare3 NULL, spare2 NULL, spare1 NULL
    },
    messageClassExtension   SEQUENCE {}
}

-- TAG-DL-DCCH-MESSAGE-STOP
-- ASN1STOP
```

– *PCCH-Message*

The *PCCH-Message* class is the set of RRC messages that may be sent from the Network to the UE on the PCCH logical channel.

```
-- ASN1START
-- TAG-PCCH-PCH-MESSAGE-START

PCCH-Message ::=                SEQUENCE {
    message                         PCCH-MessageType
}

PCCH-MessageType ::=            CHOICE {
    c1                              CHOICE {
        paging                          Paging,
        spare1  NULL
    },
    messageClassExtension       SEQUENCE {}
}

-- TAG-PCCH-PCH-MESSAGE-STOP
-- ASN1STOP
```

– *UL-CCCH-Message*

The *UL-CCCH-Message* class is the set of 48bit RRC messages that may be sent from the UE to the Network on the uplink CCCH logical channel.

```
-- ASN1START
-- TAG-UL-CCCH-MESSAGE-START


UL-CCCH-Message ::=             SEQUENCE {
    message                         UL-CCCH-MessageType
```

```
}

UL-CCCH-MessageType ::=         CHOICE {
    c1                              CHOICE {
        rrcSetupRequest                 RRCSetupRequest,
        rrcResumeRequest                RRCResumeRequest,
        rrcReestablishmentRequest       RRCReestablishmentRequest,
        rrcSystemInfoRequest            RRCSystemInfoRequest
    },
    messageClassExtension           SEQUENCE {}
}

-- TAG-UL-CCCH-MESSAGE-STOP
-- ASN1STOP
```

– *UL-CCCH1-Message*

The *UL-CCCH1-Message* class is the set of 64bit RRC messages that may be sent from the UE to the Network on the uplink CCCH1 logical channel.

```
-- ASN1START
-- TAG-UL-CCCH1-MESSAGE-START


UL-CCCH1-Message ::=            SEQUENCE {
    message                         UL-CCCH1-MessageType
}

UL-CCCH1-MessageType ::=        CHOICE {
    c1                              CHOICE {
        rrcResumeRequest1               RRCResumeRequest1,
        spare3 NULL,
        spare2 NULL,
        spare1 NULL

    },
    messageClassExtension SEQUENCE {}
}

-- TAG-UL-CCCH1-MESSAGE-STOP
-- ASN1STOP
```

– *UL-DCCH-Message*

The *UL-DCCH-Message* class is the set of RRC messages that may be sent from the UE to the network on the uplink DCCH logical channel.

```
-- ASN1START
-- TAG-UL-DCCH-MESSAGE-START

UL-DCCH-Message ::=             SEQUENCE {
    message                         UL-DCCH-MessageType
```

```
}

UL-DCCH-MessageType ::=         CHOICE {
    c1                              CHOICE {
        measurementReport               MeasurementReport,
        rrcReconfigurationComplete      RRCReconfigurationComplete,
        rrcSetupComplete                RRCSetupComplete,
        rrcReestablishmentComplete      RRCReestablishmentComplete,
        rrcResumeComplete               RRCResumeComplete,
        securityModeComplete            SecurityModeComplete,
        securityModeFailure             SecurityModeFailure,
        ulInformationTransfer           ULInformationTransfer,
        locationMeasurementIndication   LocationMeasurementIndication,
        ueCapabilityInformation         UECapabilityInformation,
        counterCheckResponse            CounterCheckResponse,
        ueAssistanceInformation         UEAssistanceInformation,
        failureInformation              FailureInformation,
        spare3 NULL,
        spare2 NULL, spare1 NULL
    },
    messageClassExtension           SEQUENCE {}
}

-- TAG-UL-DCCH-MESSAGE-STOP
-- ASN1STOP
```

6.2.2 Message definitions

– *CounterCheck*

The *CounterCheck* message is used by the network to indicate the current COUNT MSB values associated to each DRB and to request the UE to compare these to its COUNT MSB values and to report the comparison results to the network.

Signalling radio bearer: SRB1

RLC-SAP: AM

Logical channel: DCCH

Direction: Network to UE

CounterCheck message

```
-- ASN1START
-- TAG-COUNTERCHECK-START


CounterCheck ::=                SEQUENCE {
    rrc-TransactionIdentifier       RRC-TransactionIdentifier,
    criticalExtensions              CHOICE {
        counterCheck                    CounterCheck-IEs,
        criticalExtensionsFuture        SEQUENCE {}
    }
}

CounterCheck-IEs ::=            SEQUENCE {
    drb-CountMSB-InfoList           DRB-CountMSB-InfoList,
    lateNonCriticalExtension        OCTET STRING                        OPTIONAL,
    nonCriticalExtension            SEQUENCE {}                         OPTIONAL
}

DRB-CountMSB-InfoList ::=       SEQUENCE (SIZE (1..maxDRB)) OF DRB-CountMSB-Info

DRB-CountMSB-Info ::=           SEQUENCE {
    drb-Identity                    DRB-Identity,
    countMSB-Uplink                 INTEGER(0..33554431),
    countMSB-Downlink               INTEGER(0..33554431)
}

-- TAG-COUNTERCHECK-STOP
-- ASN1STOP
```

***CounterCheck-IEs* field descriptions**
drb-CountMSB-InfoList Indicates the MSBs of the COUNT values of the DRBs.

***DRB-CountMSB-Info* field descriptions**
countMSB-Downlink Indicates the value of 25 MSBs from RX_NEXT – 1 (specified in TS 38.323 [5]) associated to this DRB.
countMSB-Uplink Indicates the value of 25 MSBs from TX_NEXT – 1 (specified in TS 38.323 [5]) associated to this DRB.

– *CounterCheckResponse*

The *CounterCheckResponse* message is used by the UE to respond to a *CounterCheck* message.

Signalling radio bearer: SRB1

RLC-SAP: AM

Logical channel: DCCH

Direction: UE to Network

CounterCheckResponse message

```
-- ASN1START
-- TAG-COUNTERCHECKRESPONSE-START

CounterCheckResponse ::=        SEQUENCE {
    rrc-TransactionIdentifier       RRC-TransactionIdentifier,
    criticalExtensions              CHOICE {
        counterCheckResponse            CounterCheckResponse-IEs,
        criticalExtensionsFuture        SEQUENCE {}
    }
}

CounterCheckResponse-IEs ::=    SEQUENCE {
    drb-CountInfoList               DRB-CountInfoList,
    lateNonCriticalExtension        OCTET STRING                        OPTIONAL,
    nonCriticalExtension            SEQUENCE {}                         OPTIONAL

}

DRB-CountInfoList ::=           SEQUENCE (SIZE (0..maxDRB)) OF DRB-CountInfo

DRB-CountInfo ::=               SEQUENCE {
    drb-Identity                    DRB-Identity,
    count-Uplink                    INTEGER(0..4294967295),
    count-Downlink                  INTEGER(0..4294967295)
```

```
}

-- TAG-COUNTERCHECKRESPONSE-STOP
-- ASN1STOP
```

CounterCheckResponse-IEs field descriptions
drb-CountInfoList Indicates the COUNT values of the DRBs.

DRB-CountInfo field descriptions
count-Downlink Indicates the value of RX_NEXT – 1 (specified in TS 38.323 [5]) associated to this DRB.
count-Uplink Indicates the value of TX_NEXT – 1 (specified in TS 38.323 [5]) associated to this DRB.

– *DLInformationTransfer*

The *DLInformationTransfer* message is used for the downlink transfer of NAS dedicated information.

Signalling radio bearer: SRB2 or SRB1 (only if SRB2 not established yet. If SRB2 is suspended, the network does not send this message until SRB2 is resumed.)

RLC-SAP: AM

Logical channel: DCCH

Direction: Network to UE

***DLInformationTransfer* message**

```
-- ASN1START
-- TAG-DLINFORMATIONTRANSFER-START

DLInformationTransfer ::=           SEQUENCE {
    rrc-TransactionIdentifier           RRC-TransactionIdentifier,
    criticalExtensions                  CHOICE {
        dlInformationTransfer           DLInformationTransfer-IEs,
        criticalExtensionsFuture            SEQUENCE {}
    }
}

DLInformationTransfer-IEs ::=   SEQUENCE {
    dedicatedNAS-Message                DedicatedNAS-Message                OPTIONAL,   -- Need N
    lateNonCriticalExtension            OCTET STRING                        OPTIONAL,
    nonCriticalExtension                SEQUENCE {} OPTIONAL
}

-- TAG-DLINFORMATIONTRANSFER-STOP
```

```
-- ASN1STOP
```

– *FailureInformation*

The *FailureInformation* message is used to inform the network about a failure detected by the UE.

Signalling radio bearer: SRB1 or SRB3

RLC-SAP: AM

Logical channel: DCCH

Direction: UE to network

FailureInformation message

```
-- ASN1START
-- TAG-FAILUREINFORMATION-START

FailureInformation ::=          SEQUENCE {
    criticalExtensions              CHOICE {
        failureInformation              FailureInformation-IEs,
        criticalExtensionsFuture        SEQUENCE {}
    }
}

FailureInformation-IEs ::=      SEQUENCE {
    failureInfoRLC-Bearer           FailureInfoRLC-Bearer    OPTIONAL,
    lateNonCriticalExtension        OCTET STRING             OPTIONAL,
    nonCriticalExtension            SEQUENCE {}              OPTIONAL
}

FailureInfoRLC-Bearer ::=       SEQUENCE {
    cellGroupId                     CellGroupId,
    logicalChannelIdentity          LogicalChannelIdentity,
    failureType                     ENUMERATED {duplication, spare3, spare2, spare1}
}

-- TAG-FAILUREINFORMATION-STOP
-- ASN1STOP
```

– *LocationMeasurementIndication*

The *LocationMeasurementIndication* message is used to indicate that the UE is going to either start or stop location related measurement which requires measurement gaps.

Signalling radio bearer: SRB1

RLC-SAP: AM

Logical channel: DCCH

Direction: UE to Network

LocationMeasurementIndication message

```
-- ASN1START
-- TAG-LOCATIONMEASUREMENTINDICATION-START

LocationMeasurementIndication ::=   SEQUENCE {
    criticalExtensions                      CHOICE {
        locationMeasurementIndication               LocationMeasurementIndication-IEs,
        criticalExtensionsFuture                    SEQUENCE {}
    }
}

LocationMeasurementIndication-IEs ::=       SEQUENCE {
    measurementIndication       SetupRelease {LocationMeasurementInfo},

    lateNonCriticalExtension                OCTET STRING                                                        OPTIONAL,
    nonCriticalExtension                    SEQUENCE{}                                                          OPTIONAL
}

-- TAG-LOCATIONMEASUREMENTINDICATION-STOP
-- ASN1STOP
```

– *MIB*

The *MIB* includes the system information transmitted on BCH.

Signalling radio bearer: N/A

RLC-SAP: TM

Logical channel: BCCH

Direction: Network to UE

MIB

```
-- ASN1START
-- TAG-MIB-START

MIB ::=                             SEQUENCE {
    systemFrameNumber                   BIT STRING (SIZE (6)),
    subCarrierSpacingCommon             ENUMERATED {scs15or60, scs30or120},
    ssb-SubcarrierOffset                INTEGER (0..15),
    dmrs-TypeA-Position                 ENUMERATED {pos2, pos3},
    pdcch-ConfigSIB1                    PDCCH-ConfigSIB1,
    cellBarred                          ENUMERATED {barred, notBarred},
```

```
    intraFreqReselection                ENUMERATED {allowed, notAllowed},
    spare                               BIT STRING (SIZE (1))
}

-- TAG-MIB-STOP
-- ASN1STOP
```

MIB field descriptions
cellBarred Barred means the cell is barred, as defined in TS 38.304 [20].
dmrs-TypeA-Position Position of (first) DM-RS for downlink (see TS 38.211 [16], clause 7.4.1.1.2) and uplink (see TS 38.211 [16], clause 6.4.1.1.3).
intraFreqReselection Controls cell selection/reselection to intra-frequency cells when the highest ranked cell is barred, or treated as barred by the UE, as specified in TS 38.304 [20].
pdcch-ConfigSIB1 See TS 38.213 [13]. Determines a common *ControlResourceSet* (CORESET) a common search space and necessary PDCCH parameters. If the field *ssb-SubcarrierOffset* indicates that *SIB1* is not present, the field *pdcch-ConfigSIB1* indicate the frequency positions where the UE may find SS/PBCH block with *SIB1* or the frequency range where the network does not provide SS/PBCH block with *SIB1* (see TS 38.213 [13], clause 13).
ssb-SubcarrierOffset Corresponds to k_{SSB} (see TS 38.213 [13]), which is the frequency domain offset between SSB and the overall resource block grid in number of subcarriers. (See TS 38.211 [16], clause 7.4.3.1). The value range of this field may be extended by an additional most significant bit encoded within PBCH as specified in TS 38.213 [13]. This field may indicate that this cell does not provide *SIB1* and that there is hence no CORESET#0 configured in MIB (see TS 38.213 [13], clause 13). In this case, the field *pdcch-ConfigSIB1* may indicate the frequency positions where the UE may (not) find a SS/PBCH with a control resource set and search space for SIB1 (see TS 38.213 [13], clause 13).
subCarrierSpacingCommon Subcarrier spacing for SIB1, Msg.2/4 for initial access, paging and broadcast SI-messages. If the UE acquires this MIB on a carrier frequency <6GHz, the value *scs15or60* corresponds to 15 Khz and the value *scs30or120* corresponds to 30 kHz. If the UE acquires this MIB on a carrier frequency >6GHz, the value *scs15or60* corresponds to 60 Khz and the value *scs30or120* corresponds to 120 kHz.
systemFrameNumber The 6 most significant bit (MSB) of the 10-bit System Frame Number. The 4 LSB of the SFN are conveyed in the PBCH transport block as part of channel coding (i.e. outside the MIB encoding), as defined in clause 7.1 in TS 38.212 [17].

– *MeasurementReport*

The *MeasurementReport* message is used for the indication of measurement results.

Signalling radio bearer: SRB1, SRB3

RLC-SAP: AM

Logical channel: DCCH

Direction: UE to Network

MeasurementReport message

```
-- ASN1START
-- TAG-MEASUREMENTREPORT-START

MeasurementReport ::=                SEQUENCE {
    criticalExtensions                   CHOICE {
        measurementReport                    MeasurementReport-IEs,
        criticalExtensionsFuture             SEQUENCE {}
    }
}

MeasurementReport-IEs ::=            SEQUENCE {
    measResults                          MeasResults,

    lateNonCriticalExtension                 OCTET STRING                                                        OPTIONAL,
    nonCriticalExtension                     SEQUENCE{}                                                          OPTIONAL
}

-- TAG-MEASUREMENTREPORT-STOP
-- ASN1STOP
```

– *MobilityFromNRCommand*

The *MobilityFromNRCommand* message is used to command handover from NR to E-UTRA (connected to EPC or 5GC).

Signalling radio bearer: SRB1

RLC-SAP: AM

Logical channel: DCCH

Direction: Network to UE

MobilityFromNRCommand message

```
-- ASN1START
-- TAG-MOBILITYFROMNRCOMMAND-START

MobilityFromNRCommand ::=        SEQUENCE {
    rrc-TransactionIdentifier            RRC-TransactionIdentifier,
    criticalExtensions                   CHOICE {
            mobilityFromNRCommand                MobilityFromNRCommand-IEs,
            criticalExtensionsFuture                 SEQUENCE {}
    }
}

MobilityFromNRCommand-IEs ::=    SEQUENCE {
    targetRAT-Type                           ENUMERATED { eutra, spare3, spare2, spare1, ...},
    targetRAT-MessageContainer               OCTET STRING,
    nas-SecurityParamFromNR                  OCTET STRING                        OPTIONAL,   -- Cond HO-ToEPC
```

```
    lateNonCriticalExtension                OCTET STRING                            OPTIONAL,
    nonCriticalExtension                    SEQUENCE {}                             OPTIONAL
}

-- TAG-MOBILITYFROMNRCOMMAND-STOP
-- ASN1STOP
```

MobilityFromNRCommand-IEs field descriptions
nas-SecurityParamFromNR This field is used to deliver the key synchronisation and Key freshness for the NR to LTE/EPC handovers as specified in TS 33.501 [11] and contains the 4 LSB of the downlink NAS COUNT.
targetRAT-MessageContainer The field contains a message specified in another standard, as indicated by the targetRAT-Type, and carries information about the target cell identifier(s) and radio parameters relevant for the target radio access technology. NOTE 1. A complete message is included, as specified in the other standard.
targetRAT-Type Indicates the target RAT type.

NOTE 1: The correspondence between the value of the *targetRAT-Type*, the standard to apply, and the message contained within the *targetRAT-MessageContainer* is shown in the table below:

targetRAT-Type	Standard to apply	targetRAT-MessageContainer
eutra	3GPP TS 36.331 [10] (clause 5.4.2)	RRCConnectionReconfiguration

Conditional Presence	Explanation
HO-ToEPC	This field is mandatory present in case of inter system handover. Otherwise it is absent.

– *Paging*

The *Paging* message is used for the notification of one or more UEs.

Signalling radio bearer: N/A

RLC-SAP: TM

Logical channel: PCCH

Direction: Network to UE

Paging message

```
-- ASN1START
-- TAG-PAGING-START

Paging ::=                          SEQUENCE {
```

```
    pagingRecordList                        PagingRecordList                                                        OPTIONAL, -- Need N
    lateNonCriticalExtension                OCTET STRING                                                            OPTIONAL,
    nonCriticalExtension                    SEQUENCE{}                                                              OPTIONAL
}

PagingRecordList ::=                    SEQUENCE (SIZE(1..maxNrofPageRec)) OF PagingRecord

PagingRecord ::=                        SEQUENCE {
    ue-Identity                             PagingUE-Identity,
    accessType                              ENUMERATED {non3GPP}    OPTIONAL,   -- Need N
    ...
}

PagingUE-Identity ::=                   CHOICE {
    ng-5G-S-TMSI                            NG-5G-S-TMSI,
    fullI-RNTI                              I-RNTI-Value,
    ...
}

-- TAG-PAGING-STOP
-- ASN1STOP
```

PagingRecord field descriptions
accessType It indicates whether Paging is originated due to the PDU sessions from the non-3GPP access.

– *RRCReestablishment*

The *RRCReestablishment* message is used to re-establish SRB1.

Signalling radio bearer: SRB1

RLC-SAP: AM

Logical channel: DCCH

Direction: Network to UE

***RRCReestablishment* message**

```
-- ASN1START
-- TAG-RRCREESTABLISHMENT-START

RRCReestablishment ::=                  SEQUENCE {
    rrc-TransactionIdentifier               RRC-TransactionIdentifier,
    criticalExtensions                      CHOICE {
        rrcReestablishment                      RRCReestablishment-IEs,
        criticalExtensionsFuture                SEQUENCE {}
    }
```

```
}

RRCReestablishment-IEs ::=          SEQUENCE {
    nextHopChainingCount                NextHopChainingCount,
    lateNonCriticalExtension            OCTET STRING                        OPTIONAL,
    nonCriticalExtension                SEQUENCE {}                         OPTIONAL
}

-- TAG-RRCREESTABLISHMENT-STOP
-- ASN1STOP
```

– *RRCReestablishmentComplete*

The *RRCReestablishmentComplete* message is used to confirm the successful completion of an RRC connection re-establishment.

Signalling radio bearer: SRB1

RLC-SAP: AM

Logical channel: DCCH

Direction: UE to Network

***RRCReestablishmentComplete* message**

```
-- ASN1START
-- TAG-RRCREESTABLISHMENTCOMPLETE-START

RRCReestablishmentComplete ::=      SEQUENCE {
    rrc-TransactionIdentifier           RRC-TransactionIdentifier,
    criticalExtensions                  CHOICE {
        rrcReestablishmentComplete          RRCReestablishmentComplete-IEs,
        criticalExtensionsFuture            SEQUENCE {}
    }
}

RRCReestablishmentComplete-IEs ::=  SEQUENCE {
    lateNonCriticalExtension            OCTET STRING                    OPTIONAL,
    nonCriticalExtension                SEQUENCE {}                     OPTIONAL
}

-- TAG-RRCREESTABLISHMENTCOMPLETE-STOP
-- ASN1STOP
```

– *RRCReestablishmentRequest*

The *RRCReestablishmentRequest* message is used to request the reestablishment of an RRC connection.

Signalling radio bearer: SRB0

RLC-SAP: TM

Logical channel: CCCH

Direction: UE to Network

***RRCReestablishmentRequest* message**

```
-- ASN1START
-- TAG-RRCREESTABLISHMENTREQUEST-START


RRCReestablishmentRequest ::=       SEQUENCE {
    rrcReestablishmentRequest           RRCReestablishmentRequest-IEs
}

RRCReestablishmentRequest-IEs ::=   SEQUENCE {
    ue-Identity                         ReestabUE-Identity,
    reestablishmentCause                ReestablishmentCause,
    spare                               BIT STRING (SIZE (1))
}

ReestabUE-Identity ::=              SEQUENCE {
    c-RNTI                              RNTI-Value,
    physCellId                          PhysCellId,
    shortMAC-I                          ShortMAC-I
}

ReestablishmentCause ::=            ENUMERATED {reconfigurationFailure, handoverFailure, otherFailure, spare1}

-- TAG-RRCREESTABLISHMENTREQUEST-STOP
-- ASN1STOP
```

***ReestabUE-Identity* field descriptions**
physCellId The Physical Cell Identity of the PCell the UE was connected to prior to the failure.

***RRCReestablishmentRequest-IEs* field descriptions**
reestablishmentCause Indicates the failure cause that triggered the re-establishment procedure. gNB is not expected to reject a RRCReestablishmentRequest due to unknown cause value being used by the UE.
ue-Identity UE identity included to retrieve UE context and to facilitate contention resolution by lower layers.

– *RRCReconfiguration*

The *RRCReconfiguration* message is the command to modify an RRC connection. It may convey information for measurement configuration, mobility control, radio resource configuration (including RBs, MAC main configuration and physical channel configuration) including and security configuration.

Signalling radio bearer: SRB1 or SRB3

RLC-SAP: AM

Logical channel: DCCH

Direction: Network to UE

RRCReconfiguration message

```
-- ASN1START
-- TAG-RRCRECONFIGURATION-START

RRCReconfiguration ::=              SEQUENCE {
    rrc-TransactionIdentifier           RRC-TransactionIdentifier,
    criticalExtensions                  CHOICE {
        rrcReconfiguration                  RRCReconfiguration-IEs,
        criticalExtensionsFuture            SEQUENCE {}
    }
}

RRCReconfiguration-IEs ::=          SEQUENCE {
    radioBearerConfig                       RadioBearerConfig                                                       OPTIONAL, -- Need M
    secondaryCellGroup                      OCTET STRING (CONTAINING CellGroupConfig)                               OPTIONAL, -- Need M
    measConfig                              MeasConfig                                                              OPTIONAL, -- Need M
    lateNonCriticalExtension                OCTET STRING                                                            OPTIONAL,
    nonCriticalExtension                    RRCReconfiguration-v1530-IEs                                            OPTIONAL
}

RRCReconfiguration-v1530-IEs ::=            SEQUENCE {
    masterCellGroup                         OCTET STRING (CONTAINING CellGroupConfig)                               OPTIONAL, -- Need M
    fullConfig                              ENUMERATED {true}                                                       OPTIONAL, -- Cond FullConfig
    dedicatedNAS-MessageList                SEQUENCE (SIZE(1..maxDRB)) OF DedicatedNAS-Message                      OPTIONAL, -- Cond nonHO
    masterKeyUpdate                         MasterKeyUpdate                                                         OPTIONAL, -- Cond
MasterKeyChange
    dedicatedSIB1-Delivery                  OCTET STRING (CONTAINING SIB1)                                          OPTIONAL, -- Need N
    dedicatedSystemInformationDelivery      OCTET STRING (CONTAINING SystemInformation)                             OPTIONAL, -- Need N
    otherConfig                             OtherConfig                                                             OPTIONAL, -- Need M
    nonCriticalExtension                    RRCReconfiguration-v1540-IEs                                            OPTIONAL
}

RRCReconfiguration-v1540-IEs ::=        SEQUENCE {
    otherConfig-v1540                       OtherConfig-v1540       OPTIONAL, -- Need M
    nonCriticalExtension                    SEQUENCE {}             OPTIONAL
}

MasterKeyUpdate ::=                 SEQUENCE {
```

```
    keySetChangeIndicator           BOOLEAN,
    nextHopChainingCount            NextHopChainingCount,
    nas-Container                   OCTET STRING                                                    OPTIONAL,    -- Cond securityNASC
    ...
}

-- TAG-RRCRECONFIGURATION-STOP
-- ASN1STOP
```

RRCReconfiguration-IEs field descriptions
dedicatedNAS-MessageList This field is used to transfer UE specific NAS layer information between the network and the UE. The RRC layer is transparent for each PDU in the list.
dedicatedSIB1-Delivery This field is used to transfer SIB1 to the UE.
dedicatedSystemInformationDelivery This field is used to transfer SIB6, SIB7, SIB8 to the UE.
fullConfig Indicates that the full configuration option is applicable for the *RRCReconfiguration* message.
keySetChangeIndicator True is used in an intra-cell handover when a K_{gNB} key is derived from a K_{AMF} key taken into use through the latest successful NAS SMC procedure, or N2 handover procedure with K_{AMF} change, as described in TS 33.501 [11] for K_{gNB} re-keying. False is used in an intra-NR handover when the new K_{gNB} key is obtained from the current K_{gNB} key or from the NH as described in TS 33.501 [11].
masterCellGroup Configuration of master cell group.
nas-Container This field is used to transfer UE specific NAS layer information between the network and the UE. The RRC layer is transparent for this field, although it affects activation of AS-security after inter-system handover to NR. The content is defined in TS 24.501 [23].
nextHopChainingCount Parameter NCC: See TS 33.501 [11]
otherConfig Contains configuration related to other configurations.
radioBearerConfig Configuration of Radio Bearers (DRBs, SRBs) including SDAP/PDCP. In EN-DC this field may only be present if the RRCReconfiguration is transmitted over SRB3.
secondaryCellGroup Configuration of secondary cell group (EN-DC).

Conditional Presence	Explanation
nonHO	The field is not present in case of reconfiguration with sync within NR or to NR; otherwise it is optionally present, need N.
securityNASC	This field is mandatory present in case of inter system handover. Otherwise the field is optionally present, need N.
MasterKeyChange	This field is mandatory present in case of Handover with change of the security algorithms (as indicated in *SecurityAlgorithmConfig* in *SecurityConfig*, included in the received *RadioBearerConfig*). If *ReconfigurationWithSync* is included for other cases, this field is optionally present, need N. Otherwise the field is absent.
FullConfig	The field is mandatory present in case of inter-system handover from E-UTRA/EPC to NR. It is optionally present, Need N, during reconfiguration with sync and also in first reconfiguration after reestablishment; or for intra-system handover from E-UTRA/5GC to NR. It is not present otherwise.

– *RRCReconfigurationComplete*

The *RRCReconfigurationComplete* message is used to confirm the successful completion of an RRC connection reconfiguration.

Signalling radio bearer: SRB1 or SRB3

RLC-SAP: AM

Logical channel: DCCH

Direction: UE to Network

RRCReconfigurationComplete message

```
-- ASN1START
-- TAG-RRCRECONFIGURATIONCOMPLETE-START

RRCReconfigurationComplete ::=          SEQUENCE {
    rrc-TransactionIdentifier               RRC-TransactionIdentifier,
    criticalExtensions                      CHOICE {
        rrcReconfigurationComplete              RRCReconfigurationComplete-IEs,
        criticalExtensionsFuture                SEQUENCE {}
    }
}

RRCReconfigurationComplete-IEs ::=      SEQUENCE {
    lateNonCriticalExtension                OCTET STRING                                                        OPTIONAL,
    nonCriticalExtension                    RRCReconfigurationComplete-v1530-IEs                                OPTIONAL
}

RRCReconfigurationComplete-v1530-IEs ::=  SEQUENCE {
    uplinkTxDirectCurrentList               UplinkTxDirectCurrentList                                           OPTIONAL,
    nonCriticalExtension                    SEQUENCE {}                                                         OPTIONAL
}

-- TAG-RRCRECONFIGURATIONCOMPLETE-STOP
-- ASN1STOP
```

RRCReconfigurationComplete-v1530-IEs field descriptions
uplinkTxDirectCurrentList The Tx Direct Current locations for the configured serving cells and BWPs if requested by the NW (see reportUplinkTxDirectCurrent).

– *RRCReject*

The *RRCReject* message is used to reject an RRC connection establishment or an RRC connection resumption.

Signalling radio bearer: SRB0

RLC-SAP: TM

Logical channel: CCCH

Direction: Network to UE

***RRCReject* message**

```
-- ASN1START
-- TAG-RRCREJECT-START

RRCReject ::=                       SEQUENCE {
    criticalExtensions                  CHOICE {
        rrcReject                           RRCReject-IEs,
        criticalExtensionsFuture            SEQUENCE {}
    }
}

RRCReject-IEs ::=                   SEQUENCE {
    waitTime                            RejectWaitTime                                                          OPTIONAL,   -- Need N

    lateNonCriticalExtension            OCTET STRING                                                            OPTIONAL,
    nonCriticalExtension                SEQUENCE{}                                                              OPTIONAL
}

-- TAG-RRCREJECT-STOP
-- ASN1STOP
```

RRCReject-IEs field descriptions
waitTime Wait time value in seconds. The field is always included in case of resume or initial setup.

– *RRCRelease*

The *RRCRelease* message is used to command the release of an RRC connection or the suspension of the RRC connection.

Signalling radio bearer: SRB1

RLC-SAP: AM

Logical channel: DCCH

Direction: Network to UE

***RRCRelease* message**

```
-- ASN1START
-- TAG-RRCRELEASE-START

RRCRelease ::=                      SEQUENCE {
    rrc-TransactionIdentifier           RRC-TransactionIdentifier,
    criticalExtensions                  CHOICE {
        rrcRelease                          RRCRelease-IEs,
        criticalExtensionsFuture            SEQUENCE {}
    }
}

RRCRelease-IEs ::=                  SEQUENCE {
    redirectedCarrierInfo               RedirectedCarrierInfo                                               OPTIONAL,   -- Need N
    cellReselectionPriorities           CellReselectionPriorities                                           OPTIONAL,   -- Need R
    suspendConfig                       SuspendConfig                                                       OPTIONAL,   -- Need R
    deprioritisationReq                 SEQUENCE {
        deprioritisationType                ENUMERATED {frequency, nr},
        deprioritisationTimer               ENUMERATED {min5, min10, min15, min30}
    }                                                                                                       OPTIONAL,   -- Need N
    lateNonCriticalExtension                OCTET STRING                                                    OPTIONAL,
    nonCriticalExtension                    RRCRelease-v1540-IEs                                            OPTIONAL
}

RRCRelease-v1540-IEs ::=            SEQUENCE {
    waitTime                           RejectWaitTime                OPTIONAL, -- Need N
    nonCriticalExtension               SEQUENCE {}                   OPTIONAL
}

RedirectedCarrierInfo ::=           CHOICE {
    nr                                  CarrierInfoNR,
    eutra                               RedirectedCarrierInfo-EUTRA,
    ...
}

RedirectedCarrierInfo-EUTRA ::=     SEQUENCE {
    eutraFrequency                          ARFCN-ValueEUTRA,
    cnType-r15                              ENUMERATED {epc,fiveGC}                                         OPTIONAL    -- Need N
}

CarrierInfoNR ::=                   SEQUENCE {
    carrierFreq                         ARFCN-ValueNR,
    ssbSubcarrierSpacing                SubcarrierSpacing,
    smtc                                SSB-MTC                                                             OPTIONAL,      -- Need S
```

```
    ...
}

SuspendConfig ::=                   SEQUENCE {
    fullI-RNTI                          I-RNTI-Value,
    shortI-RNTI                         ShortI-RNTI-Value,
    ran-PagingCycle                     PagingCycle,
    ran-NotificationAreaInfo            RAN-NotificationAreaInfo                                    OPTIONAL,   -- Need M
    t380                                PeriodicRNAU-TimerValue                                     OPTIONAL,   -- Need R
    nextHopChainingCount                NextHopChainingCount,
    ...
}


PeriodicRNAU-TimerValue ::=         ENUMERATED { min5, min10, min20, min30, min60, min120, min360, min720}


CellReselectionPriorities ::=       SEQUENCE {
    freqPriorityListEUTRA               FreqPriorityListEUTRA                                       OPTIONAL,       -- Need M
    freqPriorityListNR                  FreqPriorityListNR                                          OPTIONAL,       -- Need M
    t320                                ENUMERATED {min5, min10, min20, min30, min60, min120, min180, spare1}   OPTIONAL,       -- Need R
    ...
}

PagingCycle ::=                     ENUMERATED {rf32, rf64, rf128, rf256}

FreqPriorityListEUTRA ::=           SEQUENCE (SIZE (1..maxFreq)) OF FreqPriorityEUTRA

FreqPriorityListNR ::=              SEQUENCE (SIZE (1..maxFreq)) OF FreqPriorityNR

FreqPriorityEUTRA ::=               SEQUENCE {
    carrierFreq                         ARFCN-ValueEUTRA,
    cellReselectionPriority             CellReselectionPriority,
    cellReselectionSubPriority          CellReselectionSubPriority                                  OPTIONAL        -- Need R
}

FreqPriorityNR ::=                  SEQUENCE {
    carrierFreq                         ARFCN-ValueNR,
    cellReselectionPriority             CellReselectionPriority,
    cellReselectionSubPriority          CellReselectionSubPriority                                  OPTIONAL        -- Need R
}

RAN-NotificationAreaInfo ::=        CHOICE {
    cellList                            PLMN-RAN-AreaCellList,
    ran-AreaConfigList                  PLMN-RAN-AreaConfigList,
    ...
}

PLMN-RAN-AreaCellList ::=           SEQUENCE (SIZE (1.. maxPLMNIdentities)) OF PLMN-RAN-AreaCell

PLMN-RAN-AreaCell ::=               SEQUENCE {
    plmn-Identity                       PLMN-Identity                                               OPTIONAL,   -- Need S
    ran-AreaCells                       SEQUENCE (SIZE (1..32)) OF  CellIdentity
}
```

```
PLMN-RAN-AreaConfigList ::=         SEQUENCE (SIZE (1..maxPLMNIdentities)) OF PLMN-RAN-AreaConfig

PLMN-RAN-AreaConfig ::=             SEQUENCE {
    plmn-Identity                       PLMN-Identity                                                       OPTIONAL,   -- Need S
    ran-Area                            SEQUENCE (SIZE (1..16)) OF  RAN-AreaConfig
}

RAN-AreaConfig ::=                  SEQUENCE {
    trackingAreaCode                TrackingAreaCode,
    ran-AreaCodeList                SEQUENCE (SIZE (1..32)) OF  RAN-AreaCode        OPTIONAL    -- Need R
}

-- TAG-RRCRELEASE-STOP
-- ASN1STOP
```

***RRCRelease* field descriptions**
cnType Indicate that the UE is redirected to EPC or 5GC.
deprioritisationReq Indicates whether the current frequency or RAT is to be de-prioritised.
deprioritisationTimer Indicates the period for which either the current carrier frequency or NR is deprioritised. Value minN corresponds to N minutes.
suspendConfig Indicates configuration for the RRC_INACTIVE state.
t380 Refers to the timer that triggers the periodic RNAU procedure in UE. Value min5 corresponds to 5 minutes, value min10 corresponds to 10 minutes and so on.
ran-PagingCycle Refers to the UE specific cycle for RAN-initiated paging. Value rf32 corresponds to 32 radio frames, rf64 corresponds to 64 radio frames and so on.
redirectedCarrierInfo Indicates a carrier frequency (downlink for FDD) and is used to redirect the UE to an NR or an inter-RAT carrier frequency, by means of cell selection at transition to RRC_IDLE or RRC_INACTIVE as specified in TS 38.304 [20]

***CarrierInfoNR* field descriptions**
carrierFreq Indicates the redirected NR frequency.
ssbSubcarrierSpacing Subcarrier spacing of SSB in the redirected SSB frequency. Only the values 15 or 30 (<6GHz), 120 kHz or 240 kHz (>6GHz) are applicable.
smtc The SSB periodicity/offset/duration configuration for the redirected SSB frequency. It is based on timing reference of PCell. If the field is absent, the UE uses the SMTC configured in the measObjectNR having the same SSB frequency and subcarrier spacing.

RAN-NotificationAreaInfo field descriptions
cellList A list of cells configured as RAN area.
ran-AreaConfigList A list of RAN area codes or RA code(s) as RAN area.

***PLMN-RAN-AreaConfig* field descriptions**
plmn-Identity PLMN Identity to which the cells in ran-AreaCells belong. If the field is absent the UE uses the ID of the registered PLMN.
ran-AreaCodeList The sum of RAN-AreaCodes all PLMNs does not exceed 32
ran-Area Indicates whether TA code(s) or RAN area code(s) are used for the RAN notification area. The network uses only TA code(s) or RAN area code(s) to configure a UE.

PLMN-RAN-AreaCell field descriptions
plmn-Identity PLMN Identity to which the cells in ran-AreaCells belong. If the field is absent the UE uses the ID of the registered PLMN.
ran-AreaCells The sum of cells from all PLMNs does not exceed 32

– *RRCResume*

The *RRCResume* message is used to resume the suspended RRC connection.

Signalling radio bearer: SRB1

RLC-SAP: AM

Logical channel: DCCH

Direction: Network to UE

***RRCResume* message**

```
-- ASN1START
-- TAG-RRCRESUME-START

RRCResume ::=                       SEQUENCE {
    rrc-TransactionIdentifier           RRC-TransactionIdentifier,
    criticalExtensions                  CHOICE {
        rrcResume                           RRCResume-IEs,
        criticalExtensionsFuture            SEQUENCE {}
    }
}
```

```
RRCResume-IEs ::=                   SEQUENCE {
    radioBearerConfig                   RadioBearerConfig                                                   OPTIONAL, -- Need M
    masterCellGroup                     OCTET STRING (CONTAINING CellGroupConfig)                           OPTIONAL, -- Need M
    measConfig                          MeasConfig                                                          OPTIONAL, -- Need M
    fullConfig                          ENUMERATED {true}                                                   OPTIONAL, -- Need N

    lateNonCriticalExtension            OCTET STRING                                                        OPTIONAL,
    nonCriticalExtension                SEQUENCE{}                                                          OPTIONAL

}

-- TAG-RRCRESUME-STOP
-- ASN1STOP
```

RRCResume-IEs field descriptions
masterCellGroup Configuration of the master cell group (NR Standalone):
radioBearerConfig Configuration of Radio Bearers (DRBs, SRBs) including SDAP/PDCP.

Editor's Note: FFS Whether secondary group can be resumed.

– *RRCResumeComplete*

The *RRCResumeComplete* message is used to confirm the successful completion of an RRC connection resumption.

Signalling radio bearer: SRB1

RLC-SAP: AM

Logical channel: DCCH

Direction: UE to Network

***RRCResumeComplete* message**

```
-- ASN1START
-- TAG-RRCRESUMECOMPLETE-START

RRCResumeComplete ::=                   SEQUENCE {
    rrc-TransactionIdentifier               RRC-TransactionIdentifier,
    criticalExtensions                      CHOICE {
        rrcResumeComplete                       RRCResumeComplete-IEs,
        criticalExtensionsFuture                SEQUENCE {}
    }
}
```

```
RRCResumeComplete-IEs ::=               SEQUENCE {
    dedicatedNAS-Message                    DedicatedNAS-Message                        OPTIONAL,
    selectedPLMN-Identity                   INTEGER (1..maxPLMN)                    OPTIONAL,
    uplinkTxDirectCurrentList               UplinkTxDirectCurrentList                                       OPTIONAL,
    lateNonCriticalExtension                OCTET STRING                                                    OPTIONAL,
    nonCriticalExtension                    SEQUENCE{}                                                      OPTIONAL
}

-- TAG-RRCRESUMECOMPLETE-STOP
-- ASN1STOP
```

RRCResumeComplete-IEs field descriptions
selectedPLMN-Identity Index of the PLMN selected by the UE from the *plmn-IdentityList* fields included in SIB1.
uplinkTxDirectCurrentList The Tx Direct Current locations for the configured serving cells and BWPs if requested by the NW (see reportUplinkTxDirectCurrent).

– *RRCResumeRequest*

The *RRCResumeRequest* is the 48bit message used to request the resumption of a suspended RRC connection or perform an RNA update.

Signalling radio bearer: SRB0

RLC-SAP: TM

Logical channel: CCCH

Direction: UE to Network

***RRCResumeRequest* message**

```
-- ASN1START
-- TAG-RRCRESUMEREQUEST-START

RRCResumeRequest ::=            SEQUENCE {
        rrcResumeRequest            RRCResumeRequest-IEs
}

RRCResumeRequest-IEs ::=        SEQUENCE {
    resumeIdentity                  ShortI-RNTI-Value,
    resumeMAC-I                     BIT STRING (SIZE (16)),
    resumeCause                     ResumeCause,
    spare                           BIT STRING (SIZE (1))
}

-- TAG-RRCRESUMEREQUEST-STOP
-- ASN1STOP
```

***RRCResumeRequest* field descriptions**
resumeCause Provides the resume cause for the RRC connection resume request as provided by the upper layers or RRC. The network is not expected to reject an *RRCResumeRequest* due to unknown cause value being used by the UE.
resumeIdentity UE identity to facilitate UE context retrieval at gNB.
resumeMAC-I Authentication token to facilitate UE authentication at gNB. The 16 least significant bits of the MAC-I calculated using the security configuration as specified in 5.3.13.3.

– *RRCResumeRequest1*

The *RRCResumeRequest1* is the 64 bit message used to request the resumption of a suspended RRC connection or perform an RNA update.

Signalling radio bearer: SRB0

RLC-SAP: TM

Logical channel: CCCH1

Direction: UE to Network

***RRCResumeRequest1* message**

```
-- ASN1START
-- TAG-RRCRESUMEREQUEST1-START

RRCResumeRequest1 ::= SEQUENCE {
       rrcResumeRequest1      RRCResumeRequest1-IEs
}

RRCResumeRequest1-IEs ::=    SEQUENCE {
    resumeIdentity               I-RNTI-Value,
    resumeMAC-I                  BIT STRING (SIZE (16)),
    resumeCause                  ResumeCause,
    spare                        BIT STRING (SIZE (1))
}

-- TAG-RRCRESUMEREQUEST1-STOP
-- ASN1STOP
```

RRCResumeRequest1-IEs field descriptions
resumeCause Provides the resume cause for the *RRCResumeRequest1* as provided by the upper layers or RRC. A gNB is not expected to reject an *RRCResumeRequest1* due to unknown cause value being used by the UE.
resumeIdentity UE identity to facilitate UE context retrieval at gNB.
resumeMAC-I Authentication token to facilitate UE authentication at gNB. The 16 least significant bits of the MAC-I calculated using the security configuration as specified in 5.3.13.3.

– *RRCSetup*

The *RRCSetup* message is used to establish SRB1.

Signalling radio bearer: SRB0

RLC-SAP: TM

Logical channel: CCCH

Direction: Network to UE

***RRCSetup* message**

```
-- ASN1START
-- TAG-RRCSETUP-START

RRCSetup ::=                        SEQUENCE {
    rrc-TransactionIdentifier           RRC-TransactionIdentifier,
    criticalExtensions                  CHOICE {
        rrcSetup                            RRCSetup-IEs,
        criticalExtensionsFuture            SEQUENCE {}
    }
}

RRCSetup-IEs ::=                    SEQUENCE {
    radioBearerConfig                   RadioBearerConfig,
    masterCellGroup                     OCTET STRING (CONTAINING CellGroupConfig),

    lateNonCriticalExtension            OCTET STRING                                                        OPTIONAL,
    nonCriticalExtension                SEQUENCE{}                                                          OPTIONAL
}

-- TAG-RRCSETUP-STOP
-- ASN1STOP
```

***RRCSetup-IEs* field descriptions**
masterCellGroup The network configures only the RLC bearer for the SRB1, mac-CellGroupConfig, physicalCellGroupConfig and spCellConfig.
radioBearerConfig Only SRB1 can be configured in RRC setup.

– *RRCSetupComplete*

The *RRCSetupComplete* message is used to confirm the successful completion of an RRC connection establishment.

Signalling radio bearer: SRB1

RLC-SAP: AM

Logical channel: DCCH

Direction: UE to Network

***RRCSetupComplete* message**

```
-- ASN1START
-- TAG-RRCSETUPCOMPLETE-START

RRCSetupComplete ::=                SEQUENCE {
    rrc-TransactionIdentifier           RRC-TransactionIdentifier,
    criticalExtensions                  CHOICE {
        rrcSetupComplete                    RRCSetupComplete-IEs,
        criticalExtensionsFuture            SEQUENCE {}
    }
}

RRCSetupComplete-IEs ::=            SEQUENCE {
    selectedPLMN-Identity               INTEGER (1..maxPLMN),
    registeredAMF                       RegisteredAMF                                   OPTIONAL,
    guami-Type                          ENUMERATED {native, mapped}                     OPTIONAL,
    s-nssai-List                        SEQUENCE (SIZE (1..maxNrofS-NSSAI)) OF S-NSSAI  OPTIONAL,
    dedicatedNAS-Message                DedicatedNAS-Message,
    ng-5G-S-TMSI-Value                  CHOICE {
        ng-5G-S-TMSI                        NG-5G-S-TMSI,
        ng-5G-S-TMSI-Part2                  BIT STRING (SIZE (9))
    }                                                                                   OPTIONAL,
    lateNonCriticalExtension            OCTET STRING                                    OPTIONAL,
    nonCriticalExtension                SEQUENCE{}                                      OPTIONAL
}

RegisteredAMF ::=                   SEQUENCE {
    plmn-Identity                       PLMN-Identity                                   OPTIONAL,
    amf-Identifier                      AMF-Identifier
}
```

```
-- TAG-RRCSETUPCOMPLETE-STOP
-- ASN1STOP
```

RRCSetupComplete-IEs field descriptions
guami-Type This field is used to indicate whether the guami included is native (derived from native 5G-GUTI) or mapped (from EPS, derived from EPS GUTI).
ng-5G-S-TMSI-Part2 The leftmost 9 bits of 5G-S-TMSI.
registeredAMF This field is used to transfer the AMF where the UE is registered, as provided by upper layers.
selectedPLMN-Identity Index of the PLMN selected by the UE from the *plmn-IdentityList* fields included in SIB1.

Editor's Note: FFS Field description of 5GC identifiers and other information.

– *RRCSetupRequest*

The *RRCSetupRequest* message is used to request the establishment of an RRC connection.

Signalling radio bearer: SRB0

RLC-SAP: TM

Logical channel: CCCH

Direction: UE to Network

RRCSetupRequest message

```
-- ASN1START
-- TAG-RRCSETUPREQUEST-START

RRCSetupRequest ::=                 SEQUENCE {
    rrcSetupRequest                     RRCSetupRequest-IEs
}

RRCSetupRequest-IEs ::=             SEQUENCE {
    ue-Identity                         InitialUE-Identity,
    establishmentCause                  EstablishmentCause,
    spare                               BIT STRING (SIZE (1))
}

InitialUE-Identity ::=              CHOICE {
    ng-5G-S-TMSI-Part1                  BIT STRING (SIZE (39)),
    randomValue                         BIT STRING (SIZE (39))
}
```

```
EstablishmentCause ::=              ENUMERATED {
                                        emergency, highPriorityAccess, mt-Access, mo-Signalling,
                                        mo-Data, mo-VoiceCall, mo-VideoCall, mo-SMS, mps-PriorityAccess, mcs-PriorityAccess,
                                        spare6, spare5, spare4, spare3, spare2, spare1}

-- TAG-RRCSETUPREQUEST-STOP
-- ASN1STOP
```

RRCSetupRequest-IEs field descriptions
establishmentCause Provides the establishment cause for the RRC request in accordance with the information received from upper layers. gNB is not expected to reject a RRCSetupRequest due to unknown cause value being used by the UE.
ue-Identity UE identity included to facilitate contention resolution by lower layers.

InitialUE-Identity field descriptions
ng-5G-S-TMSI-Part1 The rightmost 39 bits of 5G-S-TMSI.
randomValue Integer value in the range 0 to 2^{39} - 1.

– *RRCSystemInfoRequest*

The *RRCSystemInfoRequest* message is used to request SI message(s) required by the UE, for which *si-BroadcastStatus* in *si-SchedulingInfo* in *SIB1* is set to *notBroadcasting*, when no *si-RequestConfig* or *si-RequestConfigSUL* is included in the *si-SchedulingInfo*.

Signalling radio bearer: SRB0

RLC-SAP: TM

Logical channel: CCCH

Direction: UE to NR

RRCSystemInfoRequest message

```
-- ASN1START
-- TAG-RRCSYETEMINFOREQUEST-START

RRCSystemInfoRequest ::=            SEQUENCE {
    criticalExtensions                  CHOICE {
        rrcSystemInfoRequest-r15            RRCSystemInfoRequest-r15-IEs,
        criticalExtensionsFuture            SEQUENCE {}
    }
}
```

```
RRCSystemInfoRequest-r15-IEs ::=    SEQUENCE {
    requested-SI-List                   BIT STRING (SIZE (maxSI-Message)),  --32bits
    spare                               BIT STRING (SIZE (12))
}

-- TAG-RRCSYETEMINFOREQUEST-STOP
-- ASN1STOP
```

RRCSystemInfoRequest-r15-IEs field descriptions
requested-SI-List Contains a list of requested SI messages. According to the order of entry in the list of SI messages configured by *schedulingInfoList* in si-*SchedulingInfo* in *SIB1*, first bit corresponds to first/left most listed SI message, second to second listed SI message, and so on

– *SecurityModeCommand*

The *SecurityModeCommand* message is used to command the activation of AS security.

Signalling radio bearer: SRB1

RLC-SAP: AM

Logical channel: DCCH

Direction: Network to UE

SecurityModeCommand **message**

```
-- ASN1START
-- TAG-SECURITYMODECOMMAND-START

SecurityModeCommand ::=             SEQUENCE {
    rrc-TransactionIdentifier           RRC-TransactionIdentifier,
    criticalExtensions                  CHOICE {
        securityModeCommand                 SecurityModeCommand-IEs,
        criticalExtensionsFuture            SEQUENCE {}
    }
}

SecurityModeCommand-IEs ::=         SEQUENCE {
    securityConfigSMC                   SecurityConfigSMC,

    lateNonCriticalExtension            OCTET STRING                                                        OPTIONAL,
    nonCriticalExtension                SEQUENCE{}                                                          OPTIONAL
}

SecurityConfigSMC ::=               SEQUENCE {
    securityAlgorithmConfig             SecurityAlgorithmConfig,
    ...
```

```
}

-- TAG-SECURITYMODECOMMAND-STOP
-- ASN1STOP
```

– *SecurityModeComplete*

The *SecurityModeComplete* message is used to confirm the successful completion of a security mode command.

Signalling radio bearer: SRB1

RLC-SAP: AM

Logical channel: DCCH

Direction: UE to Network

SecurityModeComplete **message**

```
-- ASN1START
-- TAG-SECURITYMODECOMPLETE-START

SecurityModeComplete ::=            SEQUENCE {
    rrc-TransactionIdentifier           RRC-TransactionIdentifier,
    criticalExtensions                  CHOICE {
        securityModeComplete                SecurityModeComplete-IEs,
        criticalExtensionsFuture            SEQUENCE {}
    }
}

SecurityModeComplete-IEs ::=        SEQUENCE {
    lateNonCriticalExtension            OCTET STRING                                                            OPTIONAL,
    nonCriticalExtension                SEQUENCE{}                                                              OPTIONAL
}

-- TAG-SECURITYMODECOMPLETE-STOP
-- ASN1STOP
```

– *SecurityModeFailure*

The *SecurityModeFailure* message is used to indicate an unsuccessful completion of a security mode command.

Signalling radio bearer: SRB1

RLC-SAP: AM

Logical channel: DCCH

Direction: UE to Network

***SecurityModeFailure* message**

```
-- ASN1START
-- TAG-SECURITYMODEFAILURE-START

SecurityModeFailure ::=             SEQUENCE {
    rrc-TransactionIdentifier           RRC-TransactionIdentifier,
    criticalExtensions                  CHOICE {
        securityModeFailure                 SecurityModeFailure-IEs,
        criticalExtensionsFuture            SEQUENCE {}
    }
}

SecurityModeFailure-IEs ::=         SEQUENCE {
    lateNonCriticalExtension            OCTET STRING                                                OPTIONAL,
    nonCriticalExtension                SEQUENCE{}                                                  OPTIONAL
}

-- TAG-SECURITYMODEFAILURE-STOP
-- ASN1STOP
```

– *SIB1*

SIB1 contains information relevant when evaluating if a UE is allowed to access a cell and defines the scheduling of other system information. It also contains radio resource configuration information that is common for all UEs and barring information applied to the unified access control.

Signalling radio bearer: N/A

RLC-SAP: TM

Logical channels: BCCH

Direction: Network to UE

***SIB1* message**

```
-- ASN1START
-- TAG-SIB1-START

SIB1 ::=        SEQUENCE {
    cellSelectionInfo                   SEQUENCE {
        q-RxLevMin                          Q-RxLevMin,
        q-RxLevMinOffset                    INTEGER (1..8)                                  OPTIONAL,   -- Need S
        q-RxLevMinSUL                       Q-RxLevMin                                      OPTIONAL,   -- Need R
        q-QualMin                           Q-QualMin                                       OPTIONAL,   -- Need S
        q-QualMinOffset                     INTEGER (1..8)                                  OPTIONAL    -- Need S
    }                                                                                       OPTIONAL,   -- Cond Standalone
    cellAccessRelatedInfo               CellAccessRelatedInfo,
```

```
    connEstFailureControl               ConnEstFailureControl                                                   OPTIONAL,   -- Need R
    si-SchedulingInfo                   SI-SchedulingInfo                                                       OPTIONAL,   -- Need R
    servingCellConfigCommon             ServingCellConfigCommonSIB                                              OPTIONAL,   -- Need R
    ims-EmergencySupport                ENUMERATED {true}                                                       OPTIONAL,   -- Need R
    eCallOverIMS-Support                ENUMERATED {true}                                                       OPTIONAL,   -- Cond Absent
    ue-TimersAndConstants               UE-TimersAndConstants                                                   OPTIONAL,   -- Need R

    uac-BarringInfo                     SEQUENCE {
        uac-BarringForCommon                UAC-BarringPerCatList                                               OPTIONAL,   -- Need S
        uac-BarringPerPLMN-List             UAC-BarringPerPLMN-List                                             OPTIONAL,   -- Need S
        uac-BarringInfoSetList              UAC-BarringInfoSetList,
        uac-AccessCategory1-SelectionAssistanceInfo CHOICE {
            plmnCommon                               UAC-AccessCategory1-SelectionAssistanceInfo,
            individualPLMNList                       SEQUENCE (SIZE (2..maxPLMN)) OF UAC-AccessCategory1-SelectionAssistanceInfo
        }                                                                                                       OPTIONAL    -- Need S
    }                                                                                                           OPTIONAL,   -- Need R

    useFullResumeID                     ENUMERATED {true}                                                       OPTIONAL,   -- Need N

    lateNonCriticalExtension            OCTET STRING                                                            OPTIONAL,
    nonCriticalExtension                SEQUENCE{}                                                              OPTIONAL
}

UAC-AccessCategory1-SelectionAssistanceInfo ::= ENUMERATED {a, b, c}

-- TAG-SIB1-STOP
-- ASN1STOP
```

SIB1 field descriptions
cellSelectionInfo Parameters for cell selection related to the serving cell.
ims-EmergencySupport Indicates whether the cell supports IMS emergency bearer services for UEs in limited service mode. If absent, IMS emergency call is not supported by the network in the cell for UEs in limited service mode.
q-QualMin Parameter "$Q_{qualmin}$" in TS 38.304 [20], applicable for serving cell. If the field is not present, the UE applies the (default) value of negative infinity for $Q_{qualmin}$.
q-QualMinOffset Parameter "$Q_{qualminoffset}$" in TS 38.304 [20]. Actual value $Q_{qualminoffset}$ = field value [dB]. If the field is not present, the UE applies the (default) value of 0 dB for $Q_{qualminoffset}$. Affects the minimum required quality level in the cell.
q-RxLevMin Parameter "$Q_{rxlevmin}$" in TS 38.304 [20], applicable for serving cell.
q-RxLevMinOffset Parameter "$Q_{rxlevminoffset}$" in TS 38.304 [20]. Actual value $Q_{rxlevminoffset}$ = field value * 2 [dB]. If absent, the UE applies the (default) value of 0 dB for $Q_{rxlevminoffset}$. Affects the minimum required Rx level in the cell.
q-RxLevMinSUL Parameter "$Q_{rxlevminSUL}$" in TS 38.304 [20], applicable for serving cell
servingCellConfigCommon Configuration of the serving cell.
uac-AccessCategory1-SelectionAssistanceInfo Information used to determine whether Access Category 1 applies to the UE, as defined in TS 22.261 [25]. A UE compliant with this version of the specification shall ignore this field.
uac-BarringForCommon Common access control parameters for each access category. Common values are used for all PLMNs, unless overwritten by the PLMN specific configuration provided in *uac-BarringPerPLMN-List*. The parameters are specified by providing an index to the set of configurations (*uac-BarringInfoSetList*). UE behaviour upon absence of this field is specified in clause 5.3.14.2.
ue-TimersAndConstants Timer and constant values to be used by the UE.
useFullResumeID Indicates which resume identifier and Resume request message should be used. UE uses full I-RNTI and *RRCResumeRequest1* if the field is present, or short I-RNTI and *RRCResumeRequest* if the field is absent.

Conditional Presence	**Explanation**
Absent	The field is not used in this version of the specification, if received the UE shall ignore.
Standalone	The field is mandatory present in a cell that supports standalone operation, otherwise it is not present

– *SystemInformation*

The *SystemInformation* message is used to convey one or more System Information Blocks. All the SIBs included are transmitted with the same periodicity.

Signalling radio bearer: N/A

RLC-SAP: TM

Logical channels: BCCH

Direction: Network to UE

SystemInformation message

```
-- ASN1START
-- TAG-SYSTEMINFORMATION-START

SystemInformation ::=                SEQUENCE {
    criticalExtensions                   CHOICE {
        systemInformation-r15                SystemInformation-IEs,
        criticalExtensionsFuture             SEQUENCE {}
    }
}

SystemInformation-IEs ::=            SEQUENCE {
    sib-TypeAndInfo                      SEQUENCE (SIZE (1..maxSIB)) OF CHOICE {
        sib2                                 SIB2,
        sib3                                 SIB3,
        sib4                                 SIB4,
        sib5                                 SIB5,
        sib6                                 SIB6,
        sib7                                 SIB7,
        sib8                                 SIB8,
        sib9                                 SIB9,
        ...
    },

    lateNonCriticalExtension             OCTET STRING                        OPTIONAL,
    nonCriticalExtension                 SEQUENCE {}                         OPTIONAL
}

-- TAG-SYSTEMINFORMATION-STOP
-- ASN1STOP
```

– *UEAssistanceInformation*

The *UEAssistanceInformation* message is used for the indication of UE assistance information to the network.

Signalling radio bearer: SRB1

RLC-SAP: AM

Logical channel: DCCH

Direction: UE to Network

UEAssistance Information message

```
-- ASN1START
-- TAG-UEASSISTANCEINFORMATION-START

UEAssistanceInformation ::=         SEQUENCE {
    criticalExtensions                  CHOICE {
        ueAssistanceInformation             UEAssistanceInformation-IEs,
        criticalExtensionsFuture            SEQUENCE {}
    }
}

UEAssistanceInformation-IEs ::=     SEQUENCE {
    delayBudgetReport                   DelayBudgetReport                   OPTIONAL,
    lateNonCriticalExtension            OCTET STRING                        OPTIONAL,
    nonCriticalExtension                UEAssistanceInformation-v1540-IEs   OPTIONAL
}

DelayBudgetReport::=                CHOICE {
    type1                               ENUMERATED {
                                            msMinus1280, msMinus640, msMinus320, msMinus160,msMinus80, msMinus60, msMinus40,
                                            msMinus20, ms0, ms20,ms40, ms60, ms80, ms160, ms320, ms640, ms1280},
    ...
}

UEAssistanceInformation-v1540-IEs ::= SEQUENCE {
    overheatingAssistance               OverheatingAssistance               OPTIONAL,
    nonCriticalExtension                SEQUENCE {}                         OPTIONAL
}

OverheatingAssistance ::=           SEQUENCE {
    reducedMaxCCs                       SEQUENCE {
        reducedCCsDL                        INTEGER (0..31),
        reducedCCsUL                        INTEGER (0..31)
    } OPTIONAL,
    reducedMaxBW-FR1                    SEQUENCE {
        reducedBW-FR1-DL                    ReducedAggregatedBandwidth,
        reducedBW-FR1-UL                    ReducedAggregatedBandwidth
    } OPTIONAL,
    reducedMaxBW-FR2                    SEQUENCE {
        reducedBW-FR2-DL                    ReducedAggregatedBandwidth,
        reducedBW-FR2-UL                    ReducedAggregatedBandwidth
    } OPTIONAL,
    reducedMaxMIMO-LayersFR1            SEQUENCE {
        reducedMIMO-LayersFR1-DL            MIMO-LayersDL,
        reducedMIMO-LayersFR1-UL            MIMO-LayersUL
    } OPTIONAL,
    reducedMaxMIMO-LayersFR2            SEQUENCE {
        reducedMIMO-LayersFR2-DL            MIMO-LayersDL,
        reducedMIMO-LayersFR2-UL            MIMO-LayersUL
    } OPTIONAL
}

ReducedAggregatedBandwidth ::= ENUMERATED {mhz0, mhz10, mhz20, mhz30, mhz40, mhz50, mhz60, mhz80, mhz100, mhz200, mhz300, mhz400}
```

```
-- TAG-UEASSISTANCEINFORMATION-STOP
-- ASN1STOP
```

***UEAssistanceInformation* field descriptions**
delayBudgetReport Indicates the UE-preferred adjustment to connected mode DRX.
reducedBW-FR1-DL Indicates the UE's preference on reduced configuration corresponding to the maximum aggregated bandwidth across all downlink carriers of FR1 indicated by the field, to address overheating. This field is allowed to be reported only when UE is configured with serving cells operating on FR1.
reducedBW-FR1-UL Indicates the UE's preference on reduced configuration corresponding to the maximum aggregated bandwidth across all uplink carriers of FR1 indicated by the field, to address overheating. This field is allowed to be reported only when UE is configured with serving cells operating on FR1.
reducedBW-FR2-DL Indicates the UE's preference on reduced configuration corresponding to the maximum aggregated bandwidth across all downlink carriers of FR2 indicated by the field, to address overheating. This field is allowed to be reported only when UE is configured with serving cells operating on FR2. mhz0 is only applicable for FR2.
reducedBW-FR2-UL Indicates the UE's preference on reduced configuration corresponding to the maximum aggregated bandwidth across all uplink carriers of FR2 indicated by the field, to address overheating. This field is allowed to be reported only when UE is configured with serving cells operating on FR2. mhz0 is only applicable for FR2.
reducedCCsDL Indicates the UE's preference on reduced configuration corresponding to the maximum number of downlink SCells indicated by the field, to address overheating.
reducedCCsUL Indicates the UE's preference on reduced configuration corresponding to the maximum number of uplink SCells indicated by the field, to address overheating.
reducedMIMO-LayersFR1-DL Indicates the UE's preference on reduced configuration corresponding to the maximum number of downlink MIMO layers of each serving cell operating on FR1 indicated by the field, to address overheating. This field is allowed to be reported only when UE is configured with serving cells operating on FR1.
reducedMIMO-LayersFR1-UL Indicates the UE's preference on reduced configuration corresponding to the maximum number of uplink MIMO layers of each serving cell operating on FR1 indicated by the field, to address overheating. This field is allowed to be reported only when UE is configured with serving cells operating on FR1.
reducedMIMO-LayersFR2-DL Indicates the UE's preference on reduced configuration corresponding to the maximum number of downlink MIMO layers of each serving cell operating on FR2 indicated by the field, to address overheating. This field is allowed to be reported only when UE is configured with serving cells operating on FR2.
reducedMIMO-LayersFR2-UL Indicates the UE's preference on reduced configuration corresponding to the maximum number of uplink MIMO layers of each serving cell operating on FR2 indicated by the field, to address overheating. This field is allowed to be reported only when UE is configured with serving cells operating on FR2.
type1 Indicates the preferred amount of increment/decrement to the long DRX cycle length with respect to the current configuration. Value in number of milliseconds. Value ms40 corresponds to 40 milliseconds, msMinus40 corresponds to -40 milliseconds and so on.

– *UECapabilityEnquiry*

The *UECapabilityEnquiry* message is used to request UE radio access capabilities for NR as well as for other RATs.

Signalling radio bearer: SRB1

RLC-SAP: AM

Logical channel: DCCH

Direction: Network to UE

UECapabilityEnquiry information element

```
-- ASN1START
-- TAG-UECAPABILITYENQUIRY-START

UECapabilityEnquiry ::=         SEQUENCE {
    rrc-TransactionIdentifier           RRC-TransactionIdentifier,
    criticalExtensions                  CHOICE {
        ueCapabilityEnquiry                 UECapabilityEnquiry-IEs,
        criticalExtensionsFuture            SEQUENCE {}
    }
}

UECapabilityEnquiry-IEs ::=     SEQUENCE {
    ue-CapabilityRAT-RequestList        UE-CapabilityRAT-RequestList,

    lateNonCriticalExtension            OCTET STRING                                                            OPTIONAL,
    nonCriticalExtension                SEQUENCE{}                                                              OPTIONAL
}

-- TAG-UECAPABILITYENQUIRY-STOP
-- ASN1STOP
```

– *UECapabilityInformation*

The IE *UECapabilityInformation* message is used to transfer UE radio access capabilities requested by the network.

Signalling radio bearer: SRB1

RLC-SAP: AM

Logical channel: DCCH

Direction: UE to Network

UECapabilityInformation information element

```
-- ASN1START
-- TAG-UECAPABILITYINFORMATION-START

UECapabilityInformation ::=         SEQUENCE {
    rrc-TransactionIdentifier           RRC-TransactionIdentifier,
    criticalExtensions                  CHOICE {
        ueCapabilityInformation             UECapabilityInformation-IEs,
```

```
        criticalExtensionsFuture            SEQUENCE {}
    }
}

UECapabilityInformation-IEs ::=     SEQUENCE {
    ue-CapabilityRAT-ContainerList      UE-CapabilityRAT-ContainerList                                          OPTIONAL,

    lateNonCriticalExtension            OCTET STRING                                                            OPTIONAL,
    nonCriticalExtension                SEQUENCE{}                                                              OPTIONAL
}

-- TAG-UECAPABILITYINFORMATION-STOP
-- ASN1STOP
```

– *ULInformationTransfer*

The *ULInformationTransfer* message is used for the uplink transfer of NAS or non-3GPP dedicated information.

Signalling radio bearer: SRB2 or SRB1 (only if SRB2 not established yet). If SRB2 is suspended, the UE does not send this message until SRB2 is resumed

RLC-SAP: AM

Logical channel: DCCH

Direction: UE to network

ULInformationTransfer message

```
-- ASN1START
-- TAG-ULINFORMATIONTRANSFER-START

ULInformationTransfer ::=           SEQUENCE {
    criticalExtensions                  CHOICE {
        ulInformationTransfer               ULInformationTransfer-IEs,
        criticalExtensionsFuture            SEQUENCE {}
    }
}

ULInformationTransfer-IEs ::=       SEQUENCE {
    dedicatedNAS-Message                DedicatedNAS-Message                OPTIONAL,
    lateNonCriticalExtension            OCTET STRING                        OPTIONAL,
    nonCriticalExtension                SEQUENCE {}                         OPTIONAL
}

-- TAG-ULINFORMATIONTRANSFER-STOP
-- ASN1STOP
```

6.3 RRC information elements

6.3.0 Parameterized types

– *SetupRelease*

SetupRelease allows the *ElementTypeParam* to be used as the referenced data type for the setup and release entries. See A.3.8 for guidelines.

```
-- ASN1START
-- TAG-SETUP-RELEASE-START

SetupRelease { ElementTypeParam } ::= CHOICE {
    release         NULL,
    setup           ElementTypeParam
}

-- TAG-SETUP-RELEASE-STOP
-- ASN1STOP
```

6.3.1 System information blocks

– *SIB2*

SIB2 contains cell re-selection information common for intra-frequency, inter-frequency and/or inter-RAT cell re-selection (i.e. applicable for more than one type of cell re-selection but not necessarily all) as well as intra-frequency cell re-selection information other than neighbouring cell related.

***SIB2* information element**

```
-- ASN1START
-- TAG-SIB2-START

SIB2 ::=                            SEQUENCE {
    cellReselectionInfoCommon           SEQUENCE {
        nrofSS-BlocksToAverage              INTEGER (2..maxNrofSS-BlocksToAverage)          OPTIONAL,       -- Need R
        absThreshSS-BlocksConsolidation     ThresholdNR                                     OPTIONAL,       -- Need R
        rangeToBestCell                     RangeToBestCell                                 OPTIONAL,       -- Need R
        q-Hyst                              ENUMERATED {
                                                dB0, dB1, dB2, dB3, dB4, dB5, dB6, dB8, dB10,
                                                dB12, dB14, dB16, dB18, dB20, dB22, dB24},
        speedStateReselectionPars           SEQUENCE {
            mobilityStateParameters             MobilityStateParameters,
            q-HystSF                            SEQUENCE {
                sf-Medium                           ENUMERATED {dB-6, dB-4, dB-2, dB0},
                sf-High                             ENUMERATED {dB-6, dB-4, dB-2, dB0}
            }
        }                                                                                   OPTIONAL,       -- Need R
    ...
    },
```

```
    cellReselectionServingFreqInfo      SEQUENCE {
        s-NonIntraSearchP                   ReselectionThreshold                                OPTIONAL,       -- Need R
        s-NonIntraSearchQ                   ReselectionThresholdQ                               OPTIONAL,       -- Need R
        threshServingLowP                   ReselectionThreshold,
        threshServingLowQ                   ReselectionThresholdQ                               OPTIONAL,       -- Need R
        cellReselectionPriority             CellReselectionPriority,
        cellReselectionSubPriority          CellReselectionSubPriority                          OPTIONAL,       -- Need R
        ...
    },
    intraFreqCellReselectionInfo        SEQUENCE {
        q-RxLevMin                          Q-RxLevMin,
        q-RxLevMinSUL                       Q-RxLevMin                                          OPTIONAL,       -- Need R
        q-QualMin                           Q-QualMin                                           OPTIONAL,       -- Need S
        s-IntraSearchP                      ReselectionThreshold,
        s-IntraSearchQ                      ReselectionThresholdQ                               OPTIONAL,       -- Cond RSRQ
        t-ReselectionNR                     T-Reselection,
        frequencyBandList                   MultiFrequencyBandListNR-SIB                        OPTIONAL,       -- Need S
        frequencyBandListSUL                MultiFrequencyBandListNR-SIB                        OPTIONAL,       -- Need R
        p-Max                               P-Max                                               OPTIONAL,       -- Need R
        smtc                                SSB-MTC                                             OPTIONAL,       -- Need R
        ss-RSSI-Measurement                 SS-RSSI-Measurement                                 OPTIONAL,       -- Need R
        ssb-ToMeasure                       SSB-ToMeasure                                       OPTIONAL,       -- Need R
        deriveSSB-IndexFromCell             BOOLEAN,
        ...,
        [[
        t-ReselectionNR-SF                  SpeedStateScaleFactors                              OPTIONAL        -- Need N
        ]]
    },
    ...
}

RangeToBestCell ::= Q-OffsetRange

-- TAG-SIB2-STOP
-- ASN1STOP
```

SIB2 field descriptions
absThreshSS-BlocksConsolidation Threshold for consolidation of L1 measurements per RS index. If the field is absent, the UE uses the measurement quantity as specified in TS 38.304 [20].
cellReselectionInfoCommon Cell re-selection information common for intra-frequency, inter-frequency and/ or inter-RAT cell re-selection.
cellReselectionServingFreqInfo Information common for non-intra-frequency cell re-selection i.e. cell re-selection to inter-frequency and inter-RAT cells.
deriveSSB-IndexFromCell This field indicates whether the UE can utilize serving cell timing to derive the index of SS block transmitted by neighbour cell. If this field is set to TRUE, the UE assumes SFN and frame boundary alignment across cells on the serving frequency as specified in TS 38.133 [14].
frequencyBandList Indicates the list of frequency bands for which the NR cell reselection parameters apply. The UE behaviour in case the field is absent is described in subclause 5.2.2.4.3.
intraFreqCellReselectionInfo Cell re-selection information common for intra-frequency cells.
nrofSS-BlocksToAverage Number of SS blocks to average for cell measurement derivation. If the field is absent the UE uses the measurement quantity as specified in TS 38.304 [20].
p-Max Value in dBm applicable for the intra-frequency neighbouring NR cells. If absent the UE applies the maximum power according to TS 38.101 [15].
q-Hyst Parameter "Q_{hyst}" in TS 38.304 [20], Value in dB. Value dB1 corresponds to 1 dB, dB2 corresponds to 2 dB and so on.
q-HystSF Parameter "Speed dependent ScalingFactor for Qhyst" in TS 38.304 [20]. The sf-Medium and sf-High concern the additional hysteresis to be applied, in Medium and High Mobility state respectively, to Qhyst as defined in TS 38.304 [20]. In dB. Value dB-6 corresponds to -6dB, dB-4 corresponds to -4dB and so on.
q-QualMin Parameter "$Q_{qualmin}$" in TS 38.304 [20], applicable for intra-frequency neighbour cells. If the field is not present, the UE applies the (default) value of negative infinity for $Q_{qualmin}$.
q-RxLevMin Parameter "$Q_{rxlevmin}$" in TS 38.304 [20], applicable for intra-frequency neighbour cells.
q-RxLevMinSUL Parameter "$Q_{rxlevminSUL}$" in TS 38.304 [20], applicable for intra-frequency neighbour cells.
rangeToBestCell Parameter "rangeToBestCell" in TS 38.304 [20]. The network configures only non-negative (in dB) values.
s-IntraSearchP Parameter "$S_{IntraSearchP}$" in TS 38.304 [20]. If this field is not present, the UE applies the (default) value of infinity for $S_{IntraSearchP}$.
s-IntraSearchQ Parameter "$S_{IntraSearchQ}$2 in TS 38.304 [20]. If the field is not present, the UE applies the (default) value of 0 dB for $S_{IntraSearchQ}$.
s-NonIntraSearchP Parameter "$S_{nonIntraSearchP}$" in TS 38.304 [20]. If this field is not present, the UE applies the (default) value of infinity for $S_{nonIntraSearchP}$.
s-NonIntraSearchQ Parameter "$S_{nonIntraSearchQ}$" in TS 38.304 [20]. If the field is not present, the UE applies the (default) value of 0 dB for $S_{nonIntraSearchQ}$.
smtc Measurement timing configuration for intra-frequency measurement. If this field is absent, the UE assumes that SSB periodicity is 5 ms for the intra-frequnecy cells.
ssb-ToMeasure The set of SS blocks to be measured within the SMTC measurement duration (see TS 38.215 [9]). When the field is absent the UE measures on all SS-blocks.
t-ReselectionNR Parameter "$Treselection_{NR}$" in TS 38.304 [20].

SIB2 field descriptions
t-ReselectionNR-SF Parameter "Speed dependent ScalingFactor for Treselection$_{NR}$" in TS 38.304 [20]. If the field is not present, the UE behaviour is specified in TS 38.304 [20].
threshServingLowP Parameter "Thresh$_{Serving, LowP}$" in TS 38.304 [20].
threshServingLowQ Parameter "Thresh$_{Serving, LowQ}$" in TS 38.304 [20].

Conditional Presence	Explanation
RSRQ	The field is optionally present, Need R, if threshServingLowQ is present in SIB2; otherwise it is not present.

– *SIB3*

SIB3 contains neighbouring cell related information relevant only for intra-frequency cell re-selection. The IE includes cells with specific re-selection parameters as well as blacklisted cells.

SIB3 information element

```
-- ASN1START
-- TAG-SIB3-START

SIB3 ::=                            SEQUENCE {
    intraFreqNeighCellList              IntraFreqNeighCellList      OPTIONAL,   -- Need R
    intraFreqBlackCellList              IntraFreqBlackCellList      OPTIONAL,   -- Need R
    lateNonCriticalExtension            OCTET STRING                OPTIONAL,
    ...
}

IntraFreqNeighCellList ::=          SEQUENCE (SIZE (1..maxCellIntra)) OF IntraFreqNeighCellInfo

IntraFreqNeighCellInfo ::=          SEQUENCE {
    physCellId                          PhysCellId,
    q-OffsetCell                        Q-OffsetRange,
    q-RxLevMinOffsetCell                INTEGER (1..8)              OPTIONAL,   -- Need R
    q-RxLevMinOffsetCellSUL             INTEGER (1..8)              OPTIONAL,   -- Need R
    q-QualMinOffsetCell                 INTEGER (1..8)              OPTIONAL,   -- Need R
    ...
}

IntraFreqBlackCellList ::=          SEQUENCE (SIZE (1..maxCellBlack)) OF PCI-Range

-- TAG-SIB3-STOP
-- ASN1STOP
```

SIB3 field descriptions
intraFreqBlackCellList List of blacklisted intra-frequency neighbouring cells.
intraFreqNeighCellList List of intra-frequency neighbouring cells with specific cell re-selection parameters.
q-OffsetCell Parameter "$Qoffset_{s,n}$" in TS 38.304 [20].
q-QualMinOffsetCell Parameter "$Q_{qualminoffsetcell}$" in TS 38.304 [20]. Actual value $Q_{qualminoffsetcell}$ = field value [dB].
q-RxLevMinOffsetCell Parameter "$Q_{rxlevminoffsetcell}$" in TS 38.304 [20]. Actual value $Q_{rxlevminoffsetcell}$ = field value * 2 [dB].
q-RxLevMinOffsetCellSUL Parameter "$Q_{rxlevminoffsetcellSUL}$" in TS 38.304 [20]. Actual value $Q_{rxlevminoffsetcellSUL}$ = field value * 2 [dB].

– *SIB4*

SIB4 contains information relevant only for inter-frequency cell re-selection i.e. information about other NR frequencies and inter-frequency neighbouring cells relevant for cell re-selection. The IE includes cell re-selection parameters common for a frequency as well as cell specific re-selection parameters.

SIB4 information element

```
-- ASN1START
-- TAG-SIB4-START

SIB4 ::=                            SEQUENCE {
    interFreqCarrierFreqList            InterFreqCarrierFreqList,
    lateNonCriticalExtension            OCTET STRING                            OPTIONAL,
    ...
}

InterFreqCarrierFreqList ::=        SEQUENCE (SIZE (1..maxFreq)) OF InterFreqCarrierFreqInfo

InterFreqCarrierFreqInfo ::=        SEQUENCE {
    dl-CarrierFreq                      ARFCN-ValueNR,
    frequencyBandList                   MultiFrequencyBandListNR-SIB            OPTIONAL,   -- Need S
    frequencyBandListSUL                MultiFrequencyBandListNR-SIB            OPTIONAL,   -- Need R
    nrofSS-BlocksToAverage              INTEGER (2..maxNrofSS-BlocksToAverage)  OPTIONAL,   -- Need R
    absThreshSS-BlocksConsolidation     ThresholdNR                             OPTIONAL,   -- Need R
    smtc                                SSB-MTC                                 OPTIONAL,   -- Need R
    ssbSubcarrierSpacing                SubcarrierSpacing,
    ssb-ToMeasure                       SSB-ToMeasure                           OPTIONAL,   -- Need R
    deriveSSB-IndexFromCell             BOOLEAN,
    ss-RSSI-Measurement                 SS-RSSI-Measurement                     OPTIONAL,
    q-RxLevMin                          Q-RxLevMin,
    q-RxLevMinSUL                       Q-RxLevMin                              OPTIONAL,   -- Need R
    q-QualMin                           Q-QualMin                               OPTIONAL,   -- Need S,
    p-Max                               P-Max                                   OPTIONAL,   -- Need R
    t-ReselectionNR                     T-Reselection,
    t-ReselectionNR-SF                  SpeedStateScaleFactors                  OPTIONAL,    -- Need S
```

```
    threshX-HighP                       ReselectionThreshold,
    threshX-LowP                        ReselectionThreshold,
    threshX-Q                           SEQUENCE {
        threshX-HighQ                       ReselectionThresholdQ,
        threshX-LowQ                        ReselectionThresholdQ
    }                                                                           OPTIONAL,   -- Cond RSRQ
    cellReselectionPriority             CellReselectionPriority                 OPTIONAL,   -- Need R
    cellReselectionSubPriority          CellReselectionSubPriority              OPTIONAL,   -- Need R
    q-OffsetFreq                        Q-OffsetRange                           DEFAULT dB0,
    interFreqNeighCellList              InterFreqNeighCellList                  OPTIONAL,   -- Need R
    interFreqBlackCellList              InterFreqBlackCellList                  OPTIONAL,   -- Need R
    ...
}

InterFreqNeighCellList ::=          SEQUENCE (SIZE (1..maxCellInter)) OF InterFreqNeighCellInfo

InterFreqNeighCellInfo ::=          SEQUENCE {
    physCellId                          PhysCellId,
    q-OffsetCell                        Q-OffsetRange,
        q-RxLevMinOffsetCell            INTEGER (1..8)                          OPTIONAL,   -- Need R
        q-RxLevMinOffsetCellSUL         INTEGER (1..8)                          OPTIONAL,   -- Need R
    q-QualMinOffsetCell                 INTEGER (1..8)                          OPTIONAL,   -- Need R
    ...

}

InterFreqBlackCellList ::=          SEQUENCE (SIZE (1..maxCellBlack)) OF PCI-Range

-- TAG-SIB4-STOP
-- ASN1STOP
```

SIB4 field descriptions
absThreshSS-BlocksConsolidation Threshold for consolidation of L1 measurements per RS index. If the field is absent, the UE uses the measurement quantity as specified in TS 38.304 [20].
deriveSSB-IndexFromCell This field indicates whether the UE may use the timing of any detected cell on that frequency to derive the SSB index of all neighbour cells on that frequency. If this field is set to TRUE, the UE assumes SFN and frame boundary alignment across cells on the neighbor frequency as specified in TS 38.133 [14].
dl-CarrierFreq This field indicates center frequency of the SS block of the neighbour cells, where the frequency corresponds to a GSCN value as specified in TS 38.101 [15].
frequencyBandList Indicates the list of frequency bands for which the NR cell reselection parameters apply. The UE behaviour in case the field is absent is described in subclause 5.2.2.4.5.
interFreqBlackCellList List of blacklisted inter-frequency neighbouring cells.
interFreqCarrierFreqList List of neighbouring carrier frequencies and frequency specific cell re-selection information.
interFreqNeighCellList List of inter-frequency neighbouring cells with specific cell re-selection parameters.
nrofSS-BlocksToAverage Number of SS blocks to average for cell measurement derivation. If the field is absent, the UE uses the measurement quantity as specified in TS 38.304 [20].
p-Max Value in dBm applicable for the neighbouring NR cells on this carrier frequency. If absent the UE applies the maximum power according to TS 38.101 [15].
q-OffsetCell Parameter "$\text{Qoffset}_{s,n}$" in TS 38.304 [20].
q-OffsetFreq Parameter "$\text{Qoffset}_{frequency}$" in TS 38.304 [20].
q-QualMin Parameter "$Q_{qualmin}$" in TS 38.304 [20]. If the field is not present, the UE applies the (default) value of negative infinity for $Q_{qualmin}$.
q-QualMinOffsetCell Parameter "$Q_{qualminoffsetcell}$" in TS 38.304 [20]. Actual value $Q_{qualminoffsetcell}$ = field value [dB].
q-RxLevMin Parameter "Qrxlevmin" in TS 38.304 [20].
q-RxLevMinOffsetCell Parameter "$Q_{rxlevminoffsetcell}$" in TS 38.304 [20]. Actual value $Q_{rxlevminoffsetcell}$ = field value * 2 [dB].
q-RxLevMinOffsetCellSUL Parameter "$Q_{rxlevminoffsetcellSUL}$" in TS 38.304 [20]. Actual value $Q_{rxlevminoffsetcellSUL}$ = field value * 2 [dB].
q-RxLevMinSUL Parameter "Qrxlevmin" in TS 38.304 [20].
smtc Measurement timing configuration for inter-frequency measurement. If this field is absent, the UE assumes that SSB periodicity is 5 ms in this frequency.
ssb-ToMeasure The set of SS blocks to be measured within the SMTC measurement duration (see TS 38.215 [9]). When the field is absent the UE measures on all SS-blocks.
ssbSubcarrierSpacing Subcarrier spacing of SSB. Only the values 15 or 30 (<6GHz), 120 kHz or 240 kHz (>6GHz) are applicable.
threshX-HighP Parameter "$\text{Thresh}_{X, HighP}$" in TS 38.304 [20].
threshX-HighQ Parameter "$\text{Thresh}_{X, HighQ}$" in TS 38.304 [20].

***SIB4* field descriptions**
threshX-LowP Parameter "Thresh$_{X, LowP}$" in TS 38.304 [20].
threshX-LowQ Parameter "Thresh$_{X, LowQ}$" in TS 38.304 [20].
t-ReselectionNR Parameter "Treselection$_{NR}$" in TS 38.304 [20].
t-ReselectionNR-SF Parameter "Speed dependent ScalingFactor for Treselection$_{NR}$" in TS 38.304 [20]. If the field is not present, the UE behaviour is specified in TS 38.304 [20].

Conditional Presence	Explanation
RSRQ	The field is mandatory present if threshServingLowQ is present in SIB2; otherwise it is not present.

– *SIB5*

SIB5 contains information relevant only for inter-RAT cell re-selection i.e. information about E-UTRA frequencies and E-UTRAs neighbouring cells relevant for cell re-selection. The IE includes cell re-selection parameters common for a frequency.

SIB5 information element

```
-- ASN1START
-- TAG-SIB5-START

SIB5 ::=                            SEQUENCE {
    carrierFreqListEUTRA                CarrierFreqListEUTRA                        OPTIONAL,       -- Need R
    t-ReselectionEUTRA                  T-Reselection,
    t-ReselectionEUTRA-SF               SpeedStateScaleFactors                      OPTIONAL,       -- Need S
    lateNonCriticalExtension            OCTET STRING                                OPTIONAL,
    ...
}

CarrierFreqListEUTRA ::=            SEQUENCE (SIZE (1..maxEUTRA-Carrier)) OF CarrierFreqEUTRA

CarrierFreqEUTRA ::=                SEQUENCE {
    carrierFreq                         ARFCN-ValueEUTRA,
    eutra-multiBandInfoList             EUTRA-MultiBandInfoList                     OPTIONAL,       -- Need R
    eutra-FreqNeighCellList             EUTRA-FreqNeighCellList                     OPTIONAL,       -- Need R
    eutra-BlackCellList                 EUTRA-FreqBlackCellList                     OPTIONAL,       -- Need R
    allowedMeasBandwidth                EUTRA-AllowedMeasBandwidth,
    presenceAntennaPort1                EUTRA-PresenceAntennaPort1,
    cellReselectionPriority             CellReselectionPriority                     OPTIONAL,       -- Need R
    cellReselectionSubPriority          CellReselectionSubPriority                  OPTIONAL,       -- Need R
    threshX-High                        ReselectionThreshold,
    threshX-Low                         ReselectionThreshold,
    q-RxLevMin                          INTEGER (-70..-22),
    q-QualMin                           INTEGER (-34..-3),
    p-MaxEUTRA                          INTEGER (-30..33),
    threshX-Q                           SEQUENCE {
```

```
        threshX-HighQ                       ReselectionThresholdQ,
        threshX-LowQ                        ReselectionThresholdQ
    }                                                                           OPTIONAL        -- Cond RSRQ
}

EUTRA-FreqBlackCellList ::=         SEQUENCE (SIZE (1..maxEUTRA-CellBlack)) OF EUTRA-PhysCellIdRange

EUTRA-FreqNeighCellList ::=         SEQUENCE (SIZE (1..maxCellEUTRA)) OF EUTRA-FreqNeighCellInfo

EUTRA-FreqNeighCellInfo ::=         SEQUENCE {
    physCellId                          EUTRA-PhysCellId,
    q-OffsetCell                        EUTRA-Q-OffsetRange,
    q-RxLevMinOffsetCell                INTEGER (1..8)                          OPTIONAL,       -- Need R
    q-QualMinOffsetCell                 INTEGER (1..8)                          OPTIONAL        -- Need R
}

-- TAG-SIB5-STOP
-- ASN1STOP
```

***SIB5* field descriptions**
carrierFreqListEUTRA List of carrier frequencies of E-UTRA.
eutra-BlackCellList List of blacklisted E-UTRA neighbouring cells.
eutra-multiBandInfoList Indicates the list of frequency bands in addition to the band represented by *carrierFreq* for which cell reselection parameters are common, and a list of additionalPmax and additionalSpectrumEmission values, as defined in TS 36.101 [22], table 6.2.4-1, for the frequency bands in *eutra-multiBandInfoList*
p-MaxEUTRA The maximum allowed transmission power in dBm on the (uplink) carrier frequency, see TS 36.304 [27]. In dBm
q-QualMin Parameter "$Q_{qualmin}$" in TS 36.304 [27]. Actual value $Q_{qualmin}$ = field value [dB].
q-QualMinOffsetCell Parameter "$Q_{qualminoffsetcell}$" in TS 38.304 [20]. Actual value $Q_{qualminoffsetcell}$ = field value [dB].
q-RxLevMin Parameter "$Q_{rxlevmin}$" in TS 36.304 [27]. Actual value $Q_{rxlevmin}$ = field value * 2 [dBm].
q-RxLevMinOffsetCell Parameter "$Q_{rxlevminoffsetcell}$" in TS 38.304 [20]. Actual value $Q_{rxlevminoffsetcell}$ = field value * 2 [dB].
t-ReselectionEUTRA Parameter "$Treselection_{EUTRA}$" in TS 38.304 [20].
threshX-High Parameter "$Thresh_{X, HighP}$" in TS 38.304 [20].
threshX-HighQ Parameter "$Thresh_{X, HighQ}$" in TS 38.304 [20].
threshX-Low Parameter "$Thresh_{X, LowP}$" in TS 38.304 [20].
threshX-LowQ Parameter "$Thresh_{X, LowQ}$" in TS 38.304 [20].
t-ReselectionEUTRA-SF Parameter "Speed dependent ScalingFactor for $Treselection_{EUTRA}$" in TS 38.304 [20]. If the field is not present, the UE behaviour is specified in TS 38.304 [20].

Conditional Presence	Explanation
RSRQ	The field is mandatory present if the threshServingLowQ is present in SIB2; otherwise it is not present.

– *SIB6*

SIB6 contains an ETWS primary notification.

SIB6 information element

```
-- ASN1START
-- TAG-SIB6-START

SIB6 ::=                            SEQUENCE {
    messageIdentifier                   BIT STRING (SIZE (16)),
```

```
    serialNumber                        BIT STRING (SIZE (16)),
    warningType                         OCTET STRING (SIZE (2)),
    lateNonCriticalExtension            OCTET STRING                                OPTIONAL,
    ...
}

-- TAG-SIB6-STOP
-- ASN1STOP
```

***SIB6* field descriptions**
messageIdentifier Identifies the source and type of ETWS notification.
serialNumber Identifies variations of an ETWS notification.
warningType Identifies the warning type of the ETWS primary notification and provides information on emergency user alert and UE popup.

– *SIB7*

SIB7 contains an ETWS secondary notification.

SIB7 information element

```
-- ASN1START
-- TAG-SIB7-START

SIB7 ::=                            SEQUENCE {
    messageIdentifier                   BIT STRING (SIZE (16)),
    serialNumber                        BIT STRING (SIZE (16)),
    warningMessageSegmentType           ENUMERATED {notLastSegment, lastSegment},
    warningMessageSegmentNumber         INTEGER (0..63),
    warningMessageSegment               OCTET STRING,
    dataCodingScheme                    OCTET STRING (SIZE (1))                     OPTIONAL,   -- Cond Segment1
    lateNonCriticalExtension            OCTET STRING                                OPTIONAL,
    ...
}

-- TAG-SIB7-STOP
-- ASN1STOP
```

SIB7 field descriptions
dataCodingScheme Identifies the alphabet/coding and the language applied variations of an ETWS notification.
messageIdentifier Identifies the source and type of ETWS notification.
serialNumber Identifies variations of an ETWS notification.
warningMessageSegment Carries a segment of the Warning Message Contents IE.
warningMessageSegmentNumber Segment number of the ETWS warning message segment contained in the SIB. A segment number of zero corresponds to the first segment, one corresponds to the second segment, and so on.
warningMessageSegmentType Indicates whether the included ETWS warning message segment is the last segment or not.

Conditional Presence	Explanation
Segment1	The field is mandatory present in the first segment of SIB7, otherwise it is not present.

– *SIB8*

SIB8 contains a CMAS notification.

SIB8 information element

```
-- ASN1START
-- TAG-SIB8-START

SIB8 ::=                        SEQUENCE {
    messageIdentifier               BIT STRING (SIZE (16)),
    serialNumber                    BIT STRING (SIZE (16)),
    warningMessageSegmentType       ENUMERATED {notLastSegment, lastSegment},
    warningMessageSegmentNumber     INTEGER (0..63),
    warningMessageSegment           OCTET STRING,
    dataCodingScheme                OCTET STRING (SIZE (1))                 OPTIONAL,   -- Cond Segment1
    warningAreaCoordinatesSegment   OCTET STRING                            OPTIONAL,   -- Need R
    lateNonCriticalExtension        OCTET STRING                            OPTIONAL,
    ...
}

-- TAG-SIB8-STOP
-- ASN1STOP
```

SIB8 field descriptions
dataCodingScheme Identifies the alphabet/coding and the language applied variations of a CMAS notification.
messageIdentifier Identifies the source and type of CMAS notification.
serialNumber Identifies variations of a CMAS notification.
warningAreaCoordinatesSegment Carries a segment of the geographical area where the CMAS warning message is valid as defined in [28]. The first octet of the first warningAreaCoordinatesSegment is equivalent to the first octet of Warning Area Coordinates IE defined in and encoded according to TS 23.041 [29] and so on.
warningMessageSegment Carries a segment of the Warning Message Contents IE.
warningMessageSegmentNumber Segment number of the CMAS warning message segment contained in the SIB. A segment number of zero corresponds to the first segment, one corresponds to the second segment, and so on.
warningMessageSegmentType Indicates whether the included CMAS warning message segment is the last segment or not.

Conditional Presence	Explanation
Segment1	The field is mandatory present in the first segment of SIB8, otherwise it is not present.

– *SIB9*

SIB9 contains information related to GPS time and Coordinated Universal Time (UTC). The UE may use the parameters provided in this system information block to obtain the UTC, the GPS and the local time.

NOTE: The UE may use the time information for numerous purposes, possibly involving upper layers e.g. to assist GPS initialisation, to synchronise the UE clock.

SIB9 information element

```
-- ASN1START
-- TAG-SIB9-START

SIB9 ::=                            SEQUENCE {
    timeInfo                            SEQUENCE {
        timeInfoUTC                         INTEGER (0..549755813887),
        dayLightSavingTime                  BIT STRING (SIZE (2))               OPTIONAL,   -- Need R
        leapSeconds                         INTEGER (-127..128)                 OPTIONAL,   -- Need R
        localTimeOffset                     INTEGER (-63..64)                   OPTIONAL    -- Need R
    }                                                                           OPTIONAL,   -- Need R
    lateNonCriticalExtension            OCTET STRING                            OPTIONAL,
    ...
}

-- TAG-SIB9-STOP
-- ASN1STOP
```

SIB9 field descriptions
dayLightSavingTime Indicates if and how daylight-saving time (DST) is applied to obtain the local time.
leapSeconds Number of leap seconds offset between GPS Time and UTC. UTC and GPS time are related i.e. GPS time -leapSeconds = UTC time.
localTimeOffset Offset between UTC and local time in units of 15 minutes. Actual value = field value * 15 minutes. Local time of the day is calculated as UTC time + localTimeOffset.
timeInfoUTC Coordinated Universal Time corresponding to the SFN boundary at or immediately after the ending boundary of the SI-window in which SIB9 is transmitted. The field counts the number of UTC seconds in 10 ms units since 00:00:00 on Gregorian calendar date 1 January, 1900 (midnight between Sunday, December 31, 1899 and Monday, January 1, 1900). See NOTE 1. This field is excluded when estimating changes in system information, i.e. changes of timeInfoUTC should neither result in system information change notifications nor in a modification of SIBValueTag in SIB1.

NOTE 1: The UE may use this field together with the leapSeconds field to obtain GPS time as follows: GPS Time (in seconds) = timeInfoUTC (in seconds) - 2,524,953,600 (seconds) + leapSeconds, where 2,524,953,600 is the number of seconds between 00:00:00 on Gregorian calendar date 1 January, 1900 and 00:00:00 on Gregorian calendar date 6 January, 1980 (start of GPS time).

6.3.2 Radio resource control information elements

– *AdditionalSpectrumEmission*

The IE *AdditionalSpectrumEmission* is used to indicate emission requirements to be fulfilled by the UE (see TS 38.101 [15], section FFS_Section)

***AdditionalSpectrumEmission* information element**

```
-- ASN1START
-- TAG-ADDITIONALSPECTRUMEMISSION-START

AdditionalSpectrumEmission ::=              INTEGER (0..7)

-- TAG-ADDITIONALSPECTRUMEMISSION-STOP
-- ASN1STOP
```

– *Alpha*

The IE Alpha defines possible values of a the pathloss compensation coefficient for uplink power control. *alpha0* corresponds to the value 0, *alpha04* corresponds to the value 0.4, *alpha05* corresponds to the value 0.5 and so on. *alpha1* corresponds to value 1. See also clause 7.1 of TS 38.213 [13].

```
-- ASN1START
-- TAG-ALPHA-START

Alpha ::=                       ENUMERATED {alpha0, alpha04, alpha05, alpha06, alpha07, alpha08, alpha09, alpha1}

-- TAG-ALPHA-STOP
```

```
-- ASN1STOP
```

– *AMF-Identifier*

The IE *AMF-Identifier* (AMFI) comprises of an AMF Region ID, an AMF Set ID and an AMF Pointer as specified in TS 23.003 [21], clause 2.10.1.

AMF-Identifier information element

```
-- ASN1START
-- TAG-AMF-IDENTIFIER-START

AMF-Identifier ::=                      BIT STRING (SIZE (24))

-- TAG-AMF-IDENTIFIER-STOP
-- ASN1STOP
```

– *ARFCN-ValueEUTRA*

The IE *ARFCN-ValueEUTRA* is used to indicate the ARFCN applicable for a downlink, uplink or bi-directional (TDD) E-UTRA carrier frequency, as defined in TS 36.101 [22].

ARFCN-ValueEUTRA information element

```
-- ASN1START
-- TAG-ARFCN-VALUEEUTRA-START

ARFCN-ValueEUTRA ::=                INTEGER (0..maxEARFCN)

-- TAG-ARFCN-VALUEEUTRA-STOP
-- ASN1STOP
```

– *ARFCN-ValueNR*

The IE *ARFCN-ValueNR* is used to indicate the ARFCN applicable for a downlink, uplink or bi-directional (TDD) NR global frequency raster, as defined in TS 38.101 [15], clause 5.4.2.

```
-- ASN1START
-- TAG-ARFCN-VALUE-NR-START

ARFCN-ValueNR ::=               INTEGER (0..maxNARFCN)

-- TAG-ARFCN-VALUE-NR-STOP
-- ASN1STOP
```

– *BeamFailureRecoveryConfig*

The BeamFailureRecoveryConfig IE is used to configure the UE with RACH resources and candidate beams for beam failure recovery in case of beam failure detection. See also TS 38.321 [3], clause 5.1.1.

***BeamFailureRecoveryConfig* information element**

```
-- ASN1START
-- TAG-BEAM-FAILURE-RECOVERY-CONFIG-START

BeamFailureRecoveryConfig ::=       SEQUENCE {
    rootSequenceIndex-BFR               INTEGER (0..137)                                                OPTIONAL,   -- Need M
    rach-ConfigBFR                      RACH-ConfigGeneric                                              OPTIONAL,   -- Need M
    rsrp-ThresholdSSB                   RSRP-Range                                                      OPTIONAL,   -- Need M
    candidateBeamRSList                 SEQUENCE (SIZE(1..maxNrofCandidateBeams)) OF PRACH-ResourceDedicatedBFR     OPTIONAL,   -- Need M
    ssb-perRACH-Occasion                ENUMERATED {oneEighth, oneFourth, oneHalf, one, two, four, eight, sixteen}  OPTIONAL,   -- Need M
    ra-ssb-OccasionMaskIndex            INTEGER (0..15)                                                 OPTIONAL,   -- Need M
    recoverySearchSpaceId               SearchSpaceId                                                   OPTIONAL,   -- Cond CF-BFR
    ra-Prioritization                   RA-Prioritization                                               OPTIONAL,   -- Need R
    beamFailureRecoveryTimer            ENUMERATED {ms10, ms20, ms40, ms60, ms80, ms100, ms150, ms200}  OPTIONAL,   -- Need M
    ...,
    [[
    msg1-SubcarrierSpacing-v1530        SubcarrierSpacing                                               OPTIONAL    -- Need M
    ]]
}

PRACH-ResourceDedicatedBFR ::=      CHOICE {
    ssb                                 BFR-SSB-Resource,
    csi-RS                              BFR-CSIRS-Resource
}

BFR-SSB-Resource ::=                SEQUENCE {
    ssb                                 SSB-Index,
    ra-PreambleIndex                    INTEGER (0..63),
    ...
}

BFR-CSIRS-Resource ::=              SEQUENCE {
    csi-RS                              NZP-CSI-RS-ResourceId,
    ra-OccasionList                     SEQUENCE (SIZE(1..maxRA-OccasionsPerCSIRS)) OF INTEGER (0..maxRA-Occasions-1)   OPTIONAL,   -- Need R
    ra-PreambleIndex                    INTEGER (0..63)                                                 OPTIONAL,   -- Need R
    ...
}

-- TAG-BEAM-FAILURE-RECOVERY-CONFIG-STOP
-- ASN1STOP
```

BeamFailureRecoveryConfig field descriptions
beamFailureRecoveryTimer Timer for beam failure recovery timer. Upon expiration of the timer the UE does not use CFRA for BFR. Value in ms. ms10 corresponds to 10ms, ms20 to 20ms, and so on.
candidateBeamRSList A list of reference signals (CSI-RS and/or SSB) identifying the candidate beams for recovery and the associated RA parameters. The network configures these reference signals to be within the linked DL BWP (i.e., within the DL BWP with the same bwp-Id) of the UL BWP in which the BeamFailureRecoveryConfig is provided.
msg1-SubcarrierSpacing Subcarrier spacing for contention free beam failure recovery. Only the values 15 or 30 kHz (<6GHz), 60 or 120 kHz (>6GHz) are applicable. See TS 38.211 [16], clause 5.3.2.
rsrp-ThresholdSSB L1-RSRP threshold used for determining whether a candidate beam may be used by the UE to attempt contention free Random Access to recover from beam failure. (see TS 38.213 [13], clause 6)
ra-prioritization Parameters which apply for prioritized random access procedure for BFR (see TS 38.321 [3], clause 5.1.1).
ra-ssb-OccasionMaskIndex Explicitly signalled PRACH Mask Index for RA Resource selection in TS 38.321 [3]. The mask is valid for all SSB resources
rach-ConfigBFR Configuration of contention free random access occasions for BFR
recoverySearchSpaceId Search space to use for BFR RAR. The network configures this search space to be within the linked DL BWP (i.e., within the DL BWP with the same bwp-Id) of the UL BWP in which the BeamFailureRecoveryConfig is provided. The CORESET associated with the recovery search space cannot be associated with another search space.
ssb-perRACH-Occasion Number of SSBs per RACH occasion for CF-BFR (L1 parameter 'SSB-per-rach-occasion')

BFR-CSIRS-Resource field descriptions
csi-RS The ID of a NZP-CSI-RS-Resource configured in the CSI-MeasConfig of this serving cell. This reference signal determines a candidate beam for beam failure recovery (BFR).
ra-OccasionList RA occasions that the UE shall use when performing BFR upon selecting the candidate beam identified by this CSI-RS. The network ensures that the RA occasion indexes provided herein are also configured by prach-ConfigurationIndex and msg1-FDM. Each RACH occasion is sequentially numbered, first, in increasing order of frequency resource indexes for frequency multiplexed PRACH occasions; second, in increasing order of time resource indexes for time multiplexed PRACH occasions within a PRACH slot and Third, in increasing order of indexes for PRACH slots. If the field is absent the UE uses the RA occasion associated with the SSB that is QCLed with this CSI-RS.
ra-PreambleIndex The RA preamble index to use in the RA occasions associated with this CSI-RS. If the field is absent, the UE uses the preamble index associated with the SSB that is QCLed with this CSI-RS.

BFR-SSB-Resource field descriptions
ra-PreambleIndex The preamble index that the UE shall use when performing BFR upon selecting the candidate beams identified by this SSB.
ssb The ID of an SSB transmitted by this serving cell. It determines a candidate beam for beam failure recovery (BFR)

Conditional Presence	Explanation
CF-BFR	The field is mandatory present, Need R, if contention free random access resources for BFR are configured. It is optionally present otherwise.

– *BSR-Config*

The IE *BSR-Config* is used to configure buffer status reporting.

BSR-Config information element

```
-- ASN1START
-- TAG-BSR-CONFIG-START

BSR-Config ::=                      SEQUENCE {
    periodicBSR-Timer                   ENUMERATED { sf1, sf5, sf10, sf16, sf20, sf32, sf40, sf64,
                                                    sf80, sf128, sf160, sf320, sf640, sf1280, sf2560, infinity },
    retxBSR-Timer                       ENUMERATED { sf10, sf20, sf40, sf80, sf160, sf320, sf640, sf1280, sf2560,
                                                    sf5120, sf10240, spare5, spare4, spare3, spare2, spare1},
    logicalChannelSR-DelayTimer         ENUMERATED { sf20, sf40, sf64, sf128, sf512, sf1024, sf2560, spare1}           OPTIONAL,   -- Need R
    ...
}

-- TAG-BSR-CONFIG-STOP
-- ASN1STOP
```

BSR-Config field descriptions
logicalChannelSR-DelayTimer Value in number of subframes. sf1 corresponds to one subframe, sf2 corresponds to 2 subframes, and so on.
periodicBSR-Timer Value in number of subframes. Value sf1 corresponds to 1 subframe, sf5 corresponds to 5 subframes and so on.
retxBSR-Timer Value in number of subframes. Value sf10 corresponds to 10 subframes, sf20 corresponds to 20 subframes and so on.

– *BWP*

The *BWP* IE is used to configure generic parameters of a bandwidth part as defined in TS 38.211 [16], clause 4.5, and TS 38.213 [13], clause 12.

For each serving cell the network configures at least an initial downlink bandwidth part and one (if the serving cell is configured with an uplink) or two (if using supplementary uplink (SUL)) initial uplink bandwidth parts. Furthermore, the network may configure additional uplink and downlink bandwidth parts for a serving cell.

The uplink and downlink bandwidth part configurations are divided into common and dedicated parameters.

BWP information element

```
-- ASN1START
-- TAG-BANDWIDTH-PART-START
```

```
BWP ::=                             SEQUENCE {
    locationAndBandwidth                INTEGER (0..37949),
    subcarrierSpacing                   SubcarrierSpacing,
    cyclicPrefix                        ENUMERATED { extended }                                         OPTIONAL    -- Need R
}

-- TAG-BANDWIDTH-PART-STOP
-- ASN1STOP
```

***BWP* field descriptions**
cyclicPrefix Indicates whether to use the extended cyclic prefix for this bandwidth part. If not set, the UE uses the normal cyclic prefix. Normal CP is supported for all subcarrier spacings and slot formats. Extended CP is supported only for 60 kHz subcarrier spacing. (see TS 38.211 [16], clause 4.2)
locationAndBandwidth Frequency domain location and bandwidth of this bandwidth part. The value of the field shall be interpreted as resource indicator value (RIV) as defined TS 38.214 [19] with assumptions as described in TS 38.213 [13], clause 12, i.e. setting N_{BWP}^{size}=275. The first PRB is a PRB determined by subcarrierSpacing of this BWP and offsetToCarrier (configured in SCS-SpecificCarrier contained within FrequencyInfoDL / FrequencyInfoUL / FrequencyInfoUL-SIB / FrequencyInfoDL-SIB) corresponding to this subcarrier spacing. In case of TDD, a BWP-pair (UL BWP and DL BWP with the same bwp-Id) must have the same center frequency (see TS 38.213 [13], clause 12)
subcarrierSpacing Subcarrier spacing to be used in this BWP for all channels and reference signals unless explicitly configured elsewhere. Corresponds to subcarrier spacing according to TS 38.211 [16], Table 4.2-1. The value kHz15 corresponds to µ=0, kHz30 to µ=1, and so on. Only the values 15, 30, or 60 kHz (<6GHz), and 60 or 120 kHz (>6GHz) are applicable. For the initial DL BWP this field has the same value as the field subCarrierSpacingCommon in MIB of the same serving cell.

– *BWP-Downlink*

The IE *BWP-Downlink* is used to configure an additional downlink bandwidth part (not for the initial BWP). The field *bwp-Id* in this IE does not take the value 0 since that is reserved for the initial BWP.

BWP-Downlink information element

```
-- ASN1START
-- TAG-BWP-DOWNLINK-START

BWP-Downlink ::=                    SEQUENCE {
    bwp-Id                              BWP-Id,
    bwp-Common                          BWP-DownlinkCommon                                      OPTIONAL,   -- Cond SetupOtherBWP
    bwp-Dedicated                       BWP-DownlinkDedicated                                   OPTIONAL,   -- Need M
    ...
}

-- TAG-BWP-DOWNLINK-STOP
-- ASN1STOP
```

***BWP-Downlink* field descriptions**
bwp-Id An identifier for this bandwidth part. Other parts of the RRC configuration use the BWP-Id to associate themselves with a particular bandwidth part. The network configures the BWPs with consecutive IDs.

Conditional Presence	Explanation
SetupOtherBWP	The field is mandatory present, Need M, upon configuration of a new DL BWP. The field is optionally present, Need M, otherwise.

– *BWP-DownlinkCommon*

The IE *BWP-DownlinkCommon* is used to configure the common parameters of a downlink BWP. They are "cell specific" and the network ensures the necessary alignment with corresponding parameters of other UEs. The common parameters of the initial bandwidth part of the PCell are also provided via system information. For all other serving cells, the network provides the common parameters via dedicated signalling.

BWP-DownlinkCommon information element

```
-- ASN1START
-- TAG-BWP-DOWNLINKCOMMON-START

BWP-DownlinkCommon ::=              SEQUENCE {
    genericParameters                   BWP,
    pdcch-ConfigCommon                  SetupRelease { PDCCH-ConfigCommon }                                     OPTIONAL,   -- Need M
    pdsch-ConfigCommon                  SetupRelease { PDSCH-ConfigCommon }                                     OPTIONAL,   -- Need M
    ...
}

-- TAG-BWP-DOWNLINKCOMMON-STOP
-- ASN1STOP
```

***BWP-DownlinkCommon* field descriptions**
pdcch-ConfigCommon Cell specific parameters for the PDCCH of this BWP
pdsch-ConfigCommon Cell specific parameters for the PDSCH of this BWP

– *BWP-DownlinkDedicated*

The IE *BWP-DownlinkDedicated* is used to configure the dedicated (UE specific) parameters of a downlink BWP.

BWP-DownlinkDedicated information element

```
-- ASN1START
-- TAG-BWP-DOWNLINKDEDICATED-START
```

```
BWP-DownlinkDedicated ::=           SEQUENCE {
    pdcch-Config                        SetupRelease { PDCCH-Config }                                   OPTIONAL,   -- Need M
    pdsch-Config                        SetupRelease { PDSCH-Config }                                   OPTIONAL,   -- Need M
    sps-Config                          SetupRelease { SPS-Config }                                     OPTIONAL,   -- Need M
    radioLinkMonitoringConfig           SetupRelease { RadioLinkMonitoringConfig }                      OPTIONAL,   -- Need M
    ...
}

-- TAG-BWP-DOWNLINKDEDICATED-STOP
-- ASN1STOP
```

BWP-DownlinkDedicated field descriptions
pdcch-Config UE specific PDCCH configuration for one BWP
pdsch-Config UE specific PDSCH configuration for one BWP
sps-Config UE specific SPS (Semi-Persistent Scheduling) configuration for one BWP. Except for reconfiguration with sync, the NW does not reconfigure sps-Config when there is an active configured downlink assignment (see TS 38.321 [3]). However, the NW may release the sps-Config at any time.
radioLinkMonitoringConfig UE specific configuration of radio link monitoring for detecting cell- and beam radio link failure occasions. The maximum number of failure detection resources should be limited up to 8 for both cell- and beam radio link failure detection in Rel-15.

– *BWP-Id*

The IE *BWP-Id* is used to refer to Bandwidth Parts (BWP). The initial BWP is referred to by BWP-Id 0. The other BWPs are referred to by BWP-Id 1 to *maxNrofBWPs*.

BWP-Id information element

```
-- ASN1START
-- TAG-BWP-ID-START

BWP-Id ::=                          INTEGER (0..maxNrofBWPs)

-- TAG-BWP-ID-STOP
-- ASN1STOP
```

– *BWP-Uplink*

The IE *BWP-Uplink* is used to configure an additional uplink bandwidth part (not for the initial BWP). The field *bwp-Id* in this IE does not take the value 0 since that is reserved for the initial BWP.

BWP-Uplink information element

```
-- ASN1START
```

```
-- TAG-BWP-UPLINK-START

BWP-Uplink ::=                      SEQUENCE {
    bwp-Id                              BWP-Id,
    bwp-Common                          BWP-UplinkCommon                                                        OPTIONAL,   -- Cond SetupOtherBWP
    bwp-Dedicated                       BWP-UplinkDedicated                                                     OPTIONAL,   -- Need M
    ...
}

-- TAG-BWP-UPLINK-STOP
-- ASN1STOP
```

BWP-Uplink field descriptions
bwp-Id An identifier for this bandwidth part. Other parts of the RRC configuration use the BWP-Id to associate themselves with a particular bandwidth part. The network configures the BWPs with consecutive IDs.

Conditional Presence	Explanation
SetupOtherBWP	The field is mandatory present, Need M, upon configuration of a new UL BWP. The field is optionally present, Need M, otherwise.

– *BWP-UplinkCommon*

The IE *BWP-UplinkCommon* is used to configure the common parameters of an uplink BWP. They are "cell specific" and the network ensures the necessary alignment with corresponding parameters of other UEs. The common parameters of the initial bandwidth part of the PCell are also provided via system information. For all other serving cells, the network provides the common parameters via dedicated signalling.

***BWP-UplinkCommon* information element**

```
-- ASN1START
-- TAG-BWP-UPLINKCOMMON-START

BWP-UplinkCommon ::=                SEQUENCE {
    genericParameters                   BWP,
    rach-ConfigCommon                   SetupRelease { RACH-ConfigCommon }                                      OPTIONAL,   -- Need M
    pusch-ConfigCommon                  SetupRelease { PUSCH-ConfigCommon }                                     OPTIONAL,   -- Need M
    pucch-ConfigCommon                  SetupRelease { PUCCH-ConfigCommon }                                     OPTIONAL,   -- Need M
    ...
}

-- TAG-BWP-UPLINKCOMMON-STOP
-- ASN1STOP
```

BWP-UplinkCommon field descriptions
pucch-ConfigCommon Cell specific parameters for the PUCCH of this BWP.
pusch-ConfigCommon Cell specific parameters for the PUSCH of this BWP.
rach-ConfigCommon Configuration of cell specific random access parameters which the UE uses for contention based and contention free random access as well as for contention based beam failure recovery in this BWP. The NW configures SSB-based RA (and hence RACH-ConfigCommon) only for UL BWPs if the linked DL BWPs (same bwp-Id as UL-BWP) are the initial DL BWPs or DL BWPs containing the SSB associated to the initial DL BWP. The network configures rach-ConfigCommon, whenever it configures contention free random access (for reconfiguration with sync or for beam failure recovery).

– *BWP-UplinkDedicated*

The IE *BWP-UplinkDedicated* is used to configure the dedicated (UE specific) parameters of a uplink BWP.

BWP-UplinkDedicated information element

```
-- ASN1START
-- TAG-BWP-UPLINKDEDICATED-START

BWP-UplinkDedicated ::=             SEQUENCE {
    pucch-Config                        SetupRelease { PUCCH-Config }                                       OPTIONAL,   -- Need M
    pusch-Config                        SetupRelease { PUSCH-Config }                                       OPTIONAL,   -- Need M
    configuredGrantConfig               SetupRelease { ConfiguredGrantConfig }                              OPTIONAL,   -- Need M
    srs-Config                          SetupRelease { SRS-Config }                                         OPTIONAL,   -- Need M
    beamFailureRecoveryConfig           SetupRelease { BeamFailureRecoveryConfig }                          OPTIONAL,   -- Cond SpCellOnly
    ...
}

-- TAG-BWP-UPLINKDEDICATED-STOP
-- ASN1STOP
```

***BWP-UplinkDedicated* field descriptions**
beamFailureRecoveryConfig Configuration of beam failure recovery. If *supplementaryUplink* is present, the field is present only in one of the uplink carriers, either UL or SUL.
configuredGrantConfig A Configured-Grant of typ1 or type2. It may be configured for UL or SUL but in case of type1 not for both at a time. Except for reconfiguration with sync, the NW does not reconfigure configuredGrantConfig when there is an active configured uplink grant Type 2 (see TS 38.321 [3]). However, the NW may release the configuredGrantConfig at any time.
pucch-Config PUCCH configuration for one BWP of the normal UL or SUL of a serving cell. If the UE is configured with SUL, the network configures PUCCH only on the BWPs of one of the uplinks (normal UL or SUL). The network configures PUCCH-Config at least on non-initial BWP(s) for SpCell and PUCCH SCell. If supported by the UE, the network may configure at most one additional SCell of a cell group with PUCCH-Config (i.e. PUCCH SCell). For EN-DC, The NW configures at most one serving cell per frequency range with PUCCH. And for EN-DC, if two PUCCH groups are configured, the serving cells of the NR PUCCH group in FR2 use the same numerology. The NW may configure PUCCH for a BWP when setting up the BWP. The network may also add/remove the pucch-Config in an *RRCReconfiguraiton* with *reconfigurationWithSync* to move the PUCCH between the UL and SUL carrier of one serving. In other cases, only modifications of a previously configured pucch-Config are allowed. If one (S)UL BWP of a serving cell is configured with PUCCH, all other (S)UL BWPs must be configured with PUCCH, too.
pusch-Config PUSCH configuration for one BWP of the normal UL or SUL of a serving cell. If the UE is configured with SUL and if it has a PUSCH-Config for both UL and SUL, a carrier indicator field in DCI indicates for which of the two to use an UL grant. See also L1 parameter 'dynamicPUSCHSUL' (see TS 38.213 [13], section FFS_Section)
srs-Config Uplink sounding reference signal configuration

Conditional Presence	Explanation
SpCellOnly	The field is optionally present, Need M, in the BWP-UplinkDedicated of an SpCell. It is absent otherwise.

– *CellAccessRelatedInfo*

The IE *CellAccessRelatedInfo* indicates cell access related information for this cell.

***CellAccessRelatedInfo* information element**

```
-- ASN1START
-- TAG-CELL-ACCESS-RELATED-INFO-START

CellAccessRelatedInfo   ::=         SEQUENCE {
    plmn-IdentityList                   PLMN-IdentityInfoList,
    cellReservedForOtherUse             ENUMERATED {true}  OPTIONAL,            -- Need R
    ...
}

-- TAG- CELL-ACCESS-RELATED-INFO-STOP
-- ASN1STOP
```

***CellAccessRelatedInfo* field descriptions**
cellReservedForOtherUse Indicates whether the cell is reserved, as defined in 38.304 [20]. The field is applicable to all PLMNs.
plmn-IdentityList The *PLMN-IdentityList* is used to configure a set of *PLMN-IdentityInfo* elements. Each of those elements contains a list of one or more PLMN Identities and additional information associated with those PLMNs. The total number of PLMNs in the *PLMNIdentitynfoList* does not exceed 12. The PLMN index is defined as *b1+b2+…+b(n-1)+i* If this PLMN is included at the *n*-th entry of PLMN-IdentityInfoList and the *i*-th entry of its corresponding *PLMN-IdentityInfo*, where b(j) is the number of *PLMN-Identity* entries in each *PLMN-IdentityInfo* respectively.

– *CellAccessRelatedInfo-EUTRA-5GC*

The IE *CellAccessRelatedInfo-EUTRA-5GC* indicates cell access related information for an LTE cell connected to 5GC.

CellAccessRelatedInfo-EUTRA-5GC information element

```
-- ASN1START
-- TAG-CELL-ACCESS-RELATED-INFO-EUTRA-5GC-START

CellAccessRelatedInfo-EUTRA-5GC  ::=    SEQUENCE {
    plmn-IdentityList-eutra-5gc             PLMN-IdentityList-EUTRA-5GC,
    trackingAreaCode-eutra-5gc              TrackingAreaCode,
    ranac-5gc                               RAN-AreaCode                        OPTIONAL,
    cellIdentity-eutra-5gc                  CellIdentity-EUTRA-5GC
}

PLMN-IdentityList-EUTRA-5GC::=          SEQUENCE (SIZE (1..maxPLMN)) OF PLMN-Identity-EUTRA-5GC

PLMN-Identity-EUTRA-5GC ::=             CHOICE {
    plmn-Identity-EUTRA-5GC                 PLMN-Identity,
    plmn-index                              INTEGER (1..maxPLMN)
}

CellIdentity-EUTRA-5GC ::=              CHOICE {
    cellIdentity-EUTRA                      BIT STRING (SIZE (28)),
cellId-index                            INTEGER (1..maxPLMN)
}

-- TAG-CELL-ACCESS-RELATED-INFO-EUTRA-5GC-STOP
-- ASN1STOP
```

– *CellAccessRelatedInfo-EUTRA-EPC*

The IE *CellAccessRelatedInfo-EUTRA-EPC* indicates cell access related information for an LTE cell connected to EPC.

CellAccessRelatedInfo-EUTRA-EPC information element

```
-- ASN1START
-- TAG-CELL-ACCESS-RELATED-INFO-EUTRA-EPC-START
```

```
CellAccessRelatedInfo-EUTRA-EPC  ::=    SEQUENCE {
    plmn-IdentityList-eutra-epc             PLMN-IdentityList-EUTRA-EPC,
    trackingAreaCode-eutra-epc              BIT STRING (SIZE (16)),
    cellIdentity-eutra-epc                  BIT STRING (SIZE (28))
}

PLMN-IdentityList-EUTRA-EPC::=          SEQUENCE (SIZE (1..maxPLMN)) OF PLMN-Identity

-- TAG-CELL-ACCESS-RELATED-INFO-EUTRA-EPC-STOP
-- ASN1STOP
```

– *CellGroupConfig*

The *CellGroupConfig* IE is used to configure a master cell group (MCG) or secondary cell group (SCG). A cell group comprises of one MAC entity, a set of logical channels with associated RLC entities and of a primary cell (SpCell) and one or more secondary cells (SCells).

***CellGroupConfig* information element**

```
-- ASN1START
-- TAG-CELL-GROUP-CONFIG-START

-- Configuration of one Cell-Group:
CellGroupConfig ::=                         SEQUENCE {
    cellGroupId                                 CellGroupId,

    rlc-BearerToAddModList                      SEQUENCE (SIZE(1..maxLC-ID)) OF RLC-BearerConfig            OPTIONAL,   -- Need N
    rlc-BearerToReleaseList                     SEQUENCE (SIZE(1..maxLC-ID)) OF LogicalChannelIdentity      OPTIONAL,   -- Need N

    mac-CellGroupConfig                         MAC-CellGroupConfig                                         OPTIONAL,   -- Need M

    physicalCellGroupConfig                     PhysicalCellGroupConfig                                     OPTIONAL,   -- Need M

    spCellConfig                                SpCellConfig                                                OPTIONAL,   -- Need M
    sCellToAddModList                           SEQUENCE (SIZE (1..maxNrofSCells)) OF SCellConfig           OPTIONAL,   -- Need N
    sCellToReleaseList                          SEQUENCE (SIZE (1..maxNrofSCells)) OF SCellIndex            OPTIONAL,   -- Need N
    ...,
    [[
    reportUplinkTxDirectCurrent-v1530           ENUMERATED {true}                                           OPTIONAL    -- Cond BWP-Reconfig
    ]]
}


-- Serving cell specific MAC and PHY parameters for a SpCell:
SpCellConfig ::=                        SEQUENCE {
    servCellIndex                           ServCellIndex                                                   OPTIONAL,   -- Cond SCG
    reconfigurationWithSync                 ReconfigurationWithSync                                         OPTIONAL,   -- Cond ReconfWithSync
    rlf-TimersAndConstants                  SetupRelease { RLF-TimersAndConstants }                         OPTIONAL,   -- Need M
    rlmInSyncOutOfSyncThreshold             ENUMERATED {n1}                                                 OPTIONAL,   -- Need S
    spCellConfigDedicated                   ServingCellConfig                                               OPTIONAL,   -- Need M
    ...
```

```
}

ReconfigurationWithSync ::=         SEQUENCE {
    spCellConfigCommon                  ServingCellConfigCommon                                     OPTIONAL,   -- Need M
    newUE-Identity                      RNTI-Value,
    t304                                ENUMERATED {ms50, ms100, ms150, ms200, ms500, ms1000, ms2000, ms10000},
    rach-ConfigDedicated                CHOICE {
        uplink                              RACH-ConfigDedicated,
        supplementaryUplink                 RACH-ConfigDedicated
    }                                                                                               OPTIONAL,   -- Need N
    ...,
    [[
    smtc                                SSB-MTC                                                     OPTIONAL    -- Need S
    ]]
}

SCellConfig ::=                     SEQUENCE {
    sCellIndex                          SCellIndex,
    sCellConfigCommon                   ServingCellConfigCommon                                     OPTIONAL,   -- Cond SCellAdd
    sCellConfigDedicated                ServingCellConfig                                           OPTIONAL,   -- Cond SCellAddMod
    ...,
    [[
    smtc                                SSB-MTC                                                     OPTIONAL    -- Need S
    ]]
}

-- TAG-CELL-GROUP-CONFIG-STOP
-- ASN1STOP
```

***CellGroupConfig* field descriptions**
mac-CellGroupConfig MAC parameters applicable for the entire cell group.
rlc-BearerToAddModList Configuration of the MAC Logical Channel, the corresponding RLC entities and association with radio bearers.
reportUplinkTxDirectCurrent Enables reporting of uplink Direct Current location information upon BWP configuration and reconfiguration. This field is only present when the BWP configuration is modified or any serving cell is added or removed. This field is not present in the IE *CellGroupConfig* when provided as part of *RRCSetup* message.
rlmInSyncOutOfSyncThreshold BLER threshold pair index for IS/OOS indication generation, see TS 38.133 [14], Table 8.1.1-1. *n1* corresponds to the value 1. When the field is absent, the UE applies the value 0. Whenever this is reconfigured, UE resets N310 and N311, and stops T310, if running.
sCellToAddModList List of seconary serving cells (SCells) to be added or modified.
sCellToReleaseList List of secondary serving cells (SCells) to be released
spCellConfig Parameters for the SpCell of this cell group (PCell of MCG or PSCell of SCG).

***ReconfigurationWithSync* field descriptions**
rach-ConfigDedicated Random access configuration to be used for the reconfiguration with sync (e.g. handover). The UE performs the RA according to these parameters in the firstActiveUplinkBWP (see UplinkConfig).
smtc The SSB periodicity/offset/duration configuration of target cell for NR PSCell change and intra-NR handover. The network sets the *periodicityAndOffset* to indicate the same periodicity as *ssb-periodicityServingCell* in *spCellConfigCommon*. For case of intra-NR handover, the *smtc* is based on the timing reference of source PCell. For case of NR PSCell change, it is based on the timing reference of source PSCell. If the field is absent, the UE uses the SMTC configured in the measObjectNR having the same SSB frequency and subcarrier spacing.

SCellConfig field descriptions
smtc The SSB periodicity/offset/duration configuration of target cell for NR SCell addition. The network sets the *periodicityAndOffset* to indicate the same periodicity as *ssb-periodicityServingCell* in *sCellConfigCommon*. The *smtc* is based on the timing reference of (source) SpCell of associated cell group. If the field is absent, the UE uses the SMTC configured in the measObjectNR having the same SSB frequency and subcarrier spacing

SpCellConfig field descriptions
reconfigurationWithSync Parameters for the synchronous reconfiguration to the target SpCell.
rlf-TimersAndConstants Timers and constants for detecting and triggering cell-level radio link failure. For the SCG, rlf-TimersAndConstants can only be set to *setup* and is always included at SCG addition.
servCellIndex Serving cell ID of a PSCell. The PCell of the Master Cell Group uses ID = 0.

Conditional Presence	Explanation
BWP-Reconfig	The field is optionally present, Need N, if the BWPs are reconfigured or if serving cells are added or removed in the same message. Otherwise it is absent.
ReconfWithSync	The field is mandatory present in case of SpCell change, PSCell addition, SI update for PSCell and security key change; otherwise it is optionally present, need M. The field is not present in *RRCResume* or *RRCSetup* messages.
SCellAdd	The field is mandatory present, need M, upon SCell addition; otherwise it is not present
SCellAddMod	The field is mandatory present upon SCell addition; otherwise it is optionally present, need M.
SCG	The field is mandatory present in an SpCellConfig for the PSCell. It is absent otherwise.

– *CellGroupId*

The IE *CellGroupId* is used to identify a cell group. 0 identifies the master cell group. Other values identify secondary cell groups. In this version of the specification only values 0 and 1 are supported.

***CellGroupId* information element**

```
-- ASN1START
-- TAG-CELLGROUPID-START
```

```
CellGroupId ::=                             INTEGER (0.. maxSecondaryCellGroups)

-- TAG-CELLGROUPID-STOP
-- ASN1STOP
```

– *CellIdentity*

The IE *CellIdentity* is used to unambiguously identify a cell within a PLMN.

***CellIdentity* information element**

```
-- ASN1START

CellIdentity ::=                        BIT STRING (SIZE (36))

-- ASN1STOP
```

– *CellReselectionPriority*

The IE *CellReselectionPriority* concerns the absolute priority of the concerned carrier frequency, as used by the cell reselection procedure. Corresponds with parameter "priority" in TS 38.304 [20]. Value 0 means: lowest priority. The UE behaviour for the case the field is absent, if applicable, is specified in TS 38.304 [20].

***CellReselectionPriority* information element**

```
-- ASN1START
-- TAG-CELLRESELECTIONPRIORITY-START

CellReselectionPriority ::=             INTEGER (0..7)

-- TAG-CELLRESELECTIONPRIORITY-STOP
-- ASN1STOP
```

– *CellReselectionSubPriority*

The IE *CellReselectionSubPriority* indicates a fractional value to be added to the value of cellReselectionPriority to obtain the absolute priority of the concerned carrier frequency for E-UTRA and NR. Value oDot2 corresponds to 0.2, oDot4 corresponds to 0.4 and so on.

***CellReselectionSubPriority* information element**

```
-- ASN1START

CellReselectionSubPriority ::=          ENUMERATED {oDot2, oDot4, oDot6, oDot8}

-- ASN1STOP
```

– *CGI-Info*

The IE *CGI-Info* indicates cell access related information, which is reported by the UE as part of report CGI procedure.

***CGI-Info* information element**

```
-- ASN1START
-- TAG-CGI-Info-START

CGI-Info ::=                    SEQUENCE {
    plmn-IdentityInfoList               PLMN-IdentityInfoList               OPTIONAL,
    frequencyBandList                   MultiFrequencyBandListNR            OPTIONAL,
    noSIB1                              SEQUENCE {
        ssb-SubcarrierOffset                INTEGER (0..15),
        pdcch-ConfigSIB1                    PDCCH-ConfigSIB1
    }                                                                       OPTIONAL,
    ...
}

-- TAG-CGI-Info -STOP
-- ASN1STOP
```

***CGI-Info* field descriptions**
noSIB1 Contains *ssb-SubcarrierOffset* and *pdcch-ConfigSIB1* fields acquired by the UE from MIB of the cell for which report CGI procedure was requested by the network in case SIB1 was not broadcast by the cell.

– *CodebookConfig*

The IE *CodebookConfig* is used to configure codebooks of Type-I and Type-II (see TS 38.214 [19], clause 5.2.2.2)

***CodebookConfig* information element**

```
-- ASN1START
-- TAG-CODEBOOKCONFIG-START
CodebookConfig ::=                          SEQUENCE {
    codebookType                                CHOICE {
        type1                                       SEQUENCE {
            subType                                     CHOICE {
                typeI-SinglePanel                           SEQUENCE {
                    nrOfAntennaPorts                            CHOICE {
                        two                                         SEQUENCE {
                            twoTX-CodebookSubsetRestriction             BIT STRING (SIZE (6))
                        },
                        moreThanTwo                                 SEQUENCE {
                            n1-n2                                       CHOICE {
                                two-one-TypeI-SinglePanel-Restriction       BIT STRING (SIZE (8)),
                                two-two-TypeI-SinglePanel-Restriction       BIT STRING (SIZE (64)),
                                four-one-TypeI-SinglePanel-Restriction      BIT STRING (SIZE (16)),
                                three-two-TypeI-SinglePanel-Restriction     BIT STRING (SIZE (96)),
```

```
                        six-one-TypeI-SinglePanel-Restriction               BIT STRING (SIZE (24)),
                        four-two-TypeI-SinglePanel-Restriction              BIT STRING (SIZE (128)),
                        eight-one-TypeI-SinglePanel-Restriction             BIT STRING (SIZE (32)),
                        four-three-TypeI-SinglePanel-Restriction            BIT STRING (SIZE (192)),
                        six-two-TypeI-SinglePanel-Restriction               BIT STRING (SIZE (192)),
                        twelve-one-TypeI-SinglePanel-Restriction            BIT STRING (SIZE (48)),
                        four-four-TypeI-SinglePanel-Restriction             BIT STRING (SIZE (256)),
                        eight-two-TypeI-SinglePanel-Restriction             BIT STRING (SIZE (256)),
                        sixteen-one-TypeI-SinglePanel-Restriction           BIT STRING (SIZE (64))
                    },
                    typeI-SinglePanel-codebookSubsetRestriction-i2      BIT STRING (SIZE (16))        OPTIONAL    -- Need R
                }
            },
            typeI-SinglePanel-ri-Restriction                    BIT STRING (SIZE (8))
        },
        typeI-MultiPanel                                    SEQUENCE {
            ng-n1-n2                                                CHOICE {
                two-two-one-TypeI-MultiPanel-Restriction                BIT STRING (SIZE (8)),
                two-four-one-TypeI-MultiPanel-Restriction               BIT STRING (SIZE (16)),
                four-two-one-TypeI-MultiPanel-Restriction               BIT STRING (SIZE (8)),
                two-two-two-TypeI-MultiPanel-Restriction                BIT STRING (SIZE (64)),
                two-eight-one-TypeI-MultiPanel-Restriction              BIT STRING (SIZE (32)),
                four-four-one-TypeI-MultiPanel-Restriction              BIT STRING (SIZE (16)),
                two-four-two-TypeI-MultiPanel-Restriction               BIT STRING (SIZE (128)),
                four-two-two-TypeI-MultiPanel-Restriction               BIT STRING (SIZE (64))
            },
            ri-Restriction                              BIT STRING (SIZE (4))
        }
    },
    codebookMode                                        INTEGER (1..2)

},
type2                                       SEQUENCE {
    subType                                     CHOICE {
        typeII                                      SEQUENCE {
            n1-n2-codebookSubsetRestriction         CHOICE {
                two-one                                     BIT STRING (SIZE (16)),
                two-two                                     BIT STRING (SIZE (43)),
                four-one                                    BIT STRING (SIZE (32)),
                three-two                                   BIT STRING (SIZE (59)),
                six-one                                     BIT STRING (SIZE (48)),
                four-two                                    BIT STRING (SIZE (75)),
                eight-one                                   BIT STRING (SIZE (64)),
                four-three                                  BIT STRING (SIZE (107)),
                six-two                                     BIT STRING (SIZE (107)),
                twelve-one                                  BIT STRING (SIZE (96)),
                four-four                                   BIT STRING (SIZE (139)),
                eight-two                                   BIT STRING (SIZE (139)),
                sixteen-one                                 BIT STRING (SIZE (128))
            },
            typeII-RI-Restriction                   BIT STRING (SIZE (2))
        },
        typeII-PortSelection                    SEQUENCE {
            portSelectionSamplingSize               ENUMERATED {n1, n2, n3, n4}                     OPTIONAL,       -- Need R
```

```
                    typeII-PortSelectionRI-Restriction      BIT STRING (SIZE (2))
                }
            },
            phaseAlphabetSize                       ENUMERATED {n4, n8},
            subbandAmplitude                        BOOLEAN,
            numberOfBeams                           ENUMERATED {two, three, four}
        }
    }
}

-- TAG-CODEBOOKCONFIG-STOP
-- ASN1STOP
```

CodebookConfig field descriptions
codebookMode CodebookMode as specified in TS 38.214 [19], clause 5.2.2.2.2.
codebookType CodebookType including possibly sub-types and the corresponding parameters for each (see TS 38.214 [19], clause 5.2.2.2).
n1-n2-codebookSubsetRestriction Number of antenna ports in first (n1) and second (n2) dimension and codebook subset restriction (see TS 38.214 [19] clause 5.2.2.2.3). Number of bits for codebook subset restriction is ceil(log2(nchoosek(O1*O2,4)))+8*n1*n2 where nchoosek(a,b) = a!/(b!(a-b)!)
n1-n2 Number of antenna ports in first (n1) and second (n2) dimension and codebook subset restriction (see TS 38.214 [19] clause 5.2.2.2.1).
ng-n1-n2 Codebook subset restriction for Type I Multi-panel codebook (see TS 38.214 [19], clause 5.2.2.2.2).
numberOfBeams Number of beams, L, used for linear combination
phaseAlphabetSize The size of the PSK alphabet, QPSK or 8-PSK
portSelectionSamplingSize The size of the port selection codebook (parameter d)
ri-Restriction Restriction for RI for TypeI-MultiPanel-RI-Restriction (see TS 38.214 [19], clause 5.2.2.2.2).
subbandAmplitude If subband amplitude reporting is activated (true)
twoTX-CodebookSubsetRestriction Codebook subset restriction for 2TX codebook (see TS 38.214 [19] clause 5.2.2.2.1)
typeI-SinglePanel-codebookSubsetRestriction-i2 i2 codebook subset restriction for Type I Single-panel codebook used when reportQuantity is CRI/Ri/i1/CQI (see TS 38.214 [19] clause 5.2.2.2.1)
typeI-SinglePanel-ri-Restriction Restriction for RI for TypeI-SinglePanel-RI-Restriction (see TS 38.214 [19], clause 5.2.2.2.1)
typeII-PortSelectionRI-Restriction Restriction for RI for TypeII-PortSelection-RI-Restriction (see TS 38.214 [19], clause 5.2.2.4)
typeII-RI-Restriction Restriction for RI for TypeII-RI-Restriction (see TS 38.214 [19], clause 5.2.2.2.3)

– *ConfiguredGrantConfig*

The IE *ConfiguredGrantConfig* is used to configure uplink transmission without dynamic grant according to two possible schemes. The actual uplink grant may either be configured via RRC (type1) or provided via the PDCCH (addressed to CS-RNTI) (type2).

ConfiguredGrantConfig information element

```
-- ASN1START
-- TAG-CONFIGUREDGRANTCONFIG-START

ConfiguredGrantConfig ::=           SEQUENCE {
    frequencyHopping                    ENUMERATED {intraSlot, interSlot}                                          OPTIONAL,   -- Need S,
    cg-DMRS-Configuration               DMRS-UplinkConfig,
    mcs-Table                           ENUMERATED {qam256, qam64LowSE}                                            OPTIONAL,   -- Need S
    mcs-TableTransformPrecoder          ENUMERATED {qam256, qam64LowSE}                                            OPTIONAL,   -- Need S
    uci-OnPUSCH                         SetupRelease { CG-UCI-OnPUSCH }                                            OPTIONAL,   -- Need M
    resourceAllocation                  ENUMERATED { resourceAllocationType0, resourceAllocationType1, dynamicSwitch },
    rbg-Size                            ENUMERATED {config2}                                                       OPTIONAL,   -- Need S
    powerControlLoopToUse               ENUMERATED {n0, n1},
    p0-PUSCH-Alpha                      P0-PUSCH-AlphaSetId,
    transformPrecoder                   ENUMERATED {enabled, disabled}                                             OPTIONAL,   -- Need S
    nrofHARQ-Processes                  INTEGER(1..16),
    repK                                ENUMERATED {n1, n2, n4, n8},
    repK-RV                             ENUMERATED {s1-0231, s2-0303, s3-0000}                                     OPTIONAL,   -- Need R
    periodicity                         ENUMERATED {
                                                sym2, sym7, sym1x14, sym2x14, sym4x14, sym5x14, sym8x14, sym10x14, sym16x14, sym20x14,
                                                sym32x14, sym40x14, sym64x14, sym80x14, sym128x14, sym160x14, sym256x14, sym320x14, sym512x14,
                                                sym640x14, sym1024x14, sym1280x14, sym2560x14, sym5120x14,
                                                sym6, sym1x12, sym2x12, sym4x12, sym5x12, sym8x12, sym10x12, sym16x12, sym20x12, sym32x12,
                                                sym40x12, sym64x12, sym80x12, sym128x12, sym160x12, sym256x12, sym320x12, sym512x12, sym640x12,
                                                sym1280x12, sym2560x12
    },
    configuredGrantTimer                    INTEGER (1..64)                                                        OPTIONAL,   -- Need R
    rrc-ConfiguredUplinkGrant               SEQUENCE {
        timeDomainOffset                        INTEGER (0..5119),
        timeDomainAllocation                    INTEGER  (0..15),
        frequencyDomainAllocation               BIT STRING (SIZE(18)),
        antennaPort                             INTEGER (0..31),
        dmrs-SeqInitialization                  INTEGER (0..1)                                                     OPTIONAL,   -- Need R
        precodingAndNumberOfLayers              INTEGER (0..63),
        srs-ResourceIndicator                   INTEGER (0..15)                                                    OPTIONAL,   -- Need R
        mcsAndTBS                               INTEGER (0..31),
        frequencyHoppingOffset                  INTEGER (1.. maxNrofPhysicalResourceBlocks-1)                      OPTIONAL,   -- Need R
        pathlossReferenceIndex                  INTEGER (0..maxNrofPUSCH-PathlossReferenceRSs-1),
        ...
    }                                                                                                              OPTIONAL,       -- Need R
    ...
}

CG-UCI-OnPUSCH ::= CHOICE {
    dynamic                                 SEQUENCE (SIZE (1..4)) OF BetaOffsets,
    semiStatic                              BetaOffsets
}
```

```
-- TAG-CONFIGUREDGRANTCONFIG-STOP
-- ASN1STOP
```

ConfiguredGrantConfig field descriptions
antennaPort Indicates the antenna port(s) to be used for this configuration, and the maximum bitwidth is 5. See TS 38.214 [19], clause 6.1.2, and TS 38.212 [17], clause 7.3.1.
cg-DMRS-Configuration DMRS configuration (see TS 38.214 [19], clause 6.1.2.3).
configuredGrantTimer Indicates the initial value of the configured grant timer (see TS 38.321 [3]) in multiples of periodicity.
dmrs-SeqInitialization The network configures this field if transformPrecoder is disabled. Otherwise the field is absent.
frequencyDomainAllocation Indicates the frequency domain resource allocation, see TS 38.214 [19], clause 6.1.2, and TS 38.212 [17], clause 7.3.1).
frequencyHopping The value *intraSlot* enables 'Intra-slot frequency hopping' and the value *interSlot* enables 'Inter-slot frequency hopping'. If the field is absent, frequency hopping is not configured.
frequencyHoppingOffset Enables intra-slot frequency hopping with the given frequency hopping offset. Frequency hopping offset used when frequency hopping is enabled (see TS 38.214 [19], clause 6.1.2).
mcs-Table Indicates the MCS table the UE shall use for PUSCH without transform precoding. If the field is absent the UE applies the value 64QAM.
mcs-TableTransformPrecoder Indicates the MCS table the UE shall use for PUSCH with transform precoding. If the field is absent the UE applies the value 64QAM.
mcsAndTBS The modulation order, target code rate and TB size (see TS 38.214 [19], clause 6.1.2). The NW does not configure the values 28~31 in this version of the specification.
nrofHARQ-Processes The number of HARQ processes configured. It applies for both Type 1 and Type 2. See TS 38.321 [3], clause 5.4.1.
p0-PUSCH-Alpha Index of the P0-PUSCH-AlphaSet to be used for this configuration.
periodicity Periodicity for UL transmission without UL grant for type 1 and type 2 (see TS 38.321 [3], clause 5.8.2). The following periodicities are supported depending on the configured subcarrier spacing [symbols]: 15kHz: 2, 7, n*14, where n={1, 2, 4, 5, 8, 10, 16, 20, 32, 40, 64, 80, 128, 160, 320, 640} 30kHz: 2, 7, n*14, where n={1, 2, 4, 5, 8, 10, 16, 20, 32, 40, 64, 80, 128, 160, 256, 320, 640, 1280} 60kHz with normal CP: 2, 7, n*14, where n={1, 2, 4, 5, 8, 10, 16, 20, 32, 40, 64, 80, 128, 160, 256, 320, 512, 640, 1280, 2560} 60kHz with ECP: 2, 6, n*12, where n={1, 2, 4, 5, 8, 10, 16, 20, 32, 40, 64, 80, 128, 160, 256, 320, 512, 640, 1280, 2560} 120kHz: 2, 7, n*14, where n={1, 2, 4, 5, 8, 10, 16, 20, 32, 40, 64, 80, 128, 160, 256, 320, 512, 640, 1024, 1280, 2560, 5120}
powerControlLoopToUse Closed control loop to apply (see TS 38.213 [13], clause 7.1.1).
rbg-Size Selection between configuration 1 and configuration 2 for RBG size for PUSCH. The UE does not apply this field if resourceAllocation is set to *resourceAllocationType1*. Otherwise, the UE applies the value *config1* when the field is absent. Note: rbg-Size is used when the transformPrecoder parameter is disabled.
repK-RV The redundancy version (RV) sequence to use. See TS 38.214 [19], clause 6.1.2. The network configures this field if repetitions are used, i.e., if repK is set to n2, n4 or n8. Otherwise, the field is absent.
repK The number of repetitions of K.

resourceAllocation Configuration of resource allocation type 0 and resource allocation type 1. For Type 1 UL data transmission without grant, "resourceAllocation" should be resourceAllocationType0 or resourceAllocationType1.
rrc-ConfiguredUplinkGrant Configuration for "configured grant" transmission with fully RRC-configured UL grant (Type1). If this field is absent the UE uses UL grant configured by DCI addressed to CS-RNTI (Type2). Type 1 configured grant may be configured for UL or SUL, but not for both simultaneously.
srs-ResourceIndicator Indicates the SRS resource to be used.
timeDomainAllocation Indicates a combination of start symbol and length and PUSCH mapping type, see TS 38.214 [19], clause 6.1.2 and TS 38.212 [17], clause 7.3.1.
timeDomainOffset Offset related to SFN=0, see TS 38.321 [3], clause 5.8.2.
transformPrecoder Enables or disables transform precoding for type1 and type2. If the field is absent, the UE enables or disables transform precoding in accordance with the field msg3-transformPrecoder in RACH-ConfigCommon, see TS 38.214 [19], clause 6.1.3.
uci-OnPUSCH Selection between and configuration of dynamic and semi-static beta-offset. For Type 1 UL data transmission without grant, *uci-OnPUSCH* should be set to *semiStatic.*

– *ConnEstFailureControl*

The IE *ConnEstFailureControl* is used to configure parameters for connection establishment failure control.

ConnEstFailureControl information element

```
-- ASN1START
-- TAG-CONNESTFAILURECONTROL-START

ConnEstFailureControl ::=   SEQUENCE {
    connEstFailCount                   ENUMERATED {n1, n2, n3, n4},
    connEstFailOffsetValidity          ENUMERATED {s30, s60, s120, s240, s300, s420, s600, s900},
    connEstFailOffset                  INTEGER (0..15)                                                   OPTIONAL    -- Need S
}

-- TAG-CONNESTFAILURECONTROL-STOP
-- ASN1STOP
```

ConnEstFailureControl field descriptions
connEstFailCount Number of times that the UE detects T300 expiry on the same cell before applying *connEstFailOffset*.
connEstFailOffset Parameter "$Qoffset_{temp}$" in TS 38.304 [20]. If the field is not present the value of infinity shall be used for "$Qoffset_{temp}$".
connEstFailOffsetValidity Amount of time that the UE applies *connEstFailOffset* before removing the offset from evaluation of the cell. Value s30 corresponds to 30 seconds, s60 corresponds to 60 seconds, and so on.

– *ControlResourceSet*

The IE *ControlResourceSet* is used to configure a time/frequency control resource set (CORESET) in which to search for downlink control information (see TS 38.213 [13], clause FFS_Section).

ControlResourceSet information element

```
-- ASN1START
-- TAG-CONTROLRESOURCESET-START

ControlResourceSet ::=              SEQUENCE {
    controlResourceSetId                ControlResourceSetId,

    frequencyDomainResources            BIT STRING (SIZE (45)),
    duration                            INTEGER (1..maxCoReSetDuration),
    cce-REG-MappingType                 CHOICE {
        interleaved                         SEQUENCE {
            reg-BundleSize                      ENUMERATED {n2, n3, n6},
            interleaverSize                     ENUMERATED {n2, n3, n6},
            shiftIndex                          INTEGER(0..maxNrofPhysicalResourceBlocks-1)          OPTIONAL -- Need S
        },
        nonInterleaved                      NULL
    },
    precoderGranularity                 ENUMERATED {sameAsREG-bundle, allContiguousRBs},
    tci-StatesPDCCH-ToAddList           SEQUENCE(SIZE (1..maxNrofTCI-StatesPDCCH)) OF TCI-StateId    OPTIONAL,-- Cond NotSIB1-initialBWP
    tci-StatesPDCCH-ToReleaseList       SEQUENCE(SIZE (1..maxNrofTCI-StatesPDCCH)) OF TCI-StateId    OPTIONAL, -- Cond NotSIB1-initialBWP
    tci-PresentInDCI                        ENUMERATED {enabled}                                     OPTIONAL,   -- Need S
    pdcch-DMRS-ScramblingID                 INTEGER (0..65535)                                       OPTIONAL,   -- Need S
    ...
}

-- TAG-CONTROLRESOURCESET-STOP
-- ASN1STOP
```

ControlResourceSet field descriptions
cce-REG-MappingType Mapping of Control Channel Elements (CCE) to Resource Element Groups (REG) (see TS 38.211 [16], clauses 7.3.2.2 and 7.4.1.3.2).
controlResourceSetId Value 0 identifies the common CORESET configured in MIB and in ServingCellConfigCommon (controlResourceSetZero) and is hence not used here in the ControlResourceSet IE. Values 1..maxNrofControlResourceSets-1 identify CORESETs configured by dedicated signalling or in SIB1. The controlResourceSetId is unique among the BWPs of a ServingCell.
duration Contiguous time duration of the CORESET in number of symbols (see TS 38.211 [16], clause 7.3.2.2).
frequencyDomainResources Frequency domain resources for the CORESET. Each bit corresponds a group of 6 RBs, with grouping starting from the first RB group (see TS 38.213 [13], clause 10.1) in the BWP. The first (left-most / most significant) bit corresponds to the first RB group in the BWP, and so on. A bit that is set to 1 indicates that this RB group belongs to the frequency domain resource of this CORESET. Bits corresponding to a group of RBs not fully contained in the bandwidth part within which the CORESET is configured are set to zero (see TS 38.211 [16], clause 7.3.2.2).
interleaverSize Interleaver-size (see TS 38.211 [16], clause 7.3.2.2).
pdcch-DMRS-ScramblingID PDCCH DMRS scrambling initialization (see TS 38.211 [16], clause 7.4.1.3.1). When the field is absent the UE applies the value of the *physCellId* configured for this serving cell.
precoderGranularity Precoder granularity in frequency domain (see TS 38.211 [16], clauses 7.3.2.2 and 7.4.1.3.2).
reg-BundleSize Resource Element Groups (REGs) can be bundled to create REG bundles. This parameter defines the size of such bundles (see TS 38.211 [16], clause 7.3.2.2).
shiftIndex When the field is absent the UE applies the value of the *physCellId*configured for this serving cell (see TS 38.211 [16], clause 7.3.2.2).
tci-PresentInDCI If at least spatial QCL is configured/indicated, this field indicates if TCI field is present or not present in DL-related DCI. When the field is absent the UE considers the TCI to be absent/disabled (see TS 38.214 [19], clause 5.1.5).
tci-StatesPDCCH-ToAddList A subset of the TCI states defined in pdsch-Config. They are used for providing QCL relationships between the DL RS(s) in one RS Set (TCI-State) and the PDCCH DMRS ports (see TS 38.213 [13], clause 6.). The network configures at most *maxNrofTCI-StatesPDCCH* entries.

Conditional Presence	**Explanation**
NotSIB1-initialBWP	The field is absent in SIB1 and in the *PDCCH-ConfigCommon* of the initial BWP in *ServingCellConfigCommon*, if SIB1 is broadcasted. Otherwise, it is optionally present, Need N

– *ControlResourceSetId*

The *ControlResourceSetId* IE concerns a short identity, used to identify a control resource set within a serving cell. The *ControlResourceSetId* = 0 identifies the ControlResourceSet#0 configured via PBCH (MIB) and in controlResourceSetZero (ServingCellConfigCommon). The ID space is used across the BWPs of a Serving Cell. The number of CORESETs per BWP is limited to 3 (including common and UE-specific CORESETs).

***ControlResourceSetId* information element**

```
-- ASN1START
```

```
-- TAG-CONTROL-RESOURCE-SET-ID-START

ControlResourceSetId ::=                INTEGER (0..maxNrofControlResourceSets-1)

-- TAG-CONTROL-RESOURCE-SET-ID-STOP
-- ASN1STOP
```

– *ControlResourceSetZero*

The IE *ControlResourceSetZero* is used to configure CORESET#0 of the initial BWP (see TS 38.213 [13], clause 13).

***ControlResourceSetZero* information element**

```
-- ASN1START
-- TAG-CONTROLRESOURCESETZERO-START

ControlResourceSetZero ::=                  INTEGER (0..15)

-- TAG-CONTROLRESOURCESETZERO-STOP
-- ASN1STOP
```

– *CrossCarrierSchedulingConfig*

The IE *CrossCarrierSchedulingConfig* is used to specify the configuration when the cross-carrier scheduling is used in a cell.

***CrossCarrierSchedulingConfig* information elements**

```
-- ASN1START

CrossCarrierSchedulingConfig ::=        SEQUENCE {
    schedulingCellInfo                      CHOICE {
        own                                     SEQUENCE {                  -- No cross carrier scheduling
            cif-Presence                            BOOLEAN
        },
        other                                   SEQUENCE {                  -- Cross carrier scheduling
            schedulingCellId                        ServCellIndex,
            cif-InSchedulingCell                    INTEGER (1..7)
        }
    },
    ...
}

-- ASN1STOP
```

***CrossCarrierSchedulingConfig* field descriptions**
cif-Presence The field is used to indicate whether carrier indicator field is present (value TRUE) or not (value FALSE) in PDCCH DCI formats, see TS 38.213 [13].
cif-InSchedulingCell The field indicates the CIF value used in the scheduling cell to indicate a grant or assignment applicable for this cell, see TS 38.213 [13]. If *cif-Presence* is set to true, the CIF value indicating a grant or assignment for this cell is 0.
other Parameters for cross-carrier scheduling, i.e., a serving cell is scheduled by a PDCCH on another (scheduling) cell. The network configures this field only for SCells.
own Parameters for self-scheduling, i.e., a serving cell is scheduled by its own PDCCH.
schedulingCellId Indicates which cell signals the downlink allocations and uplink grants, if applicable, for the concerned SCell. In case the UE is configured with DC, the scheduling cell is part of the same cell group (i.e. MCG or SCG) as the scheduled cell.

– *CSI-AperiodicTriggerStateList*

The *CSI-AperiodicTriggerStateList* IE is used to configure the UE with a list of aperiodic trigger states. Each codepoint of the DCI field "CSI request" is associated with one trigger state. Upon reception of the value associated with a trigger state, the UE will perform measurement of CSI-RS (reference signals) and aperiodic reporting on L1 according to all entries in the *associatedReportConfigInfoList* for that trigger state.

CSI-AperiodicTriggerStateList information element

```
-- ASN1START
-- TAG-CSI-APERIODICTRIGGERSTATELIST-START

CSI-AperiodicTriggerStateList ::=   SEQUENCE (SIZE (1..maxNrOfCSI-AperiodicTriggers)) OF CSI-AperiodicTriggerState

CSI-AperiodicTriggerState ::=       SEQUENCE {
    associatedReportConfigInfoList      SEQUENCE (SIZE(1..maxNrofReportConfigPerAperiodicTrigger)) OF CSI-AssociatedReportConfigInfo,
    ...
}

CSI-AssociatedReportConfigInfo ::=      SEQUENCE {
    reportConfigId                      CSI-ReportConfigId,
    resourcesForChannel                 CHOICE {
        nzp-CSI-RS                          SEQUENCE {
            resourceSet                         INTEGER (1..maxNrofNZP-CSI-RS-ResourceSetsPerConfig),
            qcl-info                            SEQUENCE (SIZE(1..maxNrofAP-CSI-RS-ResourcesPerSet)) OF TCI-StateId OPTIONAL -- Cond Aperiodic
        },
        csi-SSB-ResourceSet                 INTEGER (1..maxNrofCSI-SSB-ResourceSetsPerConfig)
    },
    csi-IM-ResourcesForInterference     INTEGER(1..maxNrofCSI-IM-ResourceSetsPerConfig)         OPTIONAL, -- Cond CSI-IM-ForInterference
    nzp-CSI-RS-ResourcesForInterference INTEGER (1..maxNrofNZP-CSI-RS-ResourceSetsPerConfig)    OPTIONAL, -- Cond NZP-CSI-RS-ForInterference
    ...
}

-- TAG-CSI-APERIODICTRIGGERSTATELIST-STOP
-- ASN1STOP
```

***CSI-AssociatedReportConfigInfo* field descriptions**
csi-IM-ResourcesForInterference CSI-IM-ResourceSet for interference measurement. Entry number in csi-IM-ResourceSetList in the CSI-ResourceConfig indicated by csi-IM-ResourcesForInterference in the CSI-ReportConfig indicated by reportConfigId above (1 corresponds to the first entry, 2 to the second entry, and so on). The indicated CSI-IM-ResourceSet should have exactly the same number of resources like the NZP-CSI-RS-ResourceSet indicated in nzp-CSI-RS-ResourcesforChannel.
csi-SSB-ResourceSet CSI-SSB-ResourceSet for channel measurements. Entry number in csi-SSB-ResourceSetList in the CSI-ResourceConfig indicated by resourcesForChannelMeasurement in the CSI-ReportConfig indicated by reportConfigId above (1 corresponds to the first entry, 2 to the second entry, and so on).
nzp-CSI-RS-ResourcesForInterference NZP-CSI-RS-ResourceSet for interference measurement. Entry number in nzp-CSI-RS-ResourceSetList in the CSI-ResourceConfig indicated by nzp-CSI-RS-ResourcesForInterference in the CSI-ReportConfig indicated by reportConfigId above (1 corresponds to the first entry, 2 to the second entry, and so on).
qcl-info List of references to TCI-States for providing the QCL source and QCL type for each NZP-CSI-RS-Resource listed in nzp-CSI-RS-Resources of the NZP-CSI-RS-ResourceSet indicated by nzp-CSI-RS-ResourcesforChannel. Each *TCI-StateId* refers to the TCI-State which has this value for *tci-StateId* and is defined in *tci-StatesToAddModList* in the *PDSCH-Config* included in the *BWP-Downlink* corresponding to the serving cell and to the DL BWP to which the *resourcesForChannelMeasuremen*t (in the *CSI-ReportConfig* indicated by *reportConfigId* above) belong to. First entry in qcl-info-forChannel corresponds to first entry in nzp-CSI-RS-Resources of that NZP-CSI-RS-ResourceSet, second entry in qcl-info-forChannel corresponds to second entry in nzp-CSI-RS-Resources, and so on (see TS 38.214 [19], clause 5.2.1.5.1)
reportConfigId The reportConfigId of one of the CSI-ReportConfigToAddMod configured in CSI-MeasConfig
resourceSet NZP-CSI-RS-ResourceSet for channel measurements. Entry number in nzp-CSI-RS-ResourceSetList in the CSI-ResourceConfig indicated by resourcesForChannelMeasurement in the CSI-ReportConfig indicated by reportConfigId above (1 corresponds to the first entry, 2 to thesecond entry, and so on).

Conditional Presence	Explanation
Aperiodic	The field is mandatory present if the *NZP-CSI-RS-Resources* in the associated *resourceSet* have the resourceType aperiodic. The field is absent otherwise.
CSI-IM-ForInterference	This field is optional need M if the *CSI-ReportConfig* identified by *reportConfigId* is configured with *csi-IM-ResourcesForInterference*; otherwise it is absent.
NZP-CSI-RS-ForInterference	This field is optional need M if the *CSI-ReportConfig* identified by *reportConfigId* is configured with *nzp-CSI-RS-ResourcesForInterference*; otherwise it is absent.

– *CSI-FrequencyOccupation*

The IE *CSI-FrequencyOccupation* is used to configure the frequency domain occupation of a channel state information measurement resource (e.g. *NZP-CSI-RS-Resource*, *CSI-IM-Resource*).

CSI-FrequencyOccupation information element

```
-- ASN1START
-- TAG-CSI-FREQUENCYOCCUPATION-START

CSI-FrequencyOccupation ::=         SEQUENCE {
    startingRB                          INTEGER (0..maxNrofPhysicalResourceBlocks-1),
    nrofRBs                             INTEGER (24..maxNrofPhysicalResourceBlocksPlus1),
    ...
}
```

```
-- TAG-CSI-FREQUENCYOCCUPATION-STOP
-- ASN1STOP
```

CSI-FrequencyOccupation field descriptions
nrofRBs Number of PRBs across which this CSI resource spans. Only multiples of 4 are allowed. The smallest configurable number is the minimum of 24 and the width of the associated BWP. If the configured value is larger than the width of the corresponding BWP, the UE shall assume that the actual CSI-RS bandwidth is equal to the width of the BWP.
startingRB PRB where this CSI resource starts in relation to common resource block #0 (CRB#0) on the common resource block grid. Only multiples of 4 are allowed (0, 4, ...)

– *CSI-IM-Resource*

The IE *CSI-IM-Resource* is used to configure one CSI Interference Management (IM) resource.

CSI-IM-Resource information element

```
-- ASN1START
-- TAG-CSI-IM-RESOURCE-START

CSI-IM-Resource ::=                 SEQUENCE {
    csi-IM-ResourceId                   CSI-IM-ResourceId,
    csi-IM-ResourceElementPattern           CHOICE {
        pattern0                                SEQUENCE {
            subcarrierLocation-p0                   ENUMERATED { s0, s2, s4, s6, s8, s10 },
            symbolLocation-p0                       INTEGER (0..12)
        },
        pattern1                                SEQUENCE {
            subcarrierLocation-p1                   ENUMERATED { s0, s4, s8 },
            symbolLocation-p1                       INTEGER (0..13)
        }
    }                                                                                                   OPTIONAL,   -- Need M
    freqBand                            CSI-FrequencyOccupation                                         OPTIONAL,   -- Need M
    periodicityAndOffset                CSI-ResourcePeriodicityAndOffset                                OPTIONAL,   -- Cond
PeriodicOrSemiPersistent
    ...
}

-- TAG-CSI-IM-RESOURCE-STOP
-- ASN1STOP
```

***CSI-IM-Resource* field descriptions**
csi-IM-ResourceElementPattern The resource element pattern (Pattern0 (2,2) or Pattern1 (4,1)) with corresponding parameters (see TS 38.214 [19], clause 5.2.2.4)
freqBand Frequency-occupancy of CSI-IM (see TS 38.214 [19], clause 5.2.2.4)
periodicityAndOffset Periodicity and slot offset for periodic/semi-persistent CSI-IM.
subcarrierLocation-p0 OFDM subcarrier occupancy of the CSI-IM resource for Pattern0 (see TS 38.214 [19], clause 5.2.2.4)
subcarrierLocation-p1 OFDM subcarrier occupancy of the CSI-IM resource for Pattern1 (see TS 38.214 [19], clause 5.2.2.4)
symbolLocation-p0 OFDM symbol location of the CSI-IM resource for Pattern0 (see TS 38.214 [19], clause 5.2.2.4)
symbolLocation-p1 OFDM symbol location of the CSI-IM resource for Pattern1 (see TS 38.214 [19], clause 5.2.2.4)

Conditional Presence	**Explanation**
PeriodicOrSemiPersistent	The field is mandatory present, Need M, for periodic and semi-persistent CSI-IM-Resources (as indicated in CSI-ResourceConfig). The field is absent otherwise.

– *CSI-IM-ResourceId*

The IE *CSI-IM-ResourceId* is used to identify one *CSI-IM-Resource*.

***CSI-IM-ResourceId* information element**

```
-- ASN1START
-- TAG-CSI-IM-RESOURCEID-START

CSI-IM-ResourceId ::=               INTEGER (0..maxNrofCSI-IM-Resources-1)

-- TAG-CSI-IM-RESOURCEID-STOP
-- ASN1STOP
```

– *CSI-IM-ResourceSet*

The IE *CSI-IM-ResourceSet* is used to configure a set of one or more CSI Interference Management (IM) resources (their IDs) and set-specific parameters.

***CSI-IM-ResourceSet* information element**

```
-- ASN1START
-- TAG-CSI-IM-RESOURCESET-START

CSI-IM-ResourceSet ::=              SEQUENCE {
    csi-IM-ResourceSetId                CSI-IM-ResourceSetId,
```

```
    csi-IM-Resources                    SEQUENCE (SIZE(1..maxNrofCSI-IM-ResourcesPerSet)) OF CSI-IM-ResourceId,
    ...
}
-- TAG-CSI-IM-RESOURCESET-STOP
-- ASN1STOP
```

***CSI-IM-ResourceSet* field descriptions**
csi-IM-Resources CSI-IM-Resources associated with this CSI-IM-ResourceSet (see TS 38.214 [19], clause 5.2)

– *CSI-IM-ResourceSetId*

The IE *CSI-IM-ResourceSetId* is used to identify *CSI-IM-ResourceSet*s.

CSI-IM-ResourceSetId **information element**

```
-- ASN1START
-- TAG-CSI-IM-RESOURCESETID-START

CSI-IM-ResourceSetId ::=            INTEGER (0..maxNrofCSI-IM-ResourceSets-1)

-- TAG-CSI-IM-RESOURCESETID-STOP
-- ASN1STOP
```

– *CSI-MeasConfig*

The *CSI-MeasConfig* IE is used to configure CSI-RS (reference signals) belonging to the serving cell in which *CSI-MeasConfig* is included, channel state information reports to be transmitted on PUCCH on the serving cell in which *CSI-MeasConfig* is included and channel state information reports on PUSCH triggered by DCI received on the serving cell in which *CSI-MeasConfig* is included. See also TS 38.214 [19], clause 5.2.

CSI-MeasConfig **information element**

```
-- ASN1START
-- TAG-CSI-MEAS-CONFIG-START

CSI-MeasConfig ::=                  SEQUENCE {
    nzp-CSI-RS-ResourceToAddModList     SEQUENCE (SIZE (1..maxNrofNZP-CSI-RS-Resources)) OF NZP-CSI-RS-Resource           OPTIONAL, -- Need N
    nzp-CSI-RS-ResourceToReleaseList    SEQUENCE (SIZE (1..maxNrofNZP-CSI-RS-Resources)) OF NZP-CSI-RS-ResourceId         OPTIONAL, -- Need N
    nzp-CSI-RS-ResourceSetToAddModList  SEQUENCE (SIZE (1..maxNrofNZP-CSI-RS-ResourceSets)) OF NZP-CSI-RS-ResourceSet     OPTIONAL, -- Need N
    nzp-CSI-RS-ResourceSetToReleaseList SEQUENCE (SIZE (1..maxNrofNZP-CSI-RS-ResourceSets)) OF NZP-CSI-RS-ResourceSetId   OPTIONAL, -- Need N
    csi-IM-ResourceToAddModList         SEQUENCE (SIZE (1..maxNrofCSI-IM-Resources)) OF CSI-IM-Resource                   OPTIONAL, -- Need N
    csi-IM-ResourceToReleaseList        SEQUENCE (SIZE (1..maxNrofCSI-IM-Resources)) OF CSI-IM-ResourceId                 OPTIONAL, -- Need N
    csi-IM-ResourceSetToAddModList      SEQUENCE (SIZE (1..maxNrofCSI-IM-ResourceSets)) OF CSI-IM-ResourceSet             OPTIONAL, -- Need N
    csi-IM-ResourceSetToReleaseList     SEQUENCE (SIZE (1..maxNrofCSI-IM-ResourceSets)) OF CSI-IM-ResourceSetId           OPTIONAL, -- Need N
    csi-SSB-ResourceSetToAddModList     SEQUENCE (SIZE (1..maxNrofCSI-SSB-ResourceSets)) OF CSI-SSB-ResourceSet           OPTIONAL, -- Need N
    csi-SSB-ResourceSetToAddReleaseList SEQUENCE (SIZE (1..maxNrofCSI-SSB-ResourceSets)) OF CSI-SSB-ResourceSetId         OPTIONAL, -- Need N
    csi-ResourceConfigToAddModList      SEQUENCE (SIZE (1..maxNrofCSI-ResourceConfigurations)) OF CSI-ResourceConfig      OPTIONAL, -- Need N
```

```
    csi-ResourceConfigToReleaseList     SEQUENCE (SIZE (1..maxNrofCSI-ResourceConfigurations)) OF CSI-ResourceConfigId    OPTIONAL, -- Need N
    csi-ReportConfigToAddModList        SEQUENCE (SIZE (1..maxNrofCSI-ReportConfigurations)) OF CSI-ReportConfig          OPTIONAL, -- Need N
    csi-ReportConfigToReleaseList       SEQUENCE (SIZE (1..maxNrofCSI-ReportConfigurations)) OF CSI-ReportConfigId        OPTIONAL, -- Need N

    reportTriggerSize                   INTEGER (0..6)                                                                    OPTIONAL, -- Need M
    aperiodicTriggerStateList           SetupRelease { CSI-AperiodicTriggerStateList }                                    OPTIONAL, -- Need M
    semiPersistentOnPUSCH-TriggerStateList    SetupRelease { CSI-SemiPersistentOnPUSCH-TriggerStateList }                 OPTIONAL, -- Need M
    ...
}

-- TAG-CSI-MEAS-CONFIG-STOP
-- ASN1STOP
```

***CSI-MeasConfig* field descriptions**
aperiodicTriggerStateList Contains trigger states for dynamically selecting one or more aperiodic and semi-persistent reporting configurations and/or triggering one or more aperiodic CSI-RS resource sets for channel and/or interference measurement. FFS: How to address the MAC-CE configuration.
csi-IM-ResourceSetToAddModList Pool of CSI-IM-ResourceSet which can be referred to from CSI-ResourceConfig or from MAC CEs.
csi-IM-ResourceToAddModList Pool of CSI-IM-Resource which can be referred to from CSI-IM-ResourceSet.
csi-ReportConfigToAddModList Configured CSI report settings as specified in TS 38.214 [19] clause 5.2.1.1.
csi-ResourceConfigToAddModList Configured CSI resource settings as specified in TS 38.214 [19] clause 5.2.1.2.
csi-SSB-ResourceSetToAddModList Pool of CSI-SSB-ResourceSet which can be referred to from CSI-ResourceConfig.
nzp-CSI-RS-ResourceSetToAddModList Pool of NZP-CSI-RS-ResourceSet which can be referred to from CSI-ResourceConfig or from MAC CEs.
nzp-CSI-RS-ResourceToAddModList Pool of NZP-CSI-RS-Resource which can be referred to from NZP-CSI-RS-ResourceSet.
reportTriggerSize Size of CSI request field in DCI (bits) (see TS 38.214 [19], clause 5.2.1.5.1).

– *CSI-ReportConfig*

The IE *CSI-ReportConfig* is used to configure a periodic or semi-persistent report sent on PUCCH on the cell in which the *CSI-ReportConfig* is included, or to configure a semi-persistent or aperiodic report sent on PUSCH triggered by DCI received on the cell in which the CSI-ReportConfig is included (in this case, the cell on which the report is sent is determined by the received DCI). See TS 38.214 [19], clause 5.2.1.

CSI-ReportConfig information element

```
-- ASN1START
-- TAG-CSI-REPORTCONFIG-START

CSI-ReportConfig ::=                SEQUENCE {
    reportConfigId                          CSI-ReportConfigId,
```

```
    carrier                                 ServCellIndex                   OPTIONAL,   -- Need S
    resourcesForChannelMeasurement          CSI-ResourceConfigId,
    csi-IM-ResourcesForInterference         CSI-ResourceConfigId        OPTIONAL,   -- Need R
    nzp-CSI-RS-ResourcesForInterference     CSI-ResourceConfigId        OPTIONAL,   -- Need R
    reportConfigType                        CHOICE {
        periodic                                SEQUENCE {
            reportSlotConfig                        CSI-ReportPeriodicityAndOffset,
            pucch-CSI-ResourceList                  SEQUENCE (SIZE (1..maxNrofBWPs)) OF PUCCH-CSI-Resource
        },
        semiPersistentOnPUCCH                   SEQUENCE {
            reportSlotConfig                        CSI-ReportPeriodicityAndOffset,
            pucch-CSI-ResourceList                  SEQUENCE (SIZE (1..maxNrofBWPs)) OF PUCCH-CSI-Resource
        },
        semiPersistentOnPUSCH                   SEQUENCE {
            reportSlotConfig                        ENUMERATED {sl5, sl10, sl20, sl40, sl80, sl160, sl320},
            reportSlotOffsetList                SEQUENCE (SIZE (1.. maxNrofUL-Allocations)) OF INTEGER(0..32),
            p0alpha                                 P0-PUSCH-AlphaSetId
        },
        aperiodic                               SEQUENCE {
            reportSlotOffsetList                SEQUENCE (SIZE (1..maxNrofUL-Allocations)) OF INTEGER(0..32)
        }
    },
    reportQuantity                          CHOICE {
        none                                    NULL,
        cri-RI-PMI-CQI                          NULL,
        cri-RI-i1                               NULL,
        cri-RI-i1-CQI                           SEQUENCE {
            pdsch-BundleSizeForCSI                  ENUMERATED {n2, n4}                                                     OPTIONAL    -- Need S
        },
        cri-RI-CQI                              NULL,
        cri-RSRP                                NULL,
        ssb-Index-RSRP                          NULL,
        cri-RI-LI-PMI-CQI                       NULL
    },
    reportFreqConfiguration                 SEQUENCE {
        cqi-FormatIndicator                     ENUMERATED { widebandCQI, subbandCQI }                                      OPTIONAL,   -- Need R
        pmi-FormatIndicator                     ENUMERATED { widebandPMI, subbandPMI }                                      OPTIONAL,   -- Need R
        csi-ReportingBand                       CHOICE {
            subbands3                               BIT STRING(SIZE(3)),
            subbands4                               BIT STRING(SIZE(4)),
            subbands5                               BIT STRING(SIZE(5)),
            subbands6                               BIT STRING(SIZE(6)),
            subbands7                               BIT STRING(SIZE(7)),
            subbands8                               BIT STRING(SIZE(8)),
            subbands9                               BIT STRING(SIZE(9)),
            subbands10                              BIT STRING(SIZE(10)),
            subbands11                              BIT STRING(SIZE(11)),
            subbands12                              BIT STRING(SIZE(12)),
            subbands13                              BIT STRING(SIZE(13)),
            subbands14                              BIT STRING(SIZE(14)),
            subbands15                              BIT STRING(SIZE(15)),
            subbands16                              BIT STRING(SIZE(16)),
            subbands17                              BIT STRING(SIZE(17)),
            subbands18                              BIT STRING(SIZE(18)),
```

```
            ...,
            subbands19-v1530                        BIT STRING(SIZE(19))
        }   OPTIONAL    -- Need S

    }                                                                                                   OPTIONAL,   -- Need R
    timeRestrictionForChannelMeasurements           ENUMERATED {configured, notConfigured},
    timeRestrictionForInterferenceMeasurements      ENUMERATED {configured, notConfigured},
    codebookConfig                                  CodebookConfig                                      OPTIONAL,   -- Need R
    dummy                                           ENUMERATED {n1, n2}                                 OPTIONAL,   -- Need R
    groupBasedBeamReporting                     CHOICE {
        enabled                                     NULL,
        disabled                                    SEQUENCE {
            nrofReportedRS                          ENUMERATED {n1, n2, n3, n4}                         OPTIONAL    -- Need S
        }
    },
    cqi-Table                           ENUMERATED {table1, table2, table3, spare1}                     OPTIONAL,   -- Need R
    subbandSize                         ENUMERATED {value1, value2},
    non-PMI-PortIndication              SEQUENCE (SIZE (1..maxNrofNZP-CSI-RS-ResourcesPerConfig)) OF PortIndexFor8Ranks OPTIONAL,   -- Need R
    ...,
    [[
    semiPersistentOnPUSCH-v1530         SEQUENCE {
        reportSlotConfig-v1530              ENUMERATED {sl4, sl8, sl16}
    }                                                                                                   OPTIONAL    -- Need R
    ]]
}

CSI-ReportPeriodicityAndOffset ::=  CHOICE {
    slots4                              INTEGER(0..3),
    slots5                              INTEGER(0..4),
    slots8                              INTEGER(0..7),
    slots10                             INTEGER(0..9),
    slots16                             INTEGER(0..15),
    slots20                             INTEGER(0..19),
    slots40                             INTEGER(0..39),
    slots80                             INTEGER(0..79),
    slots160                            INTEGER(0..159),
    slots320                            INTEGER(0..319)
}

PUCCH-CSI-Resource ::=              SEQUENCE {
    uplinkBandwidthPartId               BWP-Id,
    pucch-Resource                      PUCCH-ResourceId
}

PortIndexFor8Ranks ::=              CHOICE {
    portIndex8                          SEQUENCE{
        rank1-8                             PortIndex8                                      OPTIONAL,   -- Need R
        rank2-8                             SEQUENCE(SIZE(2)) OF PortIndex8                 OPTIONAL,   -- Need R
        rank3-8                             SEQUENCE(SIZE(3)) OF PortIndex8                 OPTIONAL,   -- Need R
        rank4-8                             SEQUENCE(SIZE(4)) OF PortIndex8                 OPTIONAL,   -- Need R
        rank5-8                             SEQUENCE(SIZE(5)) OF PortIndex8                 OPTIONAL,   -- Need R
        rank6-8                             SEQUENCE(SIZE(6)) OF PortIndex8                 OPTIONAL,   -- Need R
        rank7-8                             SEQUENCE(SIZE(7)) OF PortIndex8                 OPTIONAL,   -- Need R
        rank8-8                             SEQUENCE(SIZE(8)) OF PortIndex8                 OPTIONAL    -- Need R
```

```
    },
    portIndex4                          SEQUENCE{
        rank1-4                             PortIndex4                                                  OPTIONAL,   -- Need R
        rank2-4                             SEQUENCE(SIZE(2)) OF PortIndex4                             OPTIONAL,   -- Need R
        rank3-4                             SEQUENCE(SIZE(3)) OF PortIndex4                             OPTIONAL,   -- Need R
        rank4-4                             SEQUENCE(SIZE(4)) OF PortIndex4                             OPTIONAL    -- Need R
    },
    portIndex2                          SEQUENCE{
        rank1-2                             PortIndex2                                                  OPTIONAL,   -- Need R
        rank2-2                             SEQUENCE(SIZE(2)) OF PortIndex2                             OPTIONAL    -- Need R
    },
    portIndex1                          NULL
}

PortIndex8::=                       INTEGER (0..7)
PortIndex4::=                       INTEGER (0..3)
PortIndex2::=                       INTEGER (0..1)

-- TAG-CSI-REPORTCONFIG-STOP
-- ASN1STOP
```

CSI-ReportConfig field descriptions
carrier Indicates in which serving cell the CSI-ResourceConfig indicated below are to be found. If the field is absent, the resources are on the same serving cell as this report configuration.
codebookConfig Codebook configuration for Type-1 or Type-II including codebook subset restriction.
cqi-FormatIndicator Indicates whether the UE shall report a single (wideband) or multiple (subband) CQI. (see TS 38.214 [19], clause 5.2.1.4).
cqi-Table Which CQI table to use for CQI calculation (see TS 38.214 [19], clause 5.2.2.1).
csi-IM-ResourcesForInterference CSI IM resources for interference measurement. csi-ResourceConfigId of a CSI-ResourceConfig included in the configuration of the serving cell indicated with the field "carrier" above. The CSI-ResourceConfig indicated here contains only CSI-IM resources. The bwp-Id in that CSI-ResourceConfig is the same value as the bwp-Id in the CSI-ResourceConfig indicated by resourcesForChannelMeasurement.
csi-ReportingBand Indicates a contiguous or non-contiguous subset of subbands in the bandwidth part which CSI shall be reported for. Each bit in the bit-string represents one subband. The right-most bit in the bit string represents the lowest subband in the BWP. The choice determines the number of subbands (subbands3 for 3 subbands, subbands4 for 4 subbands, and so on) (see TS 38.214 [19], clause 5.2.1.4). This field is absent if there are less than 24 PRBs (no sub band) and present otherwise, the number of sub bands can be from 3 (24 PRBs, sub band size 8) to 18 (72 PRBs, sub band size 4).
dummy This field is not used in the specification. If received it shall be ignored by the UE.
groupBasedBeamReporting Turning on/off group beam based reporting (see TS 38.214 [19], clause 5.2.1.4)
non-PMI-PortIndication Port indication for RI/CQI calculation. For each CSI-RS resource in the linked ResourceConfig for channel measurement, a port indication for each rank R, indicating which R ports to use. Applicable only for non-PMI feedback (see TS 38.214 [19], clause 5.2.1.4.2). The first entry in non-PMI-PortIndication corresponds to the NZP-CSI-RS-Resource indicated by the first entry in nzp-CSI-RS-Resources in the NZP-CSI-RS-ResourceSet indicated in the first entry of nzp-CSI-RS-ResourceSetList of the CSI-ResourceConfig whose CSI-ResourceConfigId is indicated in a CSI-MeasId together with the above CSI-ReportConfigId; the second entry in non-PMI-PortIndication corresponds to the NZP-CSI-RS-Resource indicated by the second entry in nzp-CSI-RS-Resources in the NZP-CSI-RS-ResourceSet indicated in the first entry of nzp-CSI-RS-ResourceSetList of the same CSI-ResourceConfig, and so on until the NZP-CSI-RS-Resource indicated by the last entry in nzp-CSI-RS-Resources in the in the NZP-CSI-RS-ResourceSet indicated in the first entry of nzp-CSI-RS-ResourceSetList of the same CSI-ResourceConfig. Then the next entry corresponds to the NZP-CSI-RS-Resource indicated by the first entry in nzp-CSI-RS-Resources in the NZP-CSI-RS-ResourceSet indicated in the second entry of nzp-CSI-RS-ResourceSetList of the same CSI-ResourceConfig and so on.
nrofReportedRS The number (N) of measured RS resources to be reported per report setting in a non-group-based report. N <= N_max, where N_max is either 2 or 4 depending on UE capability. (see TS 38.214 [19], clause 5.2.1.4) When the field is absent the UE applies the value 1
nzp-CSI-RS-ResourcesForInterference NZP CSI RS resources for interference measurement. csi-ResourceConfigId of a CSI-ResourceConfig included in the configuration of the serving cell indicated with the field "carrier" above. The CSI-ResourceConfig indicated here contains only NZP-CSI-RS resources. The bwp-Id in that CSI-ResourceConfig is the same value as the bwp-Id in the CSI-ResourceConfig indicated by resourcesForChannelMeasurement.
p0alpha Index of the p0-alpha set determining the power control for this CSI report transmission (see TS 38.214 [19], clause 6.2.1.2).
pdsch-BundleSizeForCSI PRB bundling size to assume for CQI calculation when reportQuantity is CRI/RI/i1/CQI. If the field is absent, the UE assumes that no PRB bundling is applied (see TS 38.214 [19], clause 5.2.1.4.2).

pmi-FormatIndicator Indicates whether the UE shall report a single (wideband) or multiple (subband) PMI. (see TS 38.214 [19], clause 5.2.1.4).
pucch-CSI-ResourceList Indicates which PUCCH resource to use for reporting on PUCCH.
reportConfigType Time domain behavior of reporting configuration
reportFreqConfiguration Reporting configuration in the frequency domain. (see TS 38.214 [19], clause 5.2.1.4).
reportQuantity The CSI related quantities to report. Corresponds to L1 parameter 'ReportQuantity' (see TS 38.214 [19], clause 5.2.1).
reportSlotConfig Periodicity and slot offset (see TS 38.214 [19], clause 5.2.1.4) .
reportSlotConfig-v1530 Extended value range for reportSlotConfig for semi-persistent CSI on PUSCH. If the field is present, the UE shall ignore the value provided in the legacy field (semiPersistentOnPUSCH.reportSlotConfig).
reportSlotOffsetList Timing offset Y for semi persistent reporting using PUSCH. This field lists the allowed offset values. This list must have the same number of entries as the *pusch-TimeDomainAllocationList* in *PUSCH-Config*. A particular value is indicated in DCI. The network indicates in the DCI field of the UL grant, which of the configured report slot offsets the UE shall apply. The DCI value 0 corresponds to the first report slot offset in this list, the DCI value 1 corresponds to the second report slot offset in this list, and so on. The first report is transmitted in slot n+Y, second report in n+Y+P, where P is the configured periodicity. Timing offset Y for aperiodic reporting using PUSCH. This field lists the allowed offset values. This list must have the same number of entries as the *pusch-TimeDomainAllocationList* in *PUSCH-Config*. A particular value is indicated in DCI. The network indicates in the DCI field of the UL grant, which of the configured report slot offsets the UE shall apply. The DCI value 0 corresponds to the first report slot offset in this list, the DCI value 1 corresponds to the second report slot offset in this list, and so on (see TS 38.214 [19], clause 5.2.3).
resourcesForChannelMeasurement Resources for channel measurement. csi-ResourceConfigId of a CSI-ResourceConfig included in the configuration of the serving cell indicated with the field "carrier" above. The CSI-ResourceConfig indicated here contains only NZP-CSI-RS resources and/or SSB resources. This CSI-ReportConfig is associated with the DL BWP indicated by bwp-Id in that CSI-ResourceConfig.
subbandSize Indicates one out of two possible BWP-dependent values for the subband size as indicated in TS 38.214 [19], table 5.2.1.4-2 . If *csi-ReportingBand* is absent, the UE shall ignore this field.
timeRestrictionForChannelMeasurements Time domain measurement restriction for the channel (signal) measurements (see TS 38.214 [19], clause 5.2.1.1)
timeRestrictionForInterferenceMeasurements Time domain measurement restriction for interference measurements (see TS 38.214 [19], clause 5.2.1.1)

***PortIndexFor8Ranks* field descriptions**
portIndex8 Port-Index configuration for up to rank 8. If present, the network configures port indexes for at least one of the ranks.
portIndex4 Port-Index configuration for up to rank 4. If present, the network configures port indexes for at least one of the ranks.
portIndex2 Port-Index configuration for up to rank 2. If present, the network configures port indexes for at least one of the ranks.
portIndex1 Port-Index configuration for rank 1.

***PUCCH-CSI-Resource* field descriptions**
pucch-Resource PUCCH resource for the associated uplink BWP. Only PUCCH-Resource of format 2, 3 and 4 is supported. The actual PUCCH-Resource is configured in *PUCCH-Config* and referred to by its ID.

– *CSI-ReportConfigId*

The IE *CSI-ReportConfigId* is used to identify one *CSI-ReportConfig*.

CSI-ReportConfigId information element

```
-- ASN1START
-- TAG-CSI-REPORTCONFIGID-START

CSI-ReportConfigId ::=              INTEGER (0..maxNrofCSI-ReportConfigurations-1)

-- TAG-CSI-REPORTCONFIGID-STOP
-- ASN1STOP
```

– *CSI-ResourceConfig*

The IE *CSI-ResourceConfig* defines a group of one or more *NZP-CSI-RS-ResourceSet*, *CSI-IM-ResourceSet* and/or *CSI-SSB-ResourceSet*.

CSI-ResourceConfig information element

```
-- ASN1START
-- TAG-CSI-RESOURCECONFIG-START

CSI-ResourceConfig ::=      SEQUENCE {
    csi-ResourceConfigId        CSI-ResourceConfigId,
    csi-RS-ResourceSetList      CHOICE {
        nzp-CSI-RS-SSB              SEQUENCE {
            nzp-CSI-RS-ResourceSetList  SEQUENCE (SIZE (1..maxNrofNZP-CSI-RS-ResourceSetsPerConfig)) OF NZP-CSI-RS-ResourceSetId
                                                                                                                            OPTIONAL, -- Need R
            csi-SSB-ResourceSetList     SEQUENCE (SIZE (1..maxNrofCSI-SSB-ResourceSetsPerConfig)) OF CSI-SSB-ResourceSetId
                                                                                                                            OPTIONAL  -- Need R
```

```
        },
        csi-IM-ResourceSetList      SEQUENCE (SIZE (1..maxNrofCSI-IM-ResourceSetsPerConfig)) OF CSI-IM-ResourceSetId
    },

    bwp-Id                      BWP-Id,
    resourceType                ENUMERATED { aperiodic, semiPersistent, periodic },
    ...
}

-- TAG-CSI-RESOURCECONFIG-STOP
-- ASN1STOP
```

CSI-ResourceConfig field descriptions
bwp-Id The DL BWP which the CSI-RS associated with this CSI-ResourceConfig are located in (see TS 38.214 [19], clause 5.2.1.2
csi-ResourceConfigId Used in CSI-ReportConfig to refer to an instance of CSI-ResourceConfig
csi-RS-ResourceSetList Contains up to maxNrofNZP-CSI-RS-ResourceSetsPerConfig resource sets if ResourceConfigType is 'aperiodic' and 1 otherwise (see TS 38.214 [19], clause 5.2.1.2)
csi-SSB-ResourceSetList List of SSB resources used for beam measurement and reporting in a resource set (see TS 38.214 [19], section FFS_Section)
resourceType Time domain behavior of resource configuration (see TS 38.214 [19], clause 5.2.1.2). It does not apply to resources provided in the csi-SSB-ResourceSetList.

– *CSI-ResourceConfigId*

The IE *CSI-ResourceConfigId* is used to identify a CSI-ResourceConfig.

CSI-ResourceConfigId information element

```
-- ASN1START
-- TAG-CSI-RESOURCECONFIGID-START

CSI-ResourceConfigId ::=            INTEGER (0..maxNrofCSI-ResourceConfigurations-1)

-- TAG-CSI-RESOURCECONFIGID-STOP
-- ASN1STOP
```

– *CSI-ResourcePeriodicityAndOffset*

The IE *CSI-ResourcePeriodicityAndOffset* is used to configure a periodicity and a corresponding offset for periodic and semi-persistent CSI resources, and for periodic and semi-persistent reporting on PUCCH. both, the periodicity and the offset are given in number of slots. The periodicity value slots4 corresponds to 4 slots, slots5 corresponds to 5 slots, and so on.

***CSI-ResourcePeriodicityAndOffset* information element**

```
-- ASN1START
-- TAG-CSI-RESOURCEPERIODICITYANDOFFSET-START

CSI-ResourcePeriodicityAndOffset ::=    CHOICE {
    slots4                              INTEGER (0..3),
    slots5                              INTEGER (0..4),
    slots8                              INTEGER (0..7),
    slots10                             INTEGER (0..9),
    slots16                             INTEGER (0..15),
    slots20                             INTEGER (0..19),
    slots32                             INTEGER (0..31),
    slots40                             INTEGER (0..39),
    slots64                             INTEGER (0..63),
    slots80                             INTEGER (0..79),
    slots160                            INTEGER (0..159),
    slots320                            INTEGER (0..319),
    slots640                            INTEGER (0..639)
}

-- TAG-CSI-RESOURCEPERIODICITYANDOFFSET-STOP
-- ASN1STOP
```

– *CSI-RS-ResourceConfigMobility*

The IE *CSI-RS-ResourceConfigMobility* is used to configure CSI-RS based RRM measurements.

***CSI-RS-ResourceConfigMobility* information element**

```
-- ASN1START
-- TAG-CSI-RS-RESOURCECONFIGMOBILITY-START

CSI-RS-ResourceConfigMobility ::=   SEQUENCE {
    subcarrierSpacing                   SubcarrierSpacing,
    csi-RS-CellList-Mobility            SEQUENCE (SIZE (1..maxNrofCSI-RS-CellsRRM)) OF CSI-RS-CellMobility,
    ... ,
    [[
    refServCellIndex-v1530              ServCellIndex                                                       OPTIONAL    -- Need S
    ]]


}

CSI-RS-CellMobility ::=             SEQUENCE {
    cellId                              PhysCellId,
    csi-rs-MeasurementBW                SEQUENCE {
        nrofPRBs                            ENUMERATED { size24, size48, size96, size192, size264},
        startPRB                            INTEGER(0..2169)
    },
    density                             ENUMERATED {d1,d3}                                                  OPTIONAL,   -- Need R
    csi-rs-ResourceList-Mobility        SEQUENCE (SIZE (1..maxNrofCSI-RS-ResourcesRRM)) OF CSI-RS-Resource-Mobility
```

```
}

CSI-RS-Resource-Mobility ::=        SEQUENCE {
    csi-RS-Index                        CSI-RS-Index,
    slotConfig                          CHOICE {
        ms4                                 INTEGER (0..31),
        ms5                                 INTEGER (0..39),
        ms10                                INTEGER (0..79),
        ms20                                INTEGER (0..159),
        ms40                                INTEGER (0..319)
    },
    associatedSSB                       SEQUENCE {
        ssb-Index                           SSB-Index,
        isQuasiColocated                    BOOLEAN
    }                                                                                               OPTIONAL, -- Need R
    frequencyDomainAllocation           CHOICE {
        row1                                BIT STRING (SIZE (4)),
        row2                                BIT STRING (SIZE (12))
    },
    firstOFDMSymbolInTimeDomain         INTEGER (0..13),
    sequenceGenerationConfig            INTEGER (0..1023),
    ...
}

CSI-RS-Index ::=                    INTEGER (0..maxNrofCSI-RS-ResourcesRRM-1)

-- TAG-CSI-RS-RESOURCECONFIGMOBILITY-STOP
-- ASN1STOP
```

***CSI-RS-CellMobility* field descriptions**
csi-rs-ResourceList-Mobility List of CSI-RS resources for mobility. The maximum number of CSI-RS resources that can be configured per frequency layer depends on the configuration of *associatedSSB* (see TS 38.214 [19], clause 5.1.6.1.3).
density Frequency domain density for the 1-port CSI-RS for L3 mobility Corresponds to L1 parameter 'Density' (see FFS_Spec, section FFS_Section).
nrofPRBs Allowed size of the measurement BW in PRBs Corresponds to L1 parameter 'CSI-RS-measurementBW-size' (see FFS_Spec, section FFS_Section).
startPRB Starting PRB index of the measurement bandwidth Corresponds to L1 parameter 'CSI-RS-measurement-BW-start' (see FFS_Spec, section FFS_Section) FFS_Value: Upper edge of value range unclear in RAN1.

***CSI-RS-ResourceConfigMobility* field descriptions**
csi-RS-CellList-Mobility List of cells
refServCellIndex Indicates the serving cell providing the timing reference for CSI-RS resources without *associatedSSB*. The field may be present only if there is at least one CSI-RS resource configured without *associatedSSB*. In case there is at least one CSI-RS resource configured without *associatedSSB* and this field is absent, the UE shall use the timing of the PCell. The CSI-RS resources and the serving cell indicated by *refServCellIndex* for timing reference should be located in the same band.
subcarrierSpacing Subcarrier spacing of CSI-RS. Only the values 15, 30 or 60 kHz (<6GHz), 60 or 120 kHz (>6GHz) are applicable.

***CSI-RS-Resource-Mobility* field descriptions**
associatedSSB If this field is present, the UE may base the timing of the CSI-RS resource indicated in *CSI-RS-Resource-Mobility* on the timing of the cell indicated by the *cellId* in the *CSI-RS-CellMobility*. In this case, the UE is not required to monitor that CSI-RS resource if the UE cannot detect the SS/PBCH block indicated by this *associatedSSB* and *cellId*. If this field is absent, the UE shall base the timing of the CSI-RS resource indicated in *CSI-RS-Resource-Mobility* on the timing of the serving cell indicated by *refServCellIndex*. In this case, the UE is required to measure the CSI-RS resource even if SS/PBCH block(s) with *cellId* in the *CSI-RS-CellMobility* are not detected. CSI-RS resources with and without *associatedSSB* may be configured in accordance with the rules in TS 38.214 [19], clause 5.1.6.1.3.
csi-RS-Index CSI-RS resource index associated to the CSI-RS resource to be measured (and used for reporting).
firstOFDMSymbolInTimeDomain Time domain allocation within a physical resource block. The field indicates the first OFDM symbol in the PRB used for CSI-RS, see TS 38.211 [16], clause 7.4.1.5.3. Value 2 is supported only when DL-DMRS-typeA-pos equals 3.
frequencyDomainAllocation Frequency domain allocation within a physical resource block in accordance with TS 38.211 [16], clause 7.4.1.5.3 including table 7.4.1.5.2-1. The number of bits that may be set to one depend on the chosen row in that table. For the choice "other", the row can be determined from the parameters below and from the number of bits set to 1 in frequencyDomainAllocation.
isQuasiColocated The CSI-RS resource is either QCL'ed not QCL'ed with the associated SSB in spatial parameters (see TS 38.214 [19], clause 5.1.6.1.3.
sequenceGenerationConfig Scrambling ID for CSI-RS (see TS 38.211 [16], clause 7.4.1.5.2).
slotConfig Indicates the CSI-RS periodicity (in milliseconds) and for each periodicity the offset (in number of slots). When subcarrierSpacingCSI-RS is set to 15kHZ, the maximum offset values for periodicities ms4/ms5/ms10/ms20/ms40 are 3/4/9/19/39 slots. When subcarrierSpacingCSI-RS is set to 30kHZ, the maximum offset values for periodicities ms4/ms5/ms10/ms20/ms40 are 7/9/19/39/79 slots. When subcarrierSpacingCSI-RS is set to 60kHZ, the maximum offset values for periodicities ms4/ms5/ms10/ms20/ms40 are 15/19/39/79/159 slots. When subcarrierSpacingCSI-RS is set 120kHZ, the maximum offset values for periodicities ms4/ms5/ms10/ms20/ms40 are 31/39/79/159/319 slots.

– *CSI-RS-ResourceMapping*

The IE *CSI-RS-ResourceMapping* is used to configure the resource element mapping of a CSI-RS resource in time- and frequency domain.

CSI-RS-ResourceMapping information element

```
-- ASN1START
-- TAG-CSI-RS-RESOURCEMAPPING-START
```

```
CSI-RS-ResourceMapping ::=          SEQUENCE {
    frequencyDomainAllocation           CHOICE {
        row1                                BIT STRING (SIZE (4)),
        row2                                BIT STRING (SIZE (12)),
        row4                                BIT STRING (SIZE (3)),
        other                               BIT STRING (SIZE (6))
    },
    nrofPorts                           ENUMERATED {p1,p2,p4,p8,p12,p16,p24,p32},
    firstOFDMSymbolInTimeDomain         INTEGER (0..13),
    firstOFDMSymbolInTimeDomain2        INTEGER (2..12)                                         OPTIONAL,   -- Need R
    cdm-Type                            ENUMERATED {noCDM, fd-CDM2, cdm4-FD2-TD2, cdm8-FD2-TD4},
    density                             CHOICE {
        dot5                                ENUMERATED {evenPRBs, oddPRBs},
        one                                 NULL,
        three                               NULL,
        spare                               NULL
    },
    freqBand                            CSI-FrequencyOccupation,
    ...
}

-- TAG-CSI-RS-RESOURCEMAPPING-STOP
-- ASN1STOP
```

CSI-RS-ResourceMapping field descriptions
cdm-Type CDM type (see TS 38.214 [19], clause 5.2.2.3.1).
density Density of CSI-RS resource measured in RE/port/PRB (see TS 38.211 [16], clause 7.4.1.5.3). Values 0.5 (*dot5*), 1 (one) and 3 (three) are allowed for X=1, values 0.5 (*dot5*) and 1 (one) are allowed for X=2, 16, 24 and 32, value 1 (one) is allowed for X=4, 8, 12. For density = 1/2, includes 1-bit indication for RB level comb offset indicating whether odd or even RBs are occupied by CSI-RS.
firstOFDMSymbolInTimeDomain2 Time domain allocation within a physical resource block. See TS 38.211 [16], clause 7.4.1.5.3.
firstOFDMSymbolInTimeDomain Time domain allocation within a physical resource block. The field indicates the first OFDM symbol in the PRB used for CSI-RS. See TS 38.211 [16], clause 7.4.1.5.3. Value 2 is supported only when DL-DMRS-typeA-pos equals 3.
freqBand Wideband or partial band CSI-RS, (see TS 38.214 [19], clause 5.2.2.3.1)
frequencyDomainAllocation Frequency domain allocation within a physical resource block in accordance with TS 38.211 [16], clause 7.4.1.5.3. The applicable row number in table 7.4.1.5.3-1 is determined by the frequencyDomainAllocation for rows 1, 2 and 4, and for other rows by matching the values in the column Ports, Density and CDMtype in table 7.4.1.5.3-1 with the values of nrofPorts, cdm-Type and density below and, when more than one row has the 3 values matching, by selecting the row where the column (k bar, l bar) in table 7.4.1.5.3-1 has indexes for k ranging from 0 to 2*n-1 where n is the number of bits set to 1 in frequencyDomainAllocation.
nrofPorts Number of ports (see TS 38.214 [19], clause 5.2.2.3.1)

– *CSI-SemiPersistentOnPUSCH-TriggerStateList*

The *CSI-SemiPersistentOnPUSCH-TriggerStateList* IE is used to configure the UE with list of trigger states for semi-persistent reporting of channel state information on L1. See also TS 38.214 [19], clause 5.2.

CSI-SemiPersistentOnPUSCH-TriggerStateList information element

```
-- ASN1START
-- TAG-CSI-SEMIPERSISTENTONPUSCHTRIGGERSTATELIST-START

CSI-SemiPersistentOnPUSCH-TriggerStateList ::=  SEQUENCE(SIZE (1..maxNrOfSemiPersistentPUSCH-Triggers)) OF CSI-SemiPersistentOnPUSCH-TriggerState

CSI-SemiPersistentOnPUSCH-TriggerState ::=      SEQUENCE {
    associatedReportConfigInfo                      CSI-ReportConfigId,
    ...
}

-- TAG-CSI-SEMIPERSISTENTONPUSCHTRIGGERSTATELIST-STOP
-- ASN1STOP
```

– *CSI-SSB-ResourceSet*

The IE *CSI-SSB-ResourceSet* is used to configure one SS/PBCH block resource set which refers to SS/PBCH as indicated in *ServingCellConfigCommon*.

CSI-SSB-ResourceSet information element

```
-- ASN1START
-- TAG-CSI-SSB-RESOURCESET-START

CSI-SSB-ResourceSet ::=             SEQUENCE {
    csi-SSB-ResourceSetId               CSI-SSB-ResourceSetId,
    csi-SSB-ResourceList                SEQUENCE (SIZE(1..maxNrofCSI-SSB-ResourcePerSet)) OF SSB-Index,
    ...
}

-- TAG-CSI-SSB-RESOURCESET-STOP
-- ASN1STOP
```

– *CSI-SSB-ResourceSetId*

The IE *CSI-SSB-ResourceSetId* is used to identify one SS/PBCH block resource set.

CSI-SSB-ResourceId information element

```
-- ASN1START
-- TAG-CSI-SSB-RESOURCESETID-START

CSI-SSB-ResourceSetId ::=           INTEGER (0..maxNrofCSI-SSB-ResourceSets-1)
```

```
-- TAG-CSI-SSB-RESOURCESETID-STOP
-- ASN1STOP
```

– *DedicatedNAS-Message*

The IE *DedicatedNAS-Message* is used to transfer UE specific NAS layer information between the 5GC CN and the UE. The RRC layer is transparent for this information.

DedicatedNAS-Message information element

```
-- ASN1START
-- TAG-DEDICATED-NAS-MESSAGE-START

DedicatedNAS-Message ::=        OCTET STRING

-- TAG-DEDICATED-NAS-MESSAGE-STOP
-- ASN1STOP
```

– *DMRS-DownlinkConfig*

The IE *DMRS-DownlinkConfig* is used to configure downlink demodulation reference signals for PDSCH.

DMRS-DownlinkConfig information element

```
-- ASN1START
-- TAG-DMRS-DOWNLINKCONFIG-START

DMRS-DownlinkConfig ::=             SEQUENCE {
    dmrs-Type                           ENUMERATED {type2}                                                          OPTIONAL,   -- Need S
    dmrs-AdditionalPosition             ENUMERATED {pos0, pos1, pos3}                                               OPTIONAL,   -- Need S
    maxLength                           ENUMERATED {len2}                                                           OPTIONAL,   -- Need S
    scramblingID0                       INTEGER (0..65535)                                                          OPTIONAL,   -- Need S
    scramblingID1                       INTEGER (0..65535)                                                          OPTIONAL,   -- Need S
    phaseTrackingRS                     SetupRelease { PTRS-DownlinkConfig  }                                       OPTIONAL,   -- Need M
    ...
}

-- TAG-DMRS-DOWNLINKCONFIG-STOP
-- ASN1STOP
```

***DMRS-DownlinkConfig* field descriptions**
dmrs-AdditionalPosition Position for additional DM-RS in DL, see Tables 7.4.1.1.2-3 and 7.4.1.1.2-4 in TS 38.211 [16]. If the field is absent, the UE applies the value pos2. See also clause 7.4.1.1.2 for additional constraints on how the network may set this field depending on the setting of other fields.
dmrs-Type Selection of the DMRS type to be used for DL (see TS 38.211 [16], clause 7.4.1.1.1). If the field is absent, the UE uses DMRS type 1.
maxLength The maximum number of OFDM symbols for DL front loaded DMRS. 'len1' corresponds to value 1. 'len2 corresponds to value 2. If the field is absent, the UE applies value len1. If set to len2, the UE determines the actual number of DM-RS symbols by the associated DCI. (see TS 38.214 [19], clause 7.4.1.1.2)
phaseTrackingRS Configures downlink PTRS. If absent or released, the UE assumes that downlink PTRS are not present. See TS 38.214 [19] clause 5.1.6.3
scramblingID0 DL DMRS scrambling initialization (see TS 38.211 [16], clause 7.4.1.1.1). When the field is absent the UE applies the value Physical cell ID (physCellId) configured for this serving cell."
scramblingID1 DL DMRS scrambling initialization (see TS 38.211 [16], clause 7.4.1.1.1). When the field is absent the UE applies the value (physCellId) configured for this serving cell.

– *DMRS-UplinkConfig*

The IE *DMRS-UplinkConfig* is used to configure uplink demodulation reference signals for PUSCH.

***DMRS-UplinkConfig* information element**

```
-- ASN1START
-- TAG-DMRS-UPLINKCONFIG-START

DMRS-UplinkConfig ::=               SEQUENCE {
    dmrs-Type                           ENUMERATED {type2}                                                  OPTIONAL,   -- Need S
    dmrs-AdditionalPosition             ENUMERATED {pos0, pos1, pos3}                                       OPTIONAL,   -- Need S
    phaseTrackingRS                     SetupRelease { PTRS-UplinkConfig }                                  OPTIONAL,   -- Need M
    maxLength                           ENUMERATED {len2}                                                   OPTIONAL,   -- Need S

    transformPrecodingDisabled      SEQUENCE {
        scramblingID0                   INTEGER (0..65535)                                                  OPTIONAL,   -- Need S
        scramblingID1                   INTEGER (0..65535)                                                  OPTIONAL,   -- Need S
        ...
    }                                                                                                       OPTIONAL,   -- Need R
    transformPrecodingEnabled       SEQUENCE {
        nPUSCH-Identity                 INTEGER(0..1007)                                                    OPTIONAL,   -- Need S
        sequenceGroupHopping            ENUMERATED {disabled}                                               OPTIONAL,   -- Need S
        sequenceHopping                 ENUMERATED {enabled}                                                OPTIONAL,   -- Need S
        ...
    }                                                                                                       OPTIONAL,   -- Need R
    ...
}

-- TAG-DMRS-UPLINKCONFIG-STOP
-- ASN1STOP
```

***DMRS-UplinkConfig* field descriptions**
dmrs-AdditionalPosition Position for additional DM-RS in UL (see TS 38.211 [16], clause 6.4.1.1.3). If the field is absent, the UE applies the value pos2. See also clause 6.4.1.1.3 for additional constraints on how the network may set this field depending on the setting of other fields.
dmrs-Type Selection of the DMRS type to be used for UL (see TS 38.211 [16], clause 6.4.1.1.3) If the field is absent, the UE uses DMRS type 1.
maxLength The maximum number of OFDM symbols for UL front loaded DMRS. 'len1' corresponds to value 1. 'len2 corresponds to value 2. If the field is absent, the UE applies value len1. If set to len2, the UE determines the actual number of DM-RS symbols by the associated DCI. (see TS 38.214 [19], clause 6.4.1.1.3)
nPUSCH-Identity Parameter: N_ID^(PUSCH) for DFT-s-OFDM DMRS. If the value is absent or released, the UE uses the Physical cell ID. Corresponds to L1 parameter 'nPUSCH-Identity-Transform precoding' (see TS 38.211 [16])
phaseTrackingRS Configures uplink PTRS (see TS 38.211 [16])
scramblingID0 UL DMRS scrambling initialization for CP-OFDM (see TS 38.211 [16], clause 6.4.1.1.1.1) When the field is absent the UE applies the value Physical cell ID (physCellId)
scramblingID1 UL DMRS scrambling initialization for CP-OFDM. (see TS 38.211 [16], clause 6.4.1.1.1.1) When the field is absent the UE applies the value Physical cell ID (physCellId)
sequenceGroupHopping For DMRS transmission with transform precoder the NW may configure sequence-group hopping by the cell-specific parameter groupHoppingEnabledTransformPrecoding in PUSCH-ConfigCommon. In this case, the NW may include this UE specific field to disable sequence group hopping, i.e., to override the configuration in PUSCH-ConfigCommon (see TS 38.211 [16])
sequenceHopping Determines if sequence hopping is enabled for DMRS transmission with transform precoder. If the field is absent, the UE considers sequence hopping to be disabled. Corresponds to L1 parameter 'Sequence-hopping-enabled-Transform-precoding' (see TS 38.211 [16], clause 6.4.1.1.1.2).
transformPrecodingDisabled *DMRS related parameters for Cyclic Prefix OFDM*
transformPrecodingEnabled *DMRS related parameters for DFT-s-OFDM (Transform Precoding)*

– *DownlinkConfigCommon*

The IE *DownlinkConfigCommon* provides common downlink parameters of a cell.

***DownlinkConfigCommon* information element**

```
-- ASN1START
-- TAG-DOWNLINK-CONFIG-COMMON-START

DownlinkConfigCommon ::=        SEQUENCE {
    frequencyInfoDL                 FrequencyInfoDL                                 OPTIONAL,   -- Cond InterFreqHOAndServCellAdd
    initialDownlinkBWP              BWP-DownlinkCommon                              OPTIONAL,   -- Cond ServCellAdd
    ...
}

-- TAG-DOWNLINK-CONFIG-COMMON-STOP
-- ASN1STOP
```

***DownlinkConfigCommon* field descriptions**
frequencyInfoDL Basic parameters of a downlink carrier and transmission thereon
initialDownlinkBWP The initial downlink BWP configuration for a SpCell (PCell of MCG or SCG) and SCell.The network configures the *locationAndBandwidth* so that the initial downlink BWP contains the entire CORESET#0 of this serving cell in the frequency domain.

Conditional Presence	Explanation
InterFreqHOAndServCellAdd	This field is mandatory present for inter-frequency handover, and upon serving cell (PSCell/SCell) addition. Otherwise, the field is optionally present, Need M.
ServCellAdd	This field is mandatory present upon serving cell addition (for PSCell and SCell). It is optionally present, Need M otherwise.

– *DownlinkConfigCommonSIB*

The IE *DownlinkConfigCommonSIB* provides common downlink parameters of a cell.

***DownlinkConfigCommonSIB* information element**

```
-- ASN1START
-- TAG-DOWNLINK-CONFIG-COMMON-SIB-START

DownlinkConfigCommonSIB ::=     SEQUENCE {
    frequencyInfoDL                 FrequencyInfoDL-SIB,
    initialDownlinkBWP              BWP-DownlinkCommon,
    bcch-Config                         BCCH-Config,
    pcch-Config                         PCCH-Config,
    ...
}


BCCH-Config ::=                 SEQUENCE {
    modificationPeriodCoeff         ENUMERATED {n2, n4, n8, n16},
    ...
}


PCCH-Config ::=             SEQUENCE {
    defaultPagingCycle                  PagingCycle,
    nAndPagingFrameOffset               CHOICE {
        oneT                                NULL,
        halfT                               INTEGER (0..1),
        quarterT                            INTEGER (0..3),
        oneEighthT                          INTEGER (0..7),
        oneSixteenthT                       INTEGER (0..15)
    },
    ns                                  ENUMERATED {four, two, one},
    firstPDCCH-MonitoringOccasionOfPO   CHOICE {
```

```
        sCS15KHZoneT                                                      SEQUENCE (SIZE (1..maxPO-perPF)) OF INTEGER (0..139),
        sCS30KHZoneT-SCS15KHZhalfT                                        SEQUENCE (SIZE (1..maxPO-perPF)) OF INTEGER (0..279),
        sCS60KHZoneT-SCS30KHZhalfT-SCS15KHZquarterT                       SEQUENCE (SIZE (1..maxPO-perPF)) OF INTEGER (0..559),
        sCS120KHZoneT-SCS60KHZhalfT-SCS30KHZquarterT-SCS15KHZoneEighthT   SEQUENCE (SIZE (1..maxPO-perPF)) OF INTEGER (0..1119),
        sCS120KHZhalfT-SCS60KHZquarterT-SCS30KHZoneEighthT-SCS15KHZoneSixteenthT  SEQUENCE (SIZE (1..maxPO-perPF)) OF INTEGER (0..2239),
        sCS120KHZquarterT-SCS60KHZoneEighthT-SCS30KHZoneSixteenthT        SEQUENCE (SIZE (1..maxPO-perPF)) OF INTEGER (0..4479),
        sCS120KHZoneEighthT-SCS60KHZoneSixteenthT                         SEQUENCE (SIZE (1..maxPO-perPF)) OF INTEGER (0..8959),
        sCS120KHZoneSixteenthT                                            SEQUENCE (SIZE (1..maxPO-perPF)) OF INTEGER (0..17919)
    }   OPTIONAL,           -- Need R
    ...
}

-- TAG-DOWNLINK-CONFIG-COMMON-SIB-STOP
-- ASN1STOP
```

***DownlinkConfigCommonSIB* field descriptions**
frequencyInfoDL-SIB Basic parameters of a downlink carrier and transmission thereon
initialDownlinkBWP The initial downlink BWP configuration for a SpCell (PCell of MCG or SCG). The network configures the *locationAndBandwidth* so that the initial downlink BWP contains the entire CORESET#0 of this serving cell in the frequency domain. The *locationAndBandwidth* is applicable after reception of Msg4 (FFS how to capture this more precisely).
bcch-Config The modification period related configuration.
pcch-Config The paging related configuration.

BCCH-Config field descriptions
modificationPeriodCoeff Actual modification period, expressed in number of radio frames= modificationPeriodCoeff * defaultPagingCycle. n2 corresponds to value 2, n4 corresponds to value 4, and so on.

***PCCH-Config* field descriptions**
defaultPagingCycle Default paging cycle, used to derive 'T' in TS 38.304 [20]. Value rf32 corresponds to 32 radio frames, rf64 corresponds to 64 radio frames and so on.
firstPDCCH-MonitoringOccasionOfPO Points out the first PDCCH monitoring occasion for paging of each PO of the PF, see TS 38.304 [20].
nAndPagingFrameOffset Used to derive the number of total paging frames in T (corresponding to parameter N in TS 38.304 [20]) and paging frame offset (corresponding to parameter PF_offset in TS 38.304 [20]). A value of oneSixteenthT corresponds to T / 16, a value of oneEighthT corresponds to T / 8, and so on. If *pagingSearchSpace* is set to zero and if RMSI multiplexing pattern is 2 or 3 (as specified in TS 38.213 [13]): - for *ssb-periodicityServingCell* of 5 or 10ms, N can be set to one of {oneT, halfT, quarterT, oneEighthT, oneSixteenthT} - for *ssb-periodicityServingCell* of 20ms, N can be set to one of {halfT, quarterT, oneEighthT, oneSixteenthT} - for *ssb-periodicityServingCell* of 40ms, N can be set to one of {quarterT, oneEighthT, oneSixteenthT} - for *ssb-periodicityServingCell* of 80ms, N can be set to one of {oneEighthT, oneSixteenthT} - for *ssb-periodicityServingCell* of 160ms, N can be set to 'oneSixteenthT' If *pagingSearchSpace* is set to zero and if RMSI multiplexing pattern is 1 (as specified in TS 38.213 [13]), N can be set to one of {halfT, quarterT, oneEighthT, oneSixteenthT} If *pagingSearchSpace* is not set to zero, N can be configured to one of {oneT, halfT, quarterT, oneEighthT, oneSixteenthT}
ns Number of paging occasions per paging frame

– *DownlinkPreemption*

The IE *DownlinkPreemption* is used to configure the UE to monitor PDCCH for the INT-RNTI (interruption).

DownlinkPreemption information element

```
-- ASN1START
-- TAG-DOWNLINKPREEMPTION-START

DownlinkPreemption ::=              SEQUENCE {
    int-RNTI                            RNTI-Value,
    timeFrequencySet                    ENUMERATED {set0, set1},
    dci-PayloadSize                     INTEGER (0..maxINT-DCI-PayloadSize),
    int-ConfigurationPerServingCell     SEQUENCE (SIZE (1..maxNrofServingCells)) OF INT-ConfigurationPerServingCell,
    ...
}

INT-ConfigurationPerServingCell ::= SEQUENCE {
    servingCellId                       ServCellIndex,
    positionInDCI                       INTEGER (0..maxINT-DCI-PayloadSize-1)
}

-- TAG-DOWNLINKPREEMPTION-STOP
-- ASN1STOP
```

***DownlinkPreemption* field descriptions**
dci-PayloadSize Total length of the DCI payload scrambled with INT-RNTI (see TS 38.213 [13], clause 11.2)
int-ConfigurationPerServingCell Indicates (per serving cell) the position of the 14 bit INT values inside the DCI payload (see TS 38.213 [13], clause 11.2)
int-RNTI RNTI used for indication pre-emption in DL (see TS 38.213 [13], clause 10)
timeFrequencySet Set selection for DL-preemption indication (see TS 38.213 [13], clause 11.2) The set determines how the UE interprets the DL preemption DCI payload.

***INT-ConfigurationPerServingCell* field descriptions**
positionInDCI Starting position (in number of bit) of the 14 bit INT value applicable for this serving cell (servingCellId) within the DCI payload (see TS 38.213 [13], clause 11.2). Must be multiples of 14 (bit).

– *DRB-Identity*

The IE *DRB-Identity* is used to identify a DRB used by a UE.

DRB-Identity information elements

```
-- ASN1START
-- TAG-DRB-IDENTITY-START

DRB-Identity ::=                    INTEGER (1..32)

-- TAG-DRB-IDENTITY-STOP
-- ASN1STOP
```

– *DRX-Config*

The IE *DRX-Config* is used to configure DRX related parameters.

DRX-Config information element

```
-- ASN1START
-- TAG-DRX-CONFIG-START

DRX-Config ::=                      SEQUENCE {
    drx-onDurationTimer                 CHOICE {
                                            subMilliSeconds INTEGER (1..31),
                                            milliSeconds    ENUMERATED {
                                                ms1, ms2, ms3, ms4, ms5, ms6, ms8, ms10, ms20, ms30, ms40, ms50, ms60,
                                                ms80, ms100, ms200, ms300, ms400, ms500, ms600, ms800, ms1000, ms1200,
                                                ms1600, spare8, spare7, spare6, spare5, spare4, spare3, spare2, spare1 }
                                            },
```

```
    drx-InactivityTimer                 ENUMERATED {
                                            ms0, ms1, ms2, ms3, ms4, ms5, ms6, ms8, ms10, ms20, ms30, ms40, ms50, ms60, ms80,
                                            ms100, ms200, ms300, ms500, ms750, ms1280, ms1920, ms2560, spare9, spare8,
                                            spare7, spare6, spare5, spare4, spare3, spare2, spare1},
    drx-HARQ-RTT-TimerDL                INTEGER (0..56),
    drx-HARQ-RTT-TimerUL                INTEGER (0..56),
    drx-RetransmissionTimerDL           ENUMERATED {
                                            sl0, sl1, sl2, sl4, sl6, sl8, sl16, sl24, sl33, sl40, sl64, sl80, sl96, sl112, sl128,
                                            sl160, sl320, spare15, spare14, spare13, spare12, spare11, spare10, spare9,
                                            spare8, spare7, spare6, spare5, spare4, spare3, spare2, spare1},
    drx-RetransmissionTimerUL           ENUMERATED {
                                            sl0, sl1, sl2, sl4, sl6, sl8, sl16, sl24, sl33, sl40, sl64, sl80, sl96, sl112, sl128,
                                            sl160, sl320, spare15, spare14, spare13, spare12, spare11, spare10, spare9,
                                            spare8, spare7, spare6, spare5, spare4, spare3, spare2, spare1 },
    drx-LongCycleStartOffset            CHOICE {
        ms10                                INTEGER(0..9),
        ms20                                INTEGER(0..19),
        ms32                                INTEGER(0..31),
        ms40                                INTEGER(0..39),
        ms60                                INTEGER(0..59),
        ms64                                INTEGER(0..63),
        ms70                                INTEGER(0..69),
        ms80                                INTEGER(0..79),
        ms128                               INTEGER(0..127),
        ms160                               INTEGER(0..159),
        ms256                               INTEGER(0..255),
        ms320                               INTEGER(0..319),
        ms512                               INTEGER(0..511),
        ms640                               INTEGER(0..639),
        ms1024                              INTEGER(0..1023),
        ms1280                              INTEGER(0..1279),
        ms2048                              INTEGER(0..2047),
        ms2560                              INTEGER(0..2559),
        ms5120                              INTEGER(0..5119),
        ms10240                             INTEGER(0..10239)
    },

    shortDRX                            SEQUENCE {
        drx-ShortCycle                      ENUMERATED  {
                                                ms2, ms3, ms4, ms5, ms6, ms7, ms8, ms10, ms14, ms16, ms20, ms30, ms32,
                                                ms35, ms40, ms64, ms80, ms128, ms160, ms256, ms320, ms512, ms640, spare9,
                                                spare8, spare7, spare6, spare5, spare4, spare3, spare2, spare1 },
        drx-ShortCycleTimer                 INTEGER (1..16)
    }                                                                                                   OPTIONAL,   -- Need R
    drx-SlotOffset                      INTEGER (0..31)
}

-- TAG-DRX-CONFIG-STOP
-- ASN1STOP
```

***DRX-Config* field descriptions**
drx-HARQ-RTT-TimerDL Value in number of symbols of the BWP where the transport block was received.
drx-HARQ-RTT-TimerUL Value in number of symbols of the BWP where the transport block was transmitted.
drx-InactivityTimer Value in multiple integers of 1ms. ms0 corresponds to 0, ms1 corresponds to 1ms, ms2 corresponds to 2ms, and so on.
drx-LongCycleStartOffset drx-LongCycle in ms and drx-StartOffset in multiples of 1ms. If drx-ShortCycle is configured, the value of drx-LongCycle shall be a multiple of the drx-ShortCycle value.
drx-onDurationTimer Value in multiples of 1/32 ms (subMilliSeconds) or in ms (milliSecond). For the latter, ms1 corresponds to 1ms, ms2 corresponds to 2ms, and so on.
drx-RetransmissionTimerDL Value in number of slot lengths of the BWP where the transport block was received. sl0 corresponds to 0 slots, sl1 corresponds to 1 slot, sl2 corresponds to 2 slots, and so on.
drx-RetransmissionTimerUL Value in number of slot lengths of the BWP where the transport block was transmitted. sl0 corresponds to 0 slots, sl1 corresponds to 1 slot, sl2 corresponds to 2 slots, and so on.
drx-ShortCycleTimer Value in multiples of drx-ShortCycle. A value of 1 corresponds to drx-ShortCycle, a value of 2 corresponds to 2 * drx-ShortCycle and so on.
drx-ShortCycle Value in ms. ms1 corresponds to 1ms, ms2 corresponds to 2ms, and so on.
drx-SlotOffset Value in 1/32 ms. Value 0 corresponds to 0ms, value 1 corresponds to 1/32ms, value 2 corresponds to 2/32ms, and so on.

– *FilterCoefficient*

The IE *FilterCoefficient* specifies the measurement filtering coefficient. Value *fc0* corresponds to k = 0, *fc1* corresponds to k = 1, and so on.

***FilterCoefficient* information element**

```
-- ASN1START
-- TAG-FILTERCOEFFICIENT-START

FilterCoefficient ::=               ENUMERATED { fc0, fc1, fc2, fc3, fc4, fc5, fc6, fc7, fc8, fc9, fc11, fc13, fc15, fc17, fc19, spare1, ...}

-- TAG-FILTERCOEFFICIENT-STOP
-- ASN1STOP
```

Editor's Note: Values should be checked.

– *FreqBandIndicatorNR*

The IE *FreqBandIndicatorNR* is used to convey an NR frequency band number as defined in TS 38.101 [15].

FreqBandIndicatorNR information element

```
-- ASN1START
-- TAG-FREQBANDINDICATORNR-START

FreqBandIndicatorNR ::=             INTEGER (1..1024)

-- TAG-FREQBANDINDICATORNR-STOP
-- ASN1STOP
```

– FrequencyInfoDL

The IE *FrequencyInfoDL* provides basic parameters of a downlink carrier and transmission thereon.

FrequencyInfoDL information element

```
-- ASN1START
-- TAG-FREQUENCY-INFO-DL-START

FrequencyInfoDL ::=                 SEQUENCE {
    absoluteFrequencySSB                ARFCN-ValueNR                                                               OPTIONAL,   -- Cond SpCellAdd
    frequencyBandList                   MultiFrequencyBandListNR,
    absoluteFrequencyPointA             ARFCN-ValueNR,
    scs-SpecificCarrierList             SEQUENCE (SIZE (1..maxSCSs)) OF SCS-SpecificCarrier,
    ...
}

-- TAG-FREQUENCY-INFO-DL-STOP
-- ASN1STOP
```

FrequencyInfoDL field descriptions
absoluteFrequencyPointA Absolute frequency position of the reference resource block (Common RB 0). Its lowest subcarrier is also known as Point A (see TS 38.211 [16], clause 4.4.4.2). Note that the lower edge of the actual carrier is not defined by this field but rather in the scs-SpecificCarrierList.
absoluteFrequencySSB Frequency of the SSB to be used for this serving cell. SSB related parameters (e.g. SSB index) provided for a serving cell refer to this SSB frequency unless mentioned otherwise. The cell-defining SSB of the PCell is always on the sync raster. Frequencies are considered to be on the sync raster if they are also identifiable with a GSCN value (see TS 38.101 [15]). If the field is absent, the SSB related parameters should be absent, e.g. ssb-PositionsInBurst, ssb-periodicityServingCell and subcarrierSpacing in ServingCellConfigCommon IE. If the field is absent, the UE obtains timing reference from the SpCell. This is only supported in case the Scell is in the same frequency band as the SpCell.
frequencyBandList List containing only one frequency band to which this carrier(s) belongs. Multiple values are not supported.
scs-SpecificCarrierList A set of carriers for different subcarrier spacings (numerologies). Defined in relation to Point A. The network configures a scs-SpecificCarrier at least for each numerology (SCS) that is used e.g. in a BWP (see TS 38.211 [16], clause 5.3).

Conditional Presence	Explanation
SpCellAdd	The field is mandatory present if this *FrequencyInfoDL* is for SpCell. Otherwise the field is optionally present, Need S.

– *FrequencyInfoDL-SIB*

The IE *FrequencyInfoDL-SIB* provides basic parameters of a downlink carrier and transmission thereon.

FrequencyInfoDL-SIB information element

```
-- ASN1START
-- TAG-FREQUENCY-INFO-DL-SIB-START

FrequencyInfoDL-SIB ::=            SEQUENCE {
    frequencyBandList                  MultiFrequencyBandListNR-SIB,
    offsetToPointA                     INTEGER (0..2199),
    scs-SpecificCarrierList            SEQUENCE (SIZE (1..maxSCSs)) OF SCS-SpecificCarrier
}

-- TAG-FREQUENCY-INFO-DL-SIB-STOP
-- ASN1STOP
```

FrequencyInfoDL-SIB field descriptions
offsetToPointA Represents the offset to Point A as defined in TS 38.211 [16], clause 4.4.4.2.
frequencyBandList List of one or multiple frequency bands to which this carrier(s) belongs.
scs-SpecificCarrierList A set of carriers for different subcarrier spacings (numerologies). Defined in relation to Point A. The network configures a scs-SpecificCarrier at least for each numerology (SCS) that is used e.g. in a BWP (see TS 38.211 [16], clause 5.3).

– *FrequencyInfoUL*

The IE *FrequencyInfoUL* provides basic parameters of an uplink carrier and transmission thereon.

FrequencyInfoUL information element

```
-- ASN1START
-- TAG-FREQUENCY-INFO-UL-START

FrequencyInfoUL ::=                SEQUENCE {
    frequencyBandList                  MultiFrequencyBandListNR                                   OPTIONAL,   -- Cond FDD-OrSUL
    absoluteFrequencyPointA            ARFCN-ValueNR                                              OPTIONAL,   -- Cond FDD-OrSUL
    scs-SpecificCarrierList            SEQUENCE (SIZE (1..maxSCSs)) OF SCS-SpecificCarrier,
    additionalSpectrumEmission         AdditionalSpectrumEmission                                 OPTIONAL,   -- Need S
    p-Max                              P-Max                                                      OPTIONAL,   -- Need S
    frequencyShift7p5khz               ENUMERATED {true}                                          OPTIONAL,   -- Cond FDD-OrSUL-Optional
    ...
```

```
}

-- TAG-FREQUENCY-INFO-UL-STOP
-- ASN1STOP
```

FrequencyInfoUL field descriptions
absoluteFrequencyPointA Absolute frequency of the reference resource block (Common RB 0). Its lowest subcarrier is also known as Point A. Note that the lower edge of the actual carrier is not defined by this field but rather in the scs-SpecificCarrierList (see TS 38.211 [16], clause 4.4.4.2).
additionalSpectrumEmission The additional spectrum emission requirements to be applied by the UE on this uplink. If the field is absent, the UE applies the value FFS_RAN4. (see FFS_section, section FFS_Section)
frequencyBandList List containing only one frequency band to which this carrier(s) belongs. Multiple values are not supported.
frequencyShift7p5khz Enable the NR UL transmission with a 7.5KHz shift to the LTE raster. If the field is absent, the frequency shift is disabled.
p-Max Maximum transmit power allowed in this serving cell. The maximum transmit power that the UE may use on this serving cell may be additionally limited by *p-NR-FR1* (configured for the cell group) and by *p-UE-FR1* (configured total for all serving cells operating on FR1). If absent, the UE applies the maximum power according to TS 38.101 [15]. Value in dBm.
scs-SpecificCarrierList A set of carriers for different subcarrier spacings (numerologies). Defined in relation to Point A. The network configures a scs-SpecificCarrier at least for each numerology (SCS) that is used e.g. in a BWP (see TS 38.211 [16], clause 5.3).

Conditional Presence	**Explanation**
FDD-OrSUL	The field is mandatory present if this FrequencyInfoUL is for the paired UL for a DL (defined in a FrequencyInfoDL) or if this FrequencyInfoUL is for a supplementary uplink (SUL). It is absent otherwise (if this FrequencyInfoUL is for an unpaired UL (TDD).
FDD-OrSUL-Optional	The field is optionally present, Need R, if this FrequencyInfoUL is for the paired UL for a DL (defined in a FrequencyInfoDL) or if this FrequencyInfoUL is for a supplementary uplink (SUL). It is absent otherwise.

– *FrequencyInfoUL-SIB*

The IE *FrequencyInfoUL-SIB* provides basic parameters of an uplink carrier and transmission thereon.

FrequencyInfoUL-SIB **information element**

```
-- ASN1START
-- TAG-FREQUENCY-INFO-UL-SIB-START

FrequencyInfoUL-SIB ::=             SEQUENCE {
    frequencyBandList               MultiFrequencyBandListNR-SIB                                OPTIONAL,   -- Cond FDD-OrSUL
    absoluteFrequencyPointA         ARFCN-ValueNR                                               OPTIONAL,   -- Cond FDD-OrSUL
    scs-SpecificCarrierList         SEQUENCE (SIZE (1..maxSCSs)) OF SCS-SpecificCarrier,
    p-Max                           P-Max                                                       OPTIONAL,   -- Need S
```

```
    frequencyShift7p5khz                ENUMERATED {true}                                                           OPTIONAL,   -- Cond FDD-OrSUL-Optional
    ...
}

-- TAG-FREQUENCY-INFO-UL-SIB-STOP
-- ASN1STOP
```

FrequencyInfoUL-SIB field descriptions
absoluteFrequencyPointA Absolute frequency of the reference resource block (Common RB 0). Its lowest subcarrier is also known as Point A. Note that the lower edge of the actual carrier is not defined by this field but rather in the scs-SpecificCarrierList (see TS 38.211 [16], clause 4.4.4.2).
frequencyBandList Provides the frequency band indicator and a list of *additionalPmax* and *additionalSpectrumEmission* values as defined in TS 38.101 [15], table 6.2.3-1. The UE shall apply the first listed band which it supports in the frequencyBandList field.
frequencyShift7p5khz Enable the NR UL transmission with a 7.5KHz shift to the LTE raster. If the field is absent, the frequency shift is disabled.
p-Max Value in dBm applicable for the cell. If absent the UE applies the maximum power according to TS 38.101 [15].
scs-SpecificCarrierList A set of carriers for different subcarrier spacings (numerologies). Defined in relation to Point A (see TS 38.211 [16], clause 5.3).

Conditional Presence	Explanation
FDD-OrSUL	The field is mandatory present if this FrequencyInfoUL is for the paired UL for a DL (defined in a FrequencyInfoDL) or if this FrequencyInfoUL is for a supplementary uplink (SUL). It is absent otherwise (if this FrequencyInfoUL is for an unpaired UL (TDD).
FDD-OrSUL-Optional	The field is optionally present, Need R, if this FrequencyInfoUL is for the paired UL for a DL (defined in a FrequencyInfoDL) or if this FrequencyInfoUL is for a supplementary uplink (SUL). It is absent otherwise.

– *Hysteresis*

The IE *Hysteresis* is a parameter used within the entry and leave condition of an event triggered reporting condition. The actual value is field value * 0.5 dB.

Hysteresis information element

```
-- ASN1START

Hysteresis ::=                      INTEGER (0..30)

-- ASN1STOP
```

Editor's Note: Values should be checked.

– *I-RNTI-Value*

The *I-RNTI-Value* IE is used to identify the suspended UE context of a UE in RRC_INACTIVE.

***I-RNTI-Value* information element**

```
-- ASN1START
-- TAG-I-RNTI-VALUE-START

I-RNTI-Value ::=                        BIT STRING (SIZE(40))

-- TAG-I-RNTI-VALUE-STOP
-- ASN1STOP
```

– *LocationMeasurementInfo*

The IE *LocationMeasurementInfo* defines the information sent by the UE to the network to assist with the configuration of measurement gaps for location related measurements.

```
-- ASN1START
-- TAG-LOCATION-MEASUREMENT-INFO-START

LocationMeasurementInfo ::=     CHOICE {
        eutra-RSTD                  EUTRA-RSTD-InfoList,
        ...
}

EUTRA-RSTD-InfoList ::= SEQUENCE (SIZE (1..maxInterRAT-RSTD-Freq)) OF EUTRA-RSTD-Info

EUTRA-RSTD-Info ::= SEQUENCE {
    carrierFreq                 ARFCN-ValueEUTRA,
    measPRS-Offset              INTEGER (0..39),
    ...
}

-- TAG-LOCATION-MEASUREMENT-INFO-STOP
-- ASN1STOP
```

***LocationMeasurementInfo* field descriptions**
carrierFreq The EARFCN value of the carrier received from upper layers for which the UE needs to perform the inter-RAT RSTD measurements.
measPRS-Offset Indicates the requested gap offset for performing RSTD measurements towards E-UTRA. It is the smallest subframe offset from the beginning of subframe 0 of SFN=0 of the serving cell of the requested gap for measuring PRS positioning occasions in the carrier frequency *carrierFreq* for which the UE needs to perform the inter-RAT RSTD measurements. The PRS positioning occasion information is received from upper layers. The value of *measPRS-Offset* is obtained by mapping the starting subframe of the PRS positioning occasion in the measured cell onto the corresponding subframe in the serving cell and is calculated as the serving cell's number of subframes from SFN=0 mod 40. The UE shall take into account any additional time required by the UE to start PRS measurements on the other carrier when it does this mapping for determining the *measPRS-Offset*. NOTE: Figure 6.2.2-1 in TS 36.331[10] illustrates the *measPRS-Offset* field.

– *LogicalChannelConfig*

The IE *LogicalChannelConfig* is used to configure the logical channel parameters.

***LogicalChannelConfig* information element**

```
-- ASN1START
-- TAG-LOGICAL-CHANNEL-CONFIG-START

LogicalChannelConfig ::=            SEQUENCE {
    ul-SpecificParameters               SEQUENCE {
        priority                            INTEGER (1..16),
        prioritisedBitRate                  ENUMERATED {kBps0, kBps8, kBps16, kBps32, kBps64, kBps128, kBps256, kBps512,
                                            kBps1024, kBps2048, kBps4096, kBps8192, kBps16384, kBps32768, kBps65536, infinity},
        bucketSizeDuration                  ENUMERATED {ms5, ms10, ms20, ms50, ms100, ms150, ms300, ms500, ms1000,
                                                            spare7, spare6, spare5, spare4, spare3,spare2, spare1},

        allowedServingCells                 SEQUENCE (SIZE (1..maxNrofServingCells-1)) OF ServCellIndex     OPTIONAL,   -- PDCP-CADuplication
        allowedSCS-List                     SEQUENCE (SIZE (1..maxSCSs)) OF SubcarrierSpacing               OPTIONAL,   -- Need R
        maxPUSCH-Duration                   ENUMERATED { ms0p02, ms0p04, ms0p0625, ms0p125, ms0p25, ms0p5, spare2, spare1 }
                                                                                                            OPTIONAL,   -- Need R
        configuredGrantType1Allowed         ENUMERATED {true}                                               OPTIONAL,   -- Need R

        logicalChannelGroup                 INTEGER (0..maxLCG-ID)                                          OPTIONAL,   -- Need R
        schedulingRequestID                 SchedulingRequestId                                             OPTIONAL,   -- Need R
        logicalChannelSR-Mask               BOOLEAN,
        logicalChannelSR-DelayTimerApplied  BOOLEAN,
        ...,
        bitRateQueryProhibitTimer       ENUMERATED { s0, s0dot4, s0dot8, s1dot6, s3, s6, s12,s30}           OPTIONAL    -- Need R
    }                                                                                                       OPTIONAL,   -- Cond UL

    ...
}

-- TAG-LOGICAL-CHANNEL-CONFIG-STOP
-- ASN1STOP
```

***LogicalChannelConfig* field descriptions**
allowedSCS-List If present, UL MAC SDUs from this logical channel can only be mapped to the indicated numerology. Otherwise, UL MAC SDUs from this logical channel can be mapped to any configured numerology. Only the values 15/30/60 KHz (for FR1) and 60/120 KHz (for FR2) are applicable. Corresponds to 'allowedSCS-List' as specified in TS 38.321 [3].
allowedServingCells If present, UL MAC SDUs from this logical channel can only be mapped to the serving cells indicated in this list. Otherwise, UL MAC SDUs from this logical channel can be mapped to any configured serving cell of this cell group. Corresponds to 'allowedServingCells' in TS 38.321 [3].
bitRateQueryProhibitTimer The timer is used for bit rate recommendation query in TS 38.321 [3], in seconds. Value s0 means 0s, s0dot4 means 0.4s and so on.
bucketSizeDuration Value in ms. ms5 corresponds to 5ms, ms10 corresponds to 10ms, and so on.
configuredGrantType1Allowed If present, UL MAC SDUs from this logical channel can be transmitted on a configured grant type 1. Corresponds to 'configuredGrantType1Allowed' in TS 38.321 [3].
logicalChannelGroup ID of the logical channel group, as specified in TS 38.321 [3], which the logical channel belongs to.
logicalChannelSR-Mask Controls SR triggering when a configured uplink grant of type1 or type2 is configured. TRUE indicates that SR masking is configured for this logical channel as specified in TS 38.321 [3].
logicalChannelSR-DelayTimerApplied Indicates whether to apply the delay timer for SR transmission for this logical channel. Set to FALSE if *logicalChannelSR-DelayTimer* is not included in *BSR-Config*.
maxPUSCH-Duration If present, UL MAC SDUs from this logical channel can only be transmitted using uplink grants that result in a PUSCH duration shorter than or equal to the duration indicated by this field. Otherwise, UL MAC SDUs from this logical channel can be transmitted using an uplink grant resulting in any PUSCH duration. Corresponds to "maxPUSCH-Duration" in TS 38.321 [3].
priority Logical channel priority, as specified in TS 38.321 [3].
prioritisedBitRate Value in kiloBytes/s. 0kBps corresponds to 0, 8kBps corresponds to 8 kiloBytes/s,16 kBps corresponds to 16 kiloBytes/s, and so on. For SRBs, the value can only be set to infinity.
schedulingRequestId If present, it indicates the scheduling request configuration applicable for this logical channel, as specified in TS 38.321 [3].

Conditional Presence	Explanation
PDCP-CADuplication	The field is mandatory present if the UE is configured with PDCP CA duplication in UL (see PDCP-Config -> moreThanOneRLC -> primaryPath -> logicalChannel). Otherwise the field is optionally present, need R.
UL	The field is mandatory present for a logical channel with uplink if it serves DRB. It is optionally present for a logical channel with uplink if it serves an SRB. otherwise it is not present.

– *LogicalChannelIdentity*

The IE *LogicalChannelIdentity* is used to identify one logical channel (*LogicalChannelConfig*) and the corresponding RLC bearer (*RLC-BearerConfig*).

LogicalChannelIdentity information element

```
-- ASN1START
```

```
-- TAG-LOGICALCHANNELIDENTITY-START

LogicalChannelIdentity ::=          INTEGER (1..maxLC-ID)

-- TAG-LOGICALCHANNELIDENTITY-STOP
-- ASN1STOP
```

– *MAC-CellGroupConfig*

The IE *MAC-CellGroupConfig* is used to configure MAC parameters for a cell group, including DRX.

MAC-CellGroupConfig information element

```
-- ASN1START
-- TAG-MAC-CELL-GROUP-CONFIG-START

MAC-CellGroupConfig ::=             SEQUENCE {
    drx-Config                          SetupRelease { DRX-Config }                                         OPTIONAL,   -- Need M
    schedulingRequestConfig             SchedulingRequestConfig                                             OPTIONAL,   -- Need M
    bsr-Config                          BSR-Config                                                          OPTIONAL,   -- Need M
    tag-Config                          TAG-Config                                                          OPTIONAL,   -- Need M
    phr-Config                          SetupRelease { PHR-Config }                                         OPTIONAL,   -- Need M
    skipUplinkTxDynamic                 BOOLEAN,
    ...,
    [[
    csi-Mask-v1530                          BOOLEAN                                                         OPTIONAL,   -- Need M
    dataInactivityTimer-v1530               SetupRelease { DataInactivityTimer }                            OPTIONAL    -- Cond MCG-Only
    ]]
}

DataInactivityTimer ::=         ENUMERATED {s1, s2, s3, s5, s7, s10, s15, s20, s40, s50, s60, s80, s100, s120, s150, s180}

-- TAG-MAC-CELL-GROUP-CONFIG-STOP
-- ASN1STOP
```

***MAC-CellGroupConfig* field descriptions**
csi-Mask-v1530 If set to true, the UE limits CSI reports to the on-duration period of the DRX cycle, see TS 38.321 [3].
dataInactivityTimer-v1530 Releases the RRC connection upon data inactivity as specified in clause 5.3.8.5 and in TS 38.321 [3]. Value s1 corresponds to 1 second, s2 corresponds to 2 seconds and so on.
drx-Config Used to configure DRX as specified in TS 38.321 [3].
skipUplinkTxDynamic If set to true, the UE skips UL transmissions for an uplink grant other than a configured uplink grant if no data is available for transmission in the UE buffer as described in TS 38.321 [3]. FFS : configurable per SCell?

Conditional Presence	Explanation
MCG-Only	This field is optionally present, Need M, for the MAC-CellGroupConfig of the MCG. It is absent otherwise.

– *MeasConfig*

The IE *MeasConfig* specifies measurements to be performed by the UE, and covers intra-frequency, inter-frequency and inter-RAT mobility as well as configuration of measurement gaps.

MeasConfig information element

```
-- ASN1START
-- TAG-MEAS-CONFIG-START

MeasConfig ::=                      SEQUENCE {
    measObjectToRemoveList              MeasObjectToRemoveList                                              OPTIONAL,   -- Need N
    measObjectToAddModList              MeasObjectToAddModList                                              OPTIONAL,   -- Need N
    reportConfigToRemoveList            ReportConfigToRemoveList                                            OPTIONAL,   -- Need N
    reportConfigToAddModList            ReportConfigToAddModList                                            OPTIONAL,   -- Need N
    measIdToRemoveList                  MeasIdToRemoveList                                                  OPTIONAL,   -- Need N
    measIdToAddModList                  MeasIdToAddModList                                                  OPTIONAL,   -- Need N
    s-MeasureConfig                     CHOICE {
        ssb-RSRP                            RSRP-Range,
        csi-RSRP                            RSRP-Range
    }                                                                                                       OPTIONAL,   -- Need M
    quantityConfig                      QuantityConfig                                                      OPTIONAL,   -- Need M
    measGapConfig                       MeasGapConfig                                                       OPTIONAL,   -- Need M
    measGapSharingConfig                    MeasGapSharingConfig                                            OPTIONAL,   -- Need M
    ...
}

MeasObjectToRemoveList ::=              SEQUENCE (SIZE (1..maxNrofObjectId)) OF MeasObjectId

MeasIdToRemoveList ::=                  SEQUENCE (SIZE (1..maxNrofMeasId)) OF MeasId

ReportConfigToRemoveList ::=            SEQUENCE (SIZE (1..maxReportConfigId)) OF ReportConfigId

-- TAG-MEAS-CONFIG-STOP
-- ASN1STOP
```

***MeasConfig* field descriptions**
measGapConfig Used to setup and release measurement gaps in NR.
measIdToAddModList List of measurement identities to add and/or modify.
measIdToRemoveList List of measurement identities to remove.
measObjectToAddModList List of measurement objects to add and/or modify.
measObjectToRemoveList List of measurement objects to remove.
reportConfigToAddModList List of measurement reporting configurations to add and/or modify
reportConfigToRemoveList List of measurement reporting configurations to remove.
s-MeasureConfig Threshold for NR SpCell RSRP measurement controlling when the UE is required to perform measurements on non-serving cells. Choice of *ssb-RSRP* corresponds to cell RSRP based on SS/PBCH block and choice of *csi-RSRP* corresponds to cell RSRP of CSI-RS.
MeasGapSharingConfig The IE MeasGapSharingConfig specifies the measurement gap sharing scheme

– *MeasGapConfig*

The IE *MeasGapConfig* specifies the measurement gap configuration and controls setup/ release of measurement gaps.

***MeasGapConfig* information element**

```
-- ASN1START
-- TAG-MEAS-GAP-CONFIG-START

MeasGapConfig ::=                   SEQUENCE {
    gapFR2                              SetupRelease { GapConfig }                                                      OPTIONAL,   -- Need M
    ...,
    [[
        gapFR1                          SetupRelease { GapConfig }                                                      OPTIONAL,   -- Need M
        gapUE                           SetupRelease { GapConfig }                                                      OPTIONAL    -- Need M
    ]]

}

GapConfig ::=                       SEQUENCE {
    gapOffset                           INTEGER (0..159),
    mgl                                 ENUMERATED {ms1dot5, ms3, ms3dot5, ms4, ms5dot5, ms6},
    mgrp                                ENUMERATED {ms20, ms40, ms80, ms160},
    mgta                                ENUMERATED {ms0, ms0dot25, ms0dot5},
    ...
}
```

```
-- TAG-MEAS-GAP-CONFIG-STOP
-- ASN1STOP
```

***MeasGapConfig* field descriptions**
gapFR1 Indicates measurement gap configuration that applies to FR1 only. In the case of EN-DC, *gapFR1* cannot be set up by NR RRC (i.e. only LTE RRC can configure FR1 gap). *gapFR1* can not be configured together with *gapUE*. The applicability of the measurement gap is according to Table 9.1.2-2 in TS 38.133 [14].
gapFR2 Indicates measurement gap configuration applies to FR2 only. *gapFR2* cannot be configured together with *gapUE*. The applicability of the measurement gap is according to Table 9.1.2-1 and Table 9.1.2-2 in TS 38.133 [14].
gapUE Indicates measurement gap configuration that applies to all frequencies (FR1 and FR2). In the case of EN-DC, *gapUE* cannot be set up by NR RRC (i.e. only LTE RRC can configure per UE gap). If *gapUE* is configured, then neither *gapFR1* nor *gapFR2* can be configured. The applicability of the measurement gap is according to Table 9.1.2-2 in TS 38.133 [14].
gapOffset Value *gapOffset* is the gap offset of the gap pattern with MGRP indicated in the field *mgrp*. The value range should be from 0 to *mgrp*-1.
mgl Value *mgl* is the measurement gap length in ms of the measurement gap. The applicability of the measurement gap is according to in Table 9.1.2-1 and Table 9.1.2-2 in TS 38.133 [14]. Value *ms1dot5* corresponds to 1.5ms, *ms3* corresponds to 3ms and so on.
mgrp Value *mgrp* is measurement gap repetition period in (ms) of the measurement gap. The applicability of the measurement gap is according to in Table 9.1.2-1 and Table 9.1.2-2 in TS 38.133 [14].
mgta Value *mgta* is the measurement gap timing advance in ms. The applicability of the measurement gap timing advance is according to clause 9.1.2 of TS 38.133 [14]. Value *ms0* corresponds to 0 ms, *ms0dot25* corresponds to 0.25ms and *ms0dot5* corresponds to 0.5ms.For FR2, the network only configures 0 and 0.25ms.

– *MeasGapSharingConfig*

The IE *MeasGapSharingConfig* specifies the measurement gap sharing scheme and controls setup/ release of measurement gap sharing.

***MeasGapSharingConfig* information element**

```
-- ASN1START
-- TAG-MEAS-GAP-SHARING-CONFIG-START

MeasGapSharingConfig ::=        SEQUENCE {
    gapSharingFR2                   SetupRelease { MeasGapSharingScheme }       OPTIONAL,   -- Need M
    ...,
    [[
    gapSharingFR1                   SetupRelease { MeasGapSharingScheme }       OPTIONAL,   --Need M
    gapSharingUE                    SetupRelease { MeasGapSharingScheme }       OPTIONAL    --Need M
    ]]

}

MeasGapSharingScheme::=         ENUMERATED {scheme00, scheme01, scheme10, scheme11}
```

```
-- TAG-MEAS-GAP-SHARING-CONFIG-STOP
-- ASN1STOP
```

MeasGapSharingConfig field descriptions
gapSharingFR1 Indicates the measurement gaps sharing scheme that applies to the gap set for FR1 only. In the case of EN-DC, *gapSharingFR1* cannot be set up by NR RRC (i.e. only LTE RRC can configure FR1 gap sharing). *gapSharingFR1* can not be configured together with *gapSharingUE*. For the different gap sharing schemes, see TS 38.133 [14]. Value scheme00 corresponds to "00", value scheme01 corresponds to "01", and so on.
gapSharingFR2 Indicates the measurement gaps sharing scheme that applies to the gap set for FR2 only. *gapSharingFR2* cannot be configured together with *gapSharingUE*. For the different gap sharing schemes, see TS 38.133 [14]. Value scheme00 corresponds to "00", value scheme01 corresponds to "01", and so on.
gapSharingUE Indicates the measurement gaps sharing scheme that applies to the gap set per UE. In EN-DC, *gapSharingUE* cannot be set up by NR RRC (i.e. only LTE RRC can configure per UE gap sharing). If *gapSharingUE* is configured, then neither *gapSharingFR1* nor *gapSharingFR2* can be configured. For the different gap sharing schemes, see TS 38.133 [14]. Value scheme00 corresponds to "00", value scheme01 corresponds to "01", and so on.

– *MeasId*

The IE *MeasId* is used to identify a measurement configuration, i.e., linking of a measurement object and a reporting configuration.

MeasId information element

```
-- ASN1START
-- TAG-MEAS-ID-START

MeasId ::=                          INTEGER (1..maxNrofMeasId)

-- TAG-MEAS-ID-STOP
-- ASN1STOP
```

– *MeasIdToAddModList*

The IE *MeasIdToAddModList* concerns a list of measurement identities to add or modify, with for each entry the measId, the associated *measObjectId* and the associated *reportConfigId*.

MeasIdToAddModList information element

```
-- ASN1START
-- TAG-MEAS-ID-TO-ADD-MOD-LIST-START

MeasIdToAddModList ::=              SEQUENCE (SIZE (1..maxNrofMeasId)) OF MeasIdToAddMod

MeasIdToAddMod ::=                  SEQUENCE {
    measId                              MeasId,
    measObjectId                        MeasObjectId,
    reportConfigId                      ReportConfigId
```

```
}

-- TAG-MEAS-ID-TO-ADD-MOD-LIST-STOP
-- ASN1STOP
```

– *MeasObjectEUTRA*

The IE *MeasObjectEUTRA* specifies information applicable for E-UTRA cells.

MeasObjectEUTRA information element

```
-- ASN1START
-- TAG-MEAS-OBJECT-EUTRA-NR-START

MeasObjectEUTRA::=                  SEQUENCE {
    carrierFreq                         ARFCN-ValueEUTRA,
    allowedMeasBandwidth                EUTRA-AllowedMeasBandwidth,
    cellsToRemoveListEUTRAN             EUTRA-CellIndexList                                 OPTIONAL,   -- Need N
    cellsToAddModListEUTRAN             SEQUENCE (SIZE (1..maxCellMeasEUTRA)) OF EUTRA-Cell         OPTIONAL,   -- Need N
    blackCellsToRemoveListEUTRAN        EUTRA-CellIndexList                                 OPTIONAL,   -- Need N
    blackCellsToAddModListEUTRAN        SEQUENCE (SIZE (1..maxCellMeasEUTRA)) OF EUTRA-BlackCell    OPTIONAL,   -- Need N
    eutra-PresenceAntennaPort1          EUTRA-PresenceAntennaPort1  ,
    eutra-Q-OffsetRange                 EUTRA-Q-OffsetRange                                 OPTIONAL,   -- Need R
    widebandRSRQ-Meas                   BOOLEAN,
    ...
}

EUTRA-CellIndexList ::=             SEQUENCE (SIZE (1..maxCellMeasEUTRA)) OF EUTRA-CellIndex

EUTRA-CellIndex ::=                 INTEGER (1..maxCellMeasEUTRA)


EUTRA-Cell ::=                      SEQUENCE {
    cellIndexEUTRA                      EUTRA-CellIndex,
    physCellId                          EUTRA-PhysCellId,
    cellIndividualOffset                EUTRA-Q-OffsetRange
}


EUTRA-BlackCell ::=                 SEQUENCE {
    cellIndexEUTRA                      EUTRA-CellIndex,
    physCellIdRange                 EUTRA-PhysCellIdRange
}

-- TAG-MEAS-OBJECT-EUTRA-NR-STOP
-- ASN1STOP
```

EUTRAN-BlackCell field descriptions
cellIndexEUTRA Entry index in the cell list.
physicalCellIdRange Physical cell identity or a range of physical cell identities.

EUTRAN-Cell field descriptions
physicalCellId Physical cell identity of a cell in the cell list.
cellIndividualOffset Cell individual offset applicable to a specific cell. Value dB-24 corresponds to -24 dB, dB-22 corresponds to -22 dB and so on.

MeasObjectEUTRA field descriptions
allowedMeasBandiwdth The maximum allowed measurement bandwidth on a carrier frequency as defined by the parameter Transmission Bandwidth Configuration "N_{RB}" TS 36.104 [33].
blackCellsToAddModListEUTRAN List of cells to add/ modify in the black list of cells.
blackCellsToRemoveListEUTRAN List of cells to remove from the black list of cells.
carrierFreq Identifies E-UTRA carrier frequency for which this configuration is valid. E-UTRAN does not configure more than one measurement object for the same physical frequency regardless of the E-ARFCN used to indicate this.
cellsToAddModListEUTRAN List of cells to add/ modify in the cell list.
cellsToRemoveListEUTRAN List of cells to remove from the cell list.
eutra-PresenceAntennaPort1 When set to *TRUE*, the UE may assume that at least two cell-specific antenna ports are used in all neighbouring cells.
eutra-Q-OffsetRange Used to indicate a cell, or frequency specific offset to be applied when evaluating candidates when evaluating triggering conditions for measurement reporting. The value in dB. Value dB-24 corresponds to -24 dB, dB-22 corresponds to -22 dB and so on.
widebandRSRQ-Meas If set to *TRUE*, the UE shall, when performing RSRQ measurements, use a wider bandwidth in accordance with TS 36.133 [16]. The network may set the field to *TRUE* if the measurement bandwidth indicated by *allowedMeasBandwidth* is 50 resource blocks or larger; otherwise the network sets this field to *FALSE*.

– *MeasObjectId*

The IE *MeasObjectId* used to identify a measurement object configuration.

MeasObjectId information element

```
-- ASN1START
-- TAG-MEAS-OBJECT-ID-START
```

```
MeasObjectId ::=                    INTEGER (1..maxNrofObjectId)

-- TAG-MEAS-OBJECT-ID-STOP
-- ASN1STOP
```

– *MeasObjectNR*

The IE *MeasObjectNR* specifies information applicable for SS/PBCH block(s) intra/inter-frequency measurements or CSI-RS intra/inter-frequency measurements.

***MeasObjectNR* information element**

```
-- ASN1START
-- TAG-MEAS-OBJECT-NR-START

MeasObjectNR ::=                    SEQUENCE {
    ssbFrequency                        ARFCN-ValueNR                                                   OPTIONAL,   -- Cond SSBorAssociatedSSB
    ssbSubcarrierSpacing                SubcarrierSpacing                                               OPTIONAL,   -- Cond SSBorAssociatedSSB
    smtc1                               SSB-MTC                                                         OPTIONAL,   -- Cond SSBorAssociatedSSB
    smtc2                               SSB-MTC2                                                        OPTIONAL,   -- Cond IntraFreqConnected
    refFreqCSI-RS                       ARFCN-ValueNR                                                   OPTIONAL,   -- Cond CSI-RS
    referenceSignalConfig               ReferenceSignalConfig,
    absThreshSS-BlocksConsolidation     ThresholdNR                                                     OPTIONAL,   -- Need R
    absThreshCSI-RS-Consolidation       ThresholdNR                                                     OPTIONAL,   -- Need R
    nrofSS-BlocksToAverage              INTEGER (2..maxNrofSS-BlocksToAverage)                          OPTIONAL,   -- Need R
    nrofCSI-RS-ResourcesToAverage       INTEGER (2..maxNrofCSI-RS-ResourcesToAverage)                   OPTIONAL,   -- Need R
    quantityConfigIndex                 INTEGER (1..maxNrofQuantityConfig),
    offsetMO                            Q-OffsetRangeList,
    cellsToRemoveList                   PCI-List                                                        OPTIONAL,   -- Need N
    cellsToAddModList                   CellsToAddModList                                               OPTIONAL,   -- Need N
    blackCellsToRemoveList              PCI-RangeIndexList                                              OPTIONAL,   -- Need N
    blackCellsToAddModList              SEQUENCE (SIZE (1..maxNrofPCI-Ranges)) OF PCI-RangeElement      OPTIONAL,   -- Need N
    whiteCellsToRemoveList              PCI-RangeIndexList                                              OPTIONAL,   -- Need N
    whiteCellsToAddModList              SEQUENCE (SIZE (1..maxNrofPCI-Ranges)) OF PCI-RangeElement      OPTIONAL,   -- Need N
    ... ,
    [[
    freqBandIndicatorNR-v1530           FreqBandIndicatorNR                                             OPTIONAL,   -- Need R
    measCycleSCell-v1530                ENUMERATED {sf160, sf256, sf320, sf512, sf640, sf1024, sf1280}  OPTIONAL    -- Need R
    ]]
}

ReferenceSignalConfig::=            SEQUENCE {
    ssb-ConfigMobility                  SSB-ConfigMobility                                              OPTIONAL,   -- Need M
    csi-rs-ResourceConfigMobility       SetupRelease { CSI-RS-ResourceConfigMobility }                  OPTIONAL    -- Need M
}

SSB-ConfigMobility::=               SEQUENCE {

    ssb-ToMeasure                           SetupRelease { SSB-ToMeasure }                              OPTIONAL,   -- Need M
    deriveSSB-IndexFromCell             BOOLEAN,
    ss-RSSI-Measurement                         SS-RSSI-Measurement                                     OPTIONAL,   -- Need M
    ...
}
```

```
Q-OffsetRangeList ::=               SEQUENCE {
    rsrpOffsetSSB                       Q-OffsetRange               DEFAULT dB0,
    rsrqOffsetSSB                       Q-OffsetRange               DEFAULT dB0,
    sinrOffsetSSB                       Q-OffsetRange               DEFAULT dB0,
    rsrpOffsetCSI-RS                    Q-OffsetRange               DEFAULT dB0,
    rsrqOffsetCSI-RS                    Q-OffsetRange               DEFAULT dB0,
    sinrOffsetCSI-RS                    Q-OffsetRange               DEFAULT dB0
}


ThresholdNR ::=                     SEQUENCE{
    thresholdRSRP                       RSRP-Range                                                                      OPTIONAL,   -- Need R
    thresholdRSRQ                       RSRQ-Range                                                                      OPTIONAL,   -- Need R
    thresholdSINR                       SINR-Range                                                                      OPTIONAL    -- Need R
}

CellsToAddModList ::=               SEQUENCE (SIZE (1..maxNrofCellMeas)) OF CellsToAddMod

CellsToAddMod ::=                   SEQUENCE {
    physCellId                          PhysCellId,
    cellIndividualOffset                Q-OffsetRangeList
}



-- TAG-MEAS-OBJECT-NR-STOP
-- ASN1STOP
```

CellsToAddMod field descriptions
cellIndividualOffset Cell individual offsets applicable to a specific cell.
physCellId Physical cell identity of a cell in the cell list.

MeasObjectNR field descriptions
absThreshCSI-RS-Consolidation Absolute threshold for the consolidation of measurement results per CSI-RS resource(s) from L1 filter(s). The field is used for the derivation of cell measurement results as described in 5.5.3.3 and the reporting of beam measurement information per CSI-RS resource as described in 5.5.5.2.
absThreshSS-BlocksConsolidation Absolute threshold for the consolidation of measurement results per SS/PBCH block(s) from L1 filter(s). The field is used for the derivation of cell measurement results as described in 5.5.3.3 and the reporting of beam measurement information per SS/PBCH block index as described in 5.5.5.2.
blackCellsToAddModList List of cells to add/modify in the black list of cells. It applies only to SSB resources.
blackCellsToRemoveList List of cells to remove from the black list of cells.
cellsToAddModList List of cells to add/modify in the cell list.
cellsToRemoveList List of cells to remove from the cell list.
freqBandIndicatorNR The frequency band in which the SSB and/or CSI-RS indicated in this *MeasObjectNR* are located and according to which the UE shall perform the RRM measurements. This field is always provided when the network configures measurements with this *MeasObjectNR*.
measCycleSCell The parameter is used only when an SCell is configured on the frequency indicated by the measObjectNR and is in deactivated state, see TS 38.133 [14]. gNB configures the parameter whenever an SCell is configured on the frequency indicated by the *measObjectNR*, but the field may also be signalled when an SCell is not configured. Value *sf160* corresponds to 160 sub-frames, *sf256* corresponds to 256 sub-frames and so on.
nrofCSInrofCSI-RS-ResourcesToAverage Indicates the maximum number of measurement results per beam based on CSI-RS resources to be averaged. The same value applies for each detected cell associated with this MeasObjectNR.
nrofSS-BlocksToAverage Indicates the maximum number of measurement results per beam based on SS/PBCH blocks to be averaged. The same value applies for each detected cell associated with this MeasObject.
offsetMO Offset values applicable to all measured cells with reference signal(s) indicated in this *MeasObjectNR*.
quantityConfigIndex Indicates the n-*th* element of *quantityConfigNR-List* provided in *MeasConfig*.
referenceSignalConfig RS configuration for SS/PBCH block and CSI-RS.
refFreqCSI-RS Point A which is used for mapping of CSI-RS to physical resources according to TS 38.211 [16] clause 7.4.1.5.3.
smtc1 Primary measurement timing configuration. (see clause 5.5.2.10).
smtc2 Secondary measurement timing configuration for SS corresponding to this MeasObjectNR with PCI listed in pci-List. For these SS, the periodicity is indicated by periodicity in smtc2 and the timing offset is equal to the offset indicated in periodicityAndOffset modulo periodicity. periodicity in smtc2 can only be set to a value strictly shorter than the periodicity indicated by periodicityAndOffset in smtc1 (e.g. if periodicityAndOffset indicates sf10, periodicity can only be set of sf5, if periodicityAndOffset indicates sf5, smtc2 cannot be configured).
ssbFrequency Indicates the frequency of the SS associated to this MeasObjectNR.

ssbSubcarrierSpacing Subcarrier spacing of SSB. Only the values 15 or 30 (<6GHz), 120 kHz or 240 kHz (>6GHz) are applicable.
whiteCellsToAddModList List of cells to add/modify in the white list of cells. It applies only to SSB resources.
whiteCellsToRemoveList List of cells to remove from the white list of cells.

ReferenceSignalConfig field descriptions
csi-rs-ResourceConfigMobility CSI-RS resources to be used for CSI-RS based RRM measurements
ssb-ConfigMobility SSB configuration for mobility (nominal SSBs, timing configuration)

SSB-ConfigMobility field descriptions
deriveSSB-IndexFromCell If this field is set to TRUE, UE assumes SFN and frame boundary alignment across cells on the same frequency carrier as specified in TS 38.133 [14]. Hence, if the UE is configured with a serving cell for which (*absoluteFrequencySSB*, *subcarrierSpacing*) in *ServingCellConfigCommon* is equal to (*ssbFrequency*, *ssbSubcarrierSpacing*) in this *MeasObjectNR*, this field indicates whether the UE can utilize the timing of this serving cell to derive the index of SS block transmitted by neighbour cell. Otherwise, this field indicates whether the UE may use the timing of any detected cell on that target frequency to derive the SSB index of all neighbour cells on that frequency.
ssb-ToMeasure The set of SS blocks to be measured within the SMTC measurement duration. The first/ leftmost bit corresponds to SS/PBCH block index 0, the second bit corresponds to SS/PBCH block index 1, and so on. Value 0 in the bitmap indicates that the corresponding SS/PBCH block is not to be measured while value 1 indicates that the corresponding SS/PBCH block is to be measured (see TS 38.215 [9]). When the field is not configured the UE measures on all SS blocks. Regardless of the value of this field, SS/PBCH block outside of the applicable *smtc* are not to be measured. See TS 38.215 [9] clause 5.1.1.

Conditional Presence	**Explanation**
CSI-RS	This field is mandatory present if *csi-rs-ResourceConfigMobility* is configured, otherwise, it is absent.
SSBorAssociatedSSB	This field is mandatory present if ssb-ConfigMobility is configured or associatedSSB is configured in at least one cell, otherwise, it is absent and the UE releases a previously configured value.
IntraFreqConnected	This field is optionally present, Need R if the UE is configured with a serving cell for which (absoluteFrequencySSB, subcarrierSpacing) in ServingCellConfigCommon is equal to (ssbFrequency, ssbSubcarrierSpacing) in this MeasObjectNR, otherwise, it is absent.

– *MeasObjectToAddModList*

The IE *MeasObjectToAddModList* concerns a list of measurement objects to add or modify.

MeasObjectToAddModList information element

```
-- ASN1START
-- TAG-MEAS-OBJECT-TO-ADD-MOD-LIST-START

MeasObjectToAddModList ::=                  SEQUENCE (SIZE (1..maxNrofObjectId)) OF MeasObjectToAddMod
```

```
MeasObjectToAddMod ::=                      SEQUENCE {
    measObjectId                                MeasObjectId,
    measObject                                  CHOICE {
        measObjectNR                                MeasObjectNR,
        ... ,
        measObjectEUTRA                             MeasObjectEUTRA
    }
}

-- TAG-MEAS-OBJECT-TO-ADD-MOD-LIST-STOP
-- ASN1STOP
```

– *MeasResult*CellList*SFTD*

The IE *MeasResultCellListSFTD* consists of SFN and radio frame boundary difference between the PCell and an NR cell as specified in TS 38.215 [9] and TS 38.133 [14].

MeasResultCellListSFTD information element

```
-- ASN1START
-- TAG-MEASRESULT-CELL-LIST-SFTD-START

MeasResultCellListSFTD ::=          SEQUENCE (SIZE (1..maxCellSFTD)) OF MeasResultCellSFTD

MeasResultCellSFTD ::=              SEQUENCE {
    physCellId                          PhysCellId,
    sfn-OffsetResult                    INTEGER (0..1023),
    frameBoundaryOffsetResult           INTEGER (-30720..30719),
    rsrp-Result                         RSRP-Range                      OPTIONAL
}

-- TAG-MEASRESULT-CELL-LIST-SFTD-STOP
-- ASN1STOP
```

***MeasResultSFTD* field descriptions**
sfn-OffsetResult Indicates the SFN difference between the PCell and the NR cell as an integer value according to TS 38.215 [9].
frameBoundaryOffsetResult Indicates the frame boundary difference between the PCell and the NR cell as an integer value according to TS 38.215 [9].

– *MeasResults*

The IE *MeasResults* covers measured results for intra-frequency, inter-frequency, and inter-RAT mobility.

***MeasResults* information element**

```
-- ASN1START
```

```
-- TAG-MEAS-RESULTS-START

MeasResults ::=                     SEQUENCE {
    measId                              MeasId,
    measResultServingMOList             MeasResultServMOList,
    measResultNeighCells                CHOICE {
        measResultListNR                    MeasResultListNR,
        ...,
        measResultListEUTRA                 MeasResultListEUTRA
    }                                                                                           OPTIONAL,
    ...
}

MeasResultServMOList ::=            SEQUENCE (SIZE (1..maxNrofServingCells)) OF MeasResultServMO

MeasResultServMO ::=                SEQUENCE {
    servCellId                          ServCellIndex,
    measResultServingCell               MeasResultNR,
    measResultBestNeighCell             MeasResultNR                                            OPTIONAL,
    ...
}

MeasResultListNR ::=                SEQUENCE (SIZE (1..maxCellReport)) OF MeasResultNR

MeasResultNR ::=                    SEQUENCE {
    physCellId                          PhysCellId                                              OPTIONAL,
    measResult                          SEQUENCE {
        cellResults                         SEQUENCE{
            resultsSSB-Cell                     MeasQuantityResults                             OPTIONAL,
            resultsCSI-RS-Cell                  MeasQuantityResults                             OPTIONAL
        },
        rsIndexResults                      SEQUENCE{
            resultsSSB-Indexes                  ResultsPerSSB-IndexList                         OPTIONAL,
            resultsCSI-RS-Indexes               ResultsPerCSI-RS-IndexList                      OPTIONAL
        }                                                                                       OPTIONAL
    },
    ...,
    [[
    cgi-Info                            CGI-Info                                                OPTIONAL
    ]]
}

MeasResultListEUTRA ::=             SEQUENCE (SIZE (1..maxCellReport)) OF MeasResultEUTRA

MeasResultEUTRA ::=                 SEQUENCE {
    eutra-PhysCellId                    PhysCellId,
    measResult                          MeasQuantityResultsEUTRA,

    cgi-Info                            SEQUENCE {
        cgi-info-EPC                        SEQUENCE {
            cgi-info-EPC-legacy                 CellAccessRelatedInfo-EUTRA-EPC,
            cgi-info-EPC-list                   SEQUENCE (SIZE (1..maxPLMN)) OF CellAccessRelatedInfo-EUTRA-EPC     OPTIONAL
        }                                                                                       OPTIONAL,
```

```
        cgi-info-5GC                        SEQUENCE (SIZE (1..maxPLMN)) OF CellAccessRelatedInfo-EUTRA-5GC         OPTIONAL,
        freqBandIndicator                   FreqBandIndicatorEUTRA,
        multiBandInfoList                   MultiBandInfoListEUTRA                                                  OPTIONAL,
        freqBandIndicatorPriority           ENUMERATED {true}                                                       OPTIONAL
    }                                                                                                               OPTIONAL,
    ...
}

MultiBandInfoListEUTRA ::=          SEQUENCE (SIZE (1..maxMultiBands)) OF FreqBandIndicatorEUTRA

MeasQuantityResults ::=             SEQUENCE {
    rsrp                                RSRP-Range                                                              OPTIONAL,
    rsrq                                RSRQ-Range                                                              OPTIONAL,
    sinr                                SINR-Range                                                              OPTIONAL
}


MeasQuantityResultsEUTRA ::=        SEQUENCE {
    rsrp                                RSRP-RangeEUTRA                                                         OPTIONAL,
    rsrq                                RSRQ-RangeEUTRA                                                         OPTIONAL,
    sinr                                SINR-RangeEUTRA                                                         OPTIONAL
}


ResultsPerSSB-IndexList::=          SEQUENCE (SIZE (1..maxNrofIndexesToReport2)) OF ResultsPerSSB-Index

ResultsPerSSB-Index ::=             SEQUENCE {
    ssb-Index                           SSB-Index,
    ssb-Results                         MeasQuantityResults                                                     OPTIONAL
}

ResultsPerCSI-RS-IndexList::=       SEQUENCE (SIZE (1..maxNrofIndexesToReport2)) OF ResultsPerCSI-RS-Index

ResultsPerCSI-RS-Index ::=          SEQUENCE {
    csi-RS-Index                        CSI-RS-Index,
    csi-RS-Results                      MeasQuantityResults                                                     OPTIONAL
}

-- TAG-MEAS-RESULTS-STOP
-- ASN1STOP
```

***MeasResultEUTRA* field descriptions**
cgi-info-5GC This field includes the *cellAccessRelatedInfo-5GC-r15* of TS 36.331 [10].
cgi-info-EPC-legacy This field includes the *cellAccessRelatedInfo* of TS 36.331 [10].
cgi-info-EPC-list This field includes the *cellAccessRelatedInfoList-r14* of TS 36.331 [10].
freqBandIndicatorPriority This field includes the *freqBandIndicatorPriority-r12* of TS 36.331 [10]
eutra-PhysCellId Identifies the physical cell identity of the E-UTRA cell for which the reporting is being performed. The UE reports a value in the range 0..503, other values are reserved.

***MeasResultNR* field descriptions**
cellresults Cell level measurement results.
physCellId The physical cell identity of the NR cell cell for which the reporting is being performed.
resultsSSB-Cell Cell level measurement results based on SS/PBCH related measurements.
resultsSSB-Indexes Beam level measurement results based on SS/PBCH related measurements.
resultsCSI-RS-Cell Cell level measurement results based on CSI-RS related measurements.
resultsCSI-RS-Indexes Beam level measurement results based on CSI-RS related measurements.
rsIndexResults Beam level measurement results.

***MeasResults* field descriptions**
measId Identifies the measurement identity for which the reporting is being performed.
measResultEUTRA Measured results of an E-UTRA cell.
measResultListEUTRA List of measured results for the maximum number of reported best cells for an E-UTRA measurement identity.
measResultListNR List of measured results for the maximum number of reported best cells for an NR measurement identity.
measResultNR Measured results of an NR cell.
measResultServingMOList Measured results of measured cells with reference signals indicated in the serving cell measurement objects including measurement results of SpCell, configured SCell(s) and best neighbouring cell within measured cells with reference signals indicated in on each serving cell measurement object.

Editor's Note: FFS *locationInfo*.

– *MeasResultSCG-Failure*

The IE *MeasResultSCG-Failure* is used to provide information regarding failures detected by the UE in case of EN-DC.

***MeasResultSCG-Failure* information element**

```
-- ASN1START
-- TAG-MEAS-RESULT-SCG-FAILURE-START

MeasResultSCG-Failure ::=           SEQUENCE {
    measResultPerMOList                 MeasResultList2NR,
    ...
}

MeasResultList2NR ::=               SEQUENCE (SIZE (1..maxFreq)) OF MeasResult2NR

MeasResult2NR ::=                   SEQUENCE {
    ssbFrequency                        ARFCN-ValueNR                           OPTIONAL,
    refFreqCSI-RS                       ARFCN-ValueNR                           OPTIONAL,
    measResultServingCell               MeasResultNR                            OPTIONAL,
    measResultNeighCellListNR           MeasResultListNR                        OPTIONAL,
    ...
}

-- TAG-MEAS-RESULT-SCG-FAILURE-STOP
-- ASN1STOP
```

– *MobilityStateParameters*

The IE *MobilityStateParameters* contains parameters to determine UE mobility state.

***MobilityStateParameters* information element**

```
-- ASN1START
-- TAG-MOBILITY-STATE-PARAMETERS-START

MobilityStateParameters ::=         SEQUENCE{
    t-Evaluation                        ENUMERATED {
                                            s30, s60, s120, s180, s240, spare3, spare2, spare1},
    t-HystNormal                        ENUMERATED {
                                            s30, s60, s120, s180, s240, spare3, spare2, spare1},
    n-CellChangeMedium                  INTEGER (1..16),
    n-CellChangeHigh                    INTEGER (1..16)
}

-- TAG-MOBILITY-STATE-PARAMETERS-STOP
```

```
-- ASN1STOP
```

***MobilityStateParameters* field descriptions**
n-CellChangeHigh The number of cell changes to enter high mobility state. Corresponds to N_{CR_H} in TS 38.304 [20].
n-CellChangeMedium The number of cell changes to enter medium mobility state. Corresponds to N_{CR_M} in TS 38.304 [20].
t-Evaluation The duration for evaluating criteria to enter mobility states. Corresponds to T_{CRmax} in TS 38.304 [20]. Value in seconds, s30 corresponds to 30 s and so on.
t-HystNormal The additional duration for evaluating criteria to enter normal mobility state. Corresponds to $T_{CRmaxHyst}$ in TS 38.304 [20]. Value in seconds, s30 corresponds to 30 s and so on.

– *MultiFrequencyBandListNR*

The IE *MultiFrequencyBandListNR* is used to configure a list of one or multiple NR frequency bands.

MultiFrequencyBandListNR information element

```
-- ASN1START
-- TAG-MULTIFREQUENCYBANDLISTNR-START

MultiFrequencyBandListNR ::=        SEQUENCE (SIZE (1..maxNrofMultiBands)) OF FreqBandIndicatorNR

-- TAG-MULTIFREQUENCYBANDLISTNR-STOP
-- ASN1STOP
```

– *NextHopChainingCount*

The IE *NextHopChainingCount* is used to update the K_{gNB} key and corresponds to parameter NCC: See TS 33.501 [11].

NextHopChainingCount information element

```
-- ASN1START
-- TAG-NEXTHOPCHAININGCOUNT-START

NextHopChainingCount ::=                    INTEGER (0..7)

-- TAG-NEXTHOPCHAININGCOUNT-STOP
-- ASN1STOP
```

– *NG-5G-S-TMSI*

The IE *NG-5G-S-TMSI* contains a 5G S-Temporary Mobile Subscription Identifier (5G-S-TMSI), a temporary UE identity provided by the 5GC which uniquely identifies the UE within the tracking area, see TS 23.003 [21].

NG-5G-S-TMSI information element

```
-- ASN1START
-- TAG-NG-5G-S-TMSI-START

NG-5G-S-TMSI::=                         BIT STRING (SIZE (48))

-- TAG-NG-5G-S-TMSI-STOP
-- ASN1STOP
```

NG-5G-S-TMSI field descriptions
ng-5G-S-TMSI Indicates the 5G-TMSI as defined in TS 23.003 [21].

– *NZP-CSI-RS-Resource*

The IE *NZP-CSI-RS-Resource* is used to configure Non-Zero-Power (NZP) CSI-RS transmitted in the cell where the IE is included, which the UE may be configured to measure on (see TS 38.214 [19], clause 5.2.2.3.1).

NZP-CSI-RS-Resource information element

```
-- ASN1START
-- TAG-NZP-CSI-RS-RESOURCE-START

NZP-CSI-RS-Resource ::=             SEQUENCE {
    nzp-CSI-RS-ResourceId               NZP-CSI-RS-ResourceId,
    resourceMapping                     CSI-RS-ResourceMapping,
    powerControlOffset                  INTEGER (-8..15),
    powerControlOffsetSS                ENUMERATED{db-3, db0, db3, db6}                     OPTIONAL,   -- Need R
    scramblingID                        ScramblingId,
    periodicityAndOffset                CSI-ResourcePeriodicityAndOffset                    OPTIONAL,   -- Cond PeriodicOrSemiPersistent
    qcl-InfoPeriodicCSI-RS              TCI-StateId                                         OPTIONAL,   -- Cond Periodic
    ...
}

-- TAG-NZP-CSI-RS-RESOURCE-STOP
-- ASN1STOP
```

***NZP-CSI-RS-Resource* field descriptions**
periodicityAndOffset Periodicity and slot offset *sl1* corresponds to a periodicity of 1 slot, *sl2* to a periodicity of two slots, and so on. The corresponding offset is also given in number of slots (see TS 38.214 [19], clause 5.2.2.3.1)
powerControlOffset Power offset of PDSCH RE to NZP CSI-RS RE. Value in dB (see TS 38.214 [19], clauses 5.2.2.3.1 and 4.1)
powerControlOffsetSS Power offset of NZP CSI-RS RE to SS RE. Value in dB (see TS 38.214 [19], clause 5.2.2.3.1)
qcl-InfoPeriodicCSI-RS For a target periodic CSI-RS, contains a reference to one TCI-State in TCI-States for providing the QCL source and QCL type. For periodic CSI-RS, the source can be SSB or another periodic-CSI-RS. Refers to the TCI-State which has this value for tci-StateId and is defined in *tci-StatesToAddModList* in the *PDSCH-Config* included in the *BWP-Downlink* corresponding to the serving cell and to the DL BWP to which the resource belongs to (see TS 38.214 [19], clause 5.2.2.3.1)
resourceMapping OFDM symbol location(s) in a slot and subcarrier occupancy in a PRB of the CSI-RS resource
scramblingID Scrambling ID (see TS 38.214 [19], clause 5.2.2.3.1)

Conditional Presence	**Explanation**
Periodic	The field is optionally present, Need M, for periodic NZP-CSI-RS-Resources (as indicated in CSI-ResourceConfig). The field is absent otherwise
PeriodicOrSemiPersistent	The field is mandatory present, Need M, for periodic and semi-persistent NZP-CSI-RS-Resources (as indicated in CSI-ResourceConfig). The field is absent otherwise.

– *NZP-CSI-RS-ResourceId*

The IE *NZP-CSI-RS-ResourceId* is used to identify one NZP-CSI-RS-Resource.

NZP-CSI-RS-ResourceId information element

```
-- ASN1START
-- TAG-NZP-CSI-RS-RESOURCEID-START

NZP-CSI-RS-ResourceId ::=           INTEGER (0..maxNrofNZP-CSI-RS-Resources-1)

-- TAG-NZP-CSI-RS-RESOURCEID-STOP
-- ASN1STOP
```

– *NZP-CSI-RS-ResourceSet*

The IE *NZP-CSI-RS-ResourceSet* is a set of Non-Zero-Power (NZP) CSI-RS resources (their IDs) and set-specific parameters.

NZP-CSI-RS-ResourceSet information element

```
-- ASN1START
-- TAG-NZP-CSI-RS-RESOURCESET-START
```

```
NZP-CSI-RS-ResourceSet ::=          SEQUENCE {
    nzp-CSI-ResourceSetId               NZP-CSI-RS-ResourceSetId,
    nzp-CSI-RS-Resources                SEQUENCE (SIZE (1..maxNrofNZP-CSI-RS-ResourcesPerSet)) OF NZP-CSI-RS-ResourceId,
    repetition                          ENUMERATED { on, off }                                              OPTIONAL,   -- Need S
    aperiodicTriggeringOffset           INTEGER(0..6)                                                       OPTIONAL,   -- Need S
    trs-Info                            ENUMERATED {true}                                                   OPTIONAL,   -- Need R
    ...
}

-- TAG-NZP-CSI-RS-RESOURCESET-STOP
-- ASN1STOP
```

NZP-CSI-RS-ResourceSet field descriptions
aperiodicTriggeringOffset Offset X between the slot containing the DCI that triggers a set of aperiodic NZP CSI-RS resources and the slot in which the CSI-RS resource set is transmitted. The value 0 corresponds to 0 slots, value 1 corresponds to 1 slot, value 2 corresponds to 2 slots, value 3 corresponds to 3 slots, value 4 corresponds to 4 slots, value 5 corresponds to 16 slots, value 6 corresponds to 24 slots. When the field is absent the UE applies the value 0.
nzp-CSI-RS-Resources NZP-CSI-RS-Resources associated with this NZP-CSI-RS resource set (see TS 38.214 [19], clause 5.2). For CSI, there are at most 8 NZP CSI RS resources per resource set
repetition Indicates whether repetition is on/off. If the field is set to 'OFF' or if the field is absent, the UE may not assume that the NZP-CSI-RS resources within the resource set are transmitted with the same downlink spatial domain transmission filter and with same NrofPorts in every symbol (see TS 38.214 [19], clauses 5.2.2.3.1 and 5.1.6.1.2). Can only be configured for CSI-RS resource sets which are associated with CSI-ReportConfig with report of L1 RSRP or "no report"
trs-Info Indicates that the antenna port for all NZP-CSI-RS resources in the CSI-RS resource set is same. If the field is absent or released the UE applies the value "false" (see TS 38.214 [19], clause 5.2.2.3.1).

– *NZP-CSI-RS-ResourceSetId*

The IE *NZP-CSI-RS-ResourceSetId* is used to identify one *NZP-CSI-RS-ResourceSet*.

NZP-CSI-RS-ResourceSetId information element

```
-- ASN1START
-- TAG-NZP-CSI-RS-RESOURCESETID-START

NZP-CSI-RS-ResourceSetId ::=        INTEGER (0..maxNrofNZP-CSI-RS-ResourceSets-1)

-- TAG-NZP-CSI-RS-RESOURCESETID-STOP
-- ASN1STOP
```

– *P-Max*

The IE *P-Max* is used to limit the UE's uplink transmission power on a carrier frequency, in TS 38.101 [15] and is used to calculate the parameter *Pcompensation* defined in TS 38.304 [20].

P-Max information element

```
-- ASN1START
-- TAG-P-MAX-START

P-Max ::=                           INTEGER (-30..33)

-- TAG-P-MAX-STOP
-- ASN1STOP
```

– *PCI-List*

The IE *PCI-List* concerns a list of physical cell identities, which may be used for different purposes.

PCI-List information element

```
-- ASN1START
-- TAG-PCI-LIST-START

PCI-List ::=                        SEQUENCE (SIZE (1..maxNrofCellMeas)) OF PhysCellId

-- TAG-PCI-LIST-STOP
-- ASN1STOP
```

– *PCI-Range*

The IE *PCI-Range* is used to encode either a single or a range of physical cell identities. The range is encoded by using a *start* value and by indicating the number of consecutive physical cell identities (including *start*) in the range. For fields comprising multiple occurrences of *PCI-Range*, the Network may configure overlapping ranges of physical cell identities.

PCI-Range information element

```
-- ASN1START
-- TAG-PCI-RANGE-START

PCI-Range ::=                       SEQUENCE {
    start                               PhysCellId,
    range                               ENUMERATED {n4, n8, n12, n16, n24, n32, n48, n64, n84,
                                                    n96, n128, n168, n252, n504, n1008,spare1}                 OPTIONAL    -- Need S
}

-- TAG-PCI-RANGE-STOP
-- ASN1STOP
```

PCI-Range **field descriptions**
range Indicates the number of physical cell identities in the range (including *start*). Value n4 corresponds with 4, n8 corresponds with 8 and so on. The UE shall apply value 1 in case the field is absent, in which case only the physical cell identity value indicated by *start* applies.
start Indicates the lowest physical cell identity in the range.

– *PCI-RangeElement*

The IE *PCI-RangeElement* is used to define a PCI-Range as part of a list (e.g. AddMod list).

PCI-RangeElement information element

```
-- ASN1START
-- TAG-PCI-RANGEELEMENT-START

PCI-RangeElement ::=                SEQUENCE {
    pci-RangeIndex                      PCI-RangeIndex,
    pci-Range                           PCI-Range
}

-- TAG-PCI-RANGEELEMENT-STOP
-- ASN1STOP
```

PCI-RangeElement field descriptions
pci-Range Physical cell identity or a range of physical cell identities.

– *PCI-RangeIndex*

The IE PCI-RangeIndex identifies a physical cell id range, which may be used for different purposes.

PCI-RangeIndex information element

```
-- ASN1START
-- TAG-PCI-RANGE-INDEX-START

PCI-RangeIndex ::=                  INTEGER (1..maxNrofPCI-Ranges)

-- TAG-PCI-RANGE-INDEX-STOP
-- ASN1STOP
```

– *PCI-RangeIndexList*

The IE *PCI-RangeIndexList* concerns a list of indexes of physical cell id ranges, which may be used for different purposes.

PCI-RangeIndexList information element

```
-- ASN1START
-- TAG-PCI-RANGE-INDEX-LIST-START

PCI-RangeIndexList ::=              SEQUENCE (SIZE (1..maxNrofPCI-Ranges)) OF PCI-RangeIndex

-- TAG-PCI-Range-INDEX-LIST-STOP
-- ASN1STOP
```

– *PDCCH-Config*

The *PDCCH-Config* IE is used to configure UE specific PDCCH parameters such as control resource sets (CORESET), search spaces and additional parameters for acquiring the PDCCH.

PDCCH-Config information element

```
-- ASN1START
-- TAG-PDCCH-CONFIG-START

PDCCH-Config ::=                    SEQUENCE {
    controlResourceSetToAddModList      SEQUENCE(SIZE (1..3)) OF ControlResourceSet                         OPTIONAL,   -- Need N
    controlResourceSetToReleaseList     SEQUENCE(SIZE (1..3)) OF ControlResourceSetId                       OPTIONAL,   -- Need N
    searchSpacesToAddModList            SEQUENCE(SIZE (1..10)) OF SearchSpace                               OPTIONAL,   -- Need N
    searchSpacesToReleaseList           SEQUENCE(SIZE (1..10)) OF SearchSpaceId                             OPTIONAL,   -- Need N
    downlinkPreemption                  SetupRelease { DownlinkPreemption }                                 OPTIONAL,   -- Need M
    tpc-PUSCH                           SetupRelease { PUSCH-TPC-CommandConfig }                            OPTIONAL,   -- Need M
    tpc-PUCCH                           SetupRelease { PUCCH-TPC-CommandConfig }                            OPTIONAL,   -- Cond PUCCH-CellOnly
    tpc-SRS                             SetupRelease { SRS-TPC-CommandConfig}                               OPTIONAL,   -- Need M
    ...
}

-- TAG-PDCCH-CONFIG-STOP
-- ASN1STOP
```

PDCCH-Config field descriptions
controlResourceSetToAddModList List of UE specifically configured Control Resource Sets (CORESETs) to be used by the UE. The network configures at most 3 CORESETs per BWP per cell (including UE-specific and common CORESETs). In case network reconfigures control resource set with the same *ControlResourceSetId* as used for *commonControlResourceSet* configured via *PDCCH-ConfigCommon*, the configuration from *PDCCH-Config* always takes precedence and should not be updated by the UE based on *servingCellConfigCommon*.
downlinkPreemption Configuration of downlink preemption indications to be monitored in this cell (see TS 38.213 [13], clause 11.2).
searchSpacesToAddModList List of UE specifically configured Search Spaces. The network configures at most 10 Search Spaces per BWP per cell (including UE-specific and common Search Spaces).
tpc-PUCCH Enable and configure reception of group TPC commands for PUCCH
tpc-PUSCH Enable and configure reception of group TPC commands for PUSCH
tpc-SRS Enable and configure reception of group TPC commands for SRS

Conditional Presence	Explanation
PUCCH-CellOnly	The field is optionally present, Need M, for the PDCCH-Config of an SpCells as well as for PUCCH SCells. The field is absent otherwise.

– *PDCCH-ConfigCommon*

The IE *PDCCH-ConfigCommon* is used to configure cell specific PDCCH parameters provided in SIB as well as in dedicated signalling.

PDCCH-ConfigCommon information element

```
-- ASN1START
-- TAG-PDCCH-CONFIGCOMMON-START

PDCCH-ConfigCommon ::=              SEQUENCE {
    controlResourceSetZero              ControlResourceSetZero                                          OPTIONAL,   -- Cond InitialBWP-Only
    commonControlResourceSet            ControlResourceSet                                              OPTIONAL,   -- Need R
    searchSpaceZero                     SearchSpaceZero                                                 OPTIONAL,   -- Cond InitialBWP-Only
    commonSearchSpaceList               SEQUENCE (SIZE(1..4)) OF SearchSpace                            OPTIONAL,   -- Need R
    searchSpaceSIB1                     SearchSpaceId                                                   OPTIONAL,   -- Need S
    searchSpaceOtherSystemInformation   SearchSpaceId                                                   OPTIONAL,   -- Need S
    pagingSearchSpace                   SearchSpaceId                                                   OPTIONAL,   -- Need S
    ra-SearchSpace                      SearchSpaceId                                                   OPTIONAL,   -- Need S
    ...,
    [[
    firstPDCCH-MonitoringOccasionOfPO   CHOICE {
        sCS15KHZoneT                                                        SEQUENCE (SIZE (1..maxPO-perPF)) OF INTEGER (0..139),
        sCS30KHZoneT-SCS15KHZhalfT                                          SEQUENCE (SIZE (1..maxPO-perPF)) OF INTEGER (0..279),
        sCS60KHZoneT-SCS30KHZhalfT-SCS15KHZquarterT                         SEQUENCE (SIZE (1..maxPO-perPF)) OF INTEGER (0..559),
        sCS120KHZoneT-SCS60KHZhalfT-SCS30KHZquarterT-SCS15KHZoneEighthT     SEQUENCE (SIZE (1..maxPO-perPF)) OF INTEGER (0..1119),
        sCS120KHZhalfT-SCS60KHZquarterT-SCS30KHZoneEighthT-SCS15KHZoneSixteenthT    SEQUENCE (SIZE (1..maxPO-perPF)) OF INTEGER (0..2239),
```

```
        sCS120KHZquarterT-SCS60KHZoneEighthT-SCS30KHZoneSixteenthT              SEQUENCE (SIZE (1..maxPO-perPF)) OF INTEGER (0..4479),
        sCS120KHZoneEighthT-SCS60KHZoneSixteenthT                               SEQUENCE (SIZE (1..maxPO-perPF)) OF INTEGER (0..8959),
        sCS120KHZoneSixteenthT                                                  SEQUENCE (SIZE (1..maxPO-perPF)) OF INTEGER (0..17919)
    }                                                                                                   OPTIONAL          -- Cond OtherBWP
    ]]
}

-- TAG-PDCCH-CONFIGCOMMON-STOP
-- ASN1STOP
```

PDCCH-ConfigCommon field descriptions
commonControlResourceSet An additional common control resource set which may be configured and used for any common or UE-specific search space. If the network configures this field, it uses a ControlResourceSetId other than 0 for this ControlResourceSet. The network configures the *commonControlResourceSet* in SIB1 so that it is contained in the bandwidth of CORESET#0.
commonSearchSpaceList A list of additional common search spaces. If the network configures this field, it uses the *SearchSpaceId*s other than 0.
controlResourceSetZero Parameters of the common CORESET#0 which can be used in any common or UE-specific search spaces. The values are interpreted like the corresponding bits in MIB pdcch-ConfigSIB1. Even though this field is only configured in the initial BWP (BWP#0) controlResourceSetZero can be used in search spaces configured in other DL BWP(s) than the initial DL BWP if the conditions defined in TS 38.213 [13], clause 10 are satisfied.
firstPDCCH-MonitoringOccasionOfPO Indicates the first PDCCH monitoring occasion of each PO of the PF on this BWP, see TS 38.304 [20].
pagingSearchSpace ID of the Search space for paging (see TS 38.213 [13], clause 10.1). If the field is absent, the UE does not receive paging in this BWP (see TS 38.213 [13], clause 10).
ra-SearchSpace ID of the Search space for random access procedure (see TS 38.213 [13], clause 10.1). If the field is absent, the UE does not receive RAR in this BWP. This field is mandatory present in the DL BWP(s) if the conditions described in TS 38.321 [3], subclause 5.15 are met.
searchSpaceOtherSystemInformation ID of the Search space for other system information, i.e., SIB2 and beyond (see TS 38.213 [13], clause 10.1) If the field is absent, the UE does not receive other system information in this BWP.
searchSpaceSIB1 ID of the search space for SIB1 message. In the initial DL BWP of the UE′s PCell, the network sets this field to 0. If the field is absent, the UE does not receive SIB1 in this BWP. (see TS 38.213 [13], clause 10)
searchSpaceZero Parameters of the common SearchSpace#0. The values are interpreted like the corresponding bits in MIB pdcch-ConfigSIB1. Even though this field is only configured in the initial BWP (BWP#0) searchSpaceZero can be used in search spaces configured in other DL BWP(s) than the initial DL BWP if the conditions described in TS 38.213 [13], clause 10 are satisfied.

Conditional Presence	Explanation
InitialBWP-Only	If SIB1 is broadcast the field is mandatory present in the PDCCH-ConfigCommon of the initial BWP (BWP#0) in *ServingCellConfigCommon*; it is absent in other BWPs and when sent in system information. If SIB1 is not broadcast and there is an SSB associated to the cell, the field is optionally present in the PDCCH-ConfigCommon of the initial BWP (BWP#0) in *ServingCellConfigCommon* (still with the same setting for all UEs); it is absent in other BWPs. In other cases, the field is absent.
OtherBWP	This field is optionally present, Need R, if this BWP is not the initial DL BWP and *pagingSearchSpace* is configured in this BWP. Otherwise this field is not present.

– *PDCCH-ConfigSIB1*

The IE *PDCCH-ConfigSIB1* is used to configure CORESET#0 and search space#0.

PDCCH-ConfigSIB1 information element

```
-- ASN1START
-- TAG-PDCCH-CONFIGSIB1-START

PDCCH-ConfigSIB1 ::=                SEQUENCE {
    controlResourceSetZero              ControlResourceSetZero,
    searchSpaceZero                     SearchSpaceZero
}

-- TAG-PDCCH-CONFIGSIB1-STOP
-- ASN1STOP
```

PDCCH-ConfigSIB1 field descriptions
controlResourceSetZero Corresponds to the 4 MSB RMSI-PDCCH-Config in TS 38.213 [13], clause 13. Determines a common ControlResourceSet (CORESET) with ID #0.
searchSpaceZero Corresponds to 4 LSB of RMSI-PDCCH-Config in TS 38.213 [13], clause 13. Determines a common search space with ID #0.

– *PDCCH-ServingCellConfig*

The IE *PDCCH-ServingCellConfig* is used to configure UE specific PDCCH parameters applicable across all bandwidth parts of a serving cell.

PDCCH-ServingCellConfig information element

```
-- ASN1START
-- TAG-PDCCH-SERVINGCELLCONFIG-START

PDCCH-ServingCellConfig ::=         SEQUENCE {
    slotFormatIndicator                 SetupRelease { SlotFormatIndicator }                          OPTIONAL,   -- Need M
    ...
}

-- TAG-PDCCH-SERVINGCELLCONFIG-STOP
```

```
-- ASN1STOP
```

PDCCH-ServingCellConfig field descriptions
slotFormatIndicator Configuration of Slot-Format-Indicators to be monitored in the correspondingly configured PDCCHs this serving cell.

– *PDCP-Config*

The IE *PDCP-Config* is used to set the configurable PDCP parameters for signalling and data radio bearers.

PDCP-Config information element

```
-- ASN1START
-- TAG-PDCP-CONFIG-START

PDCP-Config ::=         SEQUENCE {
    drb                     SEQUENCE {
        discardTimer            ENUMERATED {ms10, ms20, ms30, ms40, ms50, ms60, ms75, ms100, ms150, ms200,
                                            ms250, ms300, ms500, ms750, ms1500, infinity}           OPTIONAL, -- Cond Setup
        pdcp-SN-SizeUL          ENUMERATED {len12bits, len18bits}                                   OPTIONAL, -- Cond Setup2
        pdcp-SN-SizeDL          ENUMERATED {len12bits, len18bits}                                   OPTIONAL, -- Cond Setup2
        headerCompression       CHOICE {
            notUsed                 NULL,
            rohc                    SEQUENCE {
                maxCID                  INTEGER (1..16383)                                          DEFAULT 15,
                profiles                SEQUENCE {
                    profile0x0001           BOOLEAN,
                    profile0x0002           BOOLEAN,
                    profile0x0003           BOOLEAN,
                    profile0x0004           BOOLEAN,
                    profile0x0006           BOOLEAN,
                    profile0x0101           BOOLEAN,
                    profile0x0102           BOOLEAN,
                    profile0x0103           BOOLEAN,
                    profile0x0104           BOOLEAN
                },
                drb-ContinueROHC            ENUMERATED { true }                                     OPTIONAL    -- Need N
            },
            uplinkOnlyROHC          SEQUENCE {
                maxCID                  INTEGER (1..16383)                                          DEFAULT 15,
                profiles                SEQUENCE {
                    profile0x0006           BOOLEAN
                },
                drb-ContinueROHC            ENUMERATED { true }                                     OPTIONAL    -- Need N
            },
            ...
        },
        integrityProtection     ENUMERATED { enabled }                                              OPTIONAL,   -- Cond ConnectedTo5GC
        statusReportRequired    ENUMERATED { true }                                                 OPTIONAL,   -- Cond Rlc-AM
        outOfOrderDelivery      ENUMERATED { true }                                                 OPTIONAL    -- Need R
```

```
    }                                                                                                        OPTIONAL,   -- Cond DRB
    moreThanOneRLC          SEQUENCE {
        primaryPath             SEQUENCE {
            cellGroup               CellGroupId                                                              OPTIONAL,   -- Need R
            logicalChannel          LogicalChannelIdentity                                                   OPTIONAL    -- Need R
        },
        ul-DataSplitThreshold   UL-DataSplitThreshold                                                        OPTIONAL, -- Cond SplitBearer
        pdcp-Duplication            BOOLEAN                                                                  OPTIONAL    -- Need R
    }                                                                                                        OPTIONAL, -- Cond MoreThanOneRLC

    t-Reordering                ENUMERATED {
                                    ms0, ms1, ms2, ms4, ms5, ms8, ms10, ms15, ms20, ms30, ms40,
                                    ms50, ms60, ms80, ms100, ms120, ms140, ms160, ms180, ms200, ms220,
                                    ms240, ms260, ms280, ms300, ms500, ms750, ms1000, ms1250,
                                    ms1500, ms1750, ms2000, ms2250, ms2500, ms2750,
                                    ms3000, spare28, spare27, spare26, spare25, spare24,
                                    spare23, spare22, spare21, spare20,
                                    spare19, spare18, spare17, spare16, spare15, spare14,
                                    spare13, spare12, spare11, spare10, spare09,
                                    spare08, spare07, spare06, spare05, spare04, spare03,
                                    spare02, spare01 }                                                       OPTIONAL, -- Need S
    ...,
    [[
    cipheringDisabled       ENUMERATED {true}                                                                OPTIONAL    -- Cond ConnectedTo5GC
    ]]

}

UL-DataSplitThreshold ::= ENUMERATED {
                                            b0, b100, b200, b400, b800, b1600, b3200, b6400, b12800, b25600, b51200, b102400, b204800,
                                            b409600, b819200, b1228800, b1638400, b2457600, b3276800, b4096000, b4915200, b5734400,
                                            b6553600, infinity, spare8, spare7, spare6, spare5, spare4, spare3, spare2, spare1}

-- TAG-PDCP-CONFIG-STOP
-- ASN1STOP
```

***PDCP-Config* field descriptions**
cipheringDisabled If included, ciphering is disabled for this DRB regardless of which ciphering algorithm is configured for the SRB/DRBs. The field may only be included if the UE is connected to 5GC. Otherwise the field is absent. The network configures all DRBs with the same PDU-session ID with same value for this field.
discardTimer Value in ms of *discardTimer* specified in TS 38.323 [5]. Value ms50 corresponds to 50 ms, ms100 corresponds to 100 ms and so on.
drb-ContinueROHC Indicates whether the PDCP entity continues or resets the ROHC header compression protocol during PDCP re-establishment, as specified in TS 38.323 [5]. This field is configured only in case of reconfiguration with sync where the PDCP termination point is not changed and the fullConfig is not indicated.
headerCompression If rohc is configured, the UE shall apply the configured ROHC profile(s) in both uplink and downlink. If uplinkOnlyROHC is configured, the UE shall apply the configure ROHC profile(s) in uplink (there is no header compression in downlink). ROHC can be configured for any bearer type. The network reconfigures headerCompression only upon reconfiguration involving PDCP re-establishment. Network configures headerCompression to notUsed when outOfOrderDelivery is configured.
integrityProtection Indicates whether or not integrity protection is configured for this radio bearer. The value of integrityProtection for a DRB can only be changed using reconfiguration with sync. The network configures all DRBs with the same PDU-session ID with same value for this field.
maxCID Indicates the value of the MAX_CID parameter as specified in TS 38.323 [5]. The total value of MAX_CIDs across all bearers for the UE should be less than or equal to the value of *maxNumberROHC-ContextSessions* parameter as indicated by the UE. The network configures the same value for *maxCID* in both *rohc* and *uplinkOnlyROHC*.
moreThanOneRLC This field configures UL data transmission when more than one RLC entity is associated with the PDCP entity.
outOfOrderDelivery Indicates whether or not *outOfOrderDelivery* specified in TS 38.323 [5] is configured. Out-of-order delivery is configured only when the radio bearer is established.
pdcp-Duplication Indicates whether or not uplink duplication status at the time of receiving this IE is configured and activated as specified in TS 38.323 [5]. The presence of this field indicates whether duplication is configured. PDCP duplication is not configured for CA packet duplication of LTE RLC bearer. The value of this field, when the field is present, indicates the initial state of the duplication. If set to TRUE, duplication is activated. The value of this field is always TRUE, when configured for a SRB.
pdcp-SN-SizeDL PDCP sequence number size for downlink, 12 or 18 bits, as specified in TS 38.323 [5]. For SRBs only the value 12 is applicable.
pdcp-SN-SizeUL PDCP sequence number size for uplink, 12 or 18 bits, as specified in TS 38.323 [5]. For SRBs only the value 12 is applicable.
primaryPath Indicates the cell group ID and LCID of the primary RLC entity as specified in TS 38.323 [5], clause 5.2.1 for UL data transmission when more than one RLC entity is associated with the PDCP entity. In this version of the specification, only cell group ID corresponding to MCG is supported for SRBs. The NW indicates cellGroup for split bearers using logical channels in different cell groups. The NW indicates logicalChannel for CA based PDCP duplication, i.e., if both logical channels terminate in the same cell group.
statusReportRequired For AM DRBs, indicates whether the DRB is configured to send a PDCP status report in the uplink, as specified in TS 38.323 [5].
t-Reordering Value in ms of t-Reordering specified in TS 38.323 [5]. Value *ms0* corresponds to 0 ms, value *ms20* corresponds to 20 ms, value *ms40* corresponds to 40 ms, and so on. When the field is absent the UE applies the value *infinity*.
ul-DataSplitThreshold Parameter specified in TS 38.323 [5]. Value b0 corresponds to 0 bytes, value b100 corresponds to 100 bytes, value b200 corresponds to 200 bytes, and so on. The network sets this field to 'infinity' for UEs not supporting splitDRB-withUL-Both-MCG-SCG. If the field is absent when the split bearer is configured for the radio bearer first time, then the default value infinity is applied.

Conditional presence	Explanation
DRB	This field is mandatory present when the corresponding DRB is being set up, not present for SRBs. Otherwise this field is optionally present, need M.
MoreThanOneRLC	This field is mandatory present upon RRC reconfiguration with setup of a PDCP entity for a radio bearer with more than one associated logical channel and upon RRC reconfiguration with the association of an additional logical channel to the PDCP entity. Upon RRC reconfiguration when a PDCP entity is associated with multiple logical channels, this field is optionally present need M. Otherwise, this field is absent, and all its included parameters are released.
Rlc-AM	For RLC AM, the field is optionally present, need R. Otherwise, the field is not present.
Setup	The field is mandatory present in case of radio bearer setup. Otherwise the field is optionally present, need M.
SplitBearer	The field is absent for SRBs. Otherwise, the field is optional present, need M, in case of radio bearer with more than one associated RLC mapped to different cell groups.
ConnectedTo5GC	The field is optionally present, need R, if the UE is connected to 5GC. Otherwise the field is absent.
Setup2	This field is mandatory present in case for radio bearer setup for RLC-AM and RLC-UM. Otherwise, this field is not present.

– *PDSCH-Config*

The *PDSCH-Config* IE is used to configure the UE specific PDSCH parameters.

PDSCH-Config information element

```
-- ASN1START
-- TAG-PDSCH-CONFIG-START

PDSCH-Config ::=                        SEQUENCE {
    dataScramblingIdentityPDSCH             INTEGER (0..1023)                                                   OPTIONAL,   -- Need S
    dmrs-DownlinkForPDSCH-MappingTypeA      SetupRelease { DMRS-DownlinkConfig }                                OPTIONAL,   -- Need M
    dmrs-DownlinkForPDSCH-MappingTypeB      SetupRelease { DMRS-DownlinkConfig }                                OPTIONAL,   -- Need M

    tci-StatesToAddModList                  SEQUENCE (SIZE(1..maxNrofTCI-States)) OF TCI-State                  OPTIONAL,   -- Need N
    tci-StatesToReleaseList                 SEQUENCE (SIZE(1..maxNrofTCI-States)) OF TCI-StateId                OPTIONAL,   -- Need N
    vrb-ToPRB-Interleaver                   ENUMERATED {n2, n4}                                                 OPTIONAL,   -- Need S
    resourceAllocation                      ENUMERATED { resourceAllocationType0, resourceAllocationType1, dynamicSwitch},
    pdsch-TimeDomainAllocationList          SetupRelease { PDSCH-TimeDomainResourceAllocationList }             OPTIONAL,   -- Need M
    pdsch-AggregationFactor                 ENUMERATED { n2, n4, n8 }                                           OPTIONAL,   -- Need S
    rateMatchPatternToAddModList            SEQUENCE (SIZE (1..maxNrofRateMatchPatterns)) OF RateMatchPattern   OPTIONAL,   -- Need N
    rateMatchPatternToReleaseList           SEQUENCE (SIZE (1..maxNrofRateMatchPatterns)) OF RateMatchPatternId OPTIONAL,   -- Need N
    rateMatchPatternGroup1                  RateMatchPatternGroup                                               OPTIONAL,   -- Need R
    rateMatchPatternGroup2                  RateMatchPatternGroup                                               OPTIONAL,   -- Need R

    rbg-Size                                ENUMERATED {config1, config2},
    mcs-Table                               ENUMERATED {qam256, qam64LowSE}                                     OPTIONAL,   -- Need S
    maxNrofCodeWordsScheduledByDCI          ENUMERATED {n1, n2}                                                 OPTIONAL,   -- Need R

    prb-BundlingType                        CHOICE {
        staticBundling                          SEQUENCE {
            bundleSize                              ENUMERATED { n4, wideband }                                 OPTIONAL    -- Need S
        },
        dynamicBundling                     SEQUENCE {
            bundleSizeSet1                          ENUMERATED { n4, wideband, n2-wideband, n4-wideband }       OPTIONAL,   -- Need S
            bundleSizeSet2                          ENUMERATED { n4, wideband }                                 OPTIONAL    -- Need S
```

```
        }
    },
    zp-CSI-RS-ResourceToAddModList                  SEQUENCE (SIZE (1..maxNrofZP-CSI-RS-Resources)) OF ZP-CSI-RS-Resource
                                                                                                                  OPTIONAL,   -- Need N
    zp-CSI-RS-ResourceToReleaseList                 SEQUENCE (SIZE (1..maxNrofZP-CSI-RS-Resources)) OF ZP-CSI-RS-ResourceId
                                                                                                                  OPTIONAL,   -- Need N
    aperiodic-ZP-CSI-RS-ResourceSetsToAddModList    SEQUENCE (SIZE (1..maxNrofZP-CSI-RS-ResourceSets)) OF ZP-CSI-RS-ResourceSet
                                                                                                                  OPTIONAL,   -- Need N
    aperiodic-ZP-CSI-RS-ResourceSetsToReleaseList SEQUENCE (SIZE (1..maxNrofZP-CSI-RS-ResourceSets)) OF ZP-CSI-RS-ResourceSetId
                                                                                                                  OPTIONAL,   -- Need N
    sp-ZP-CSI-RS-ResourceSetsToAddModList   SEQUENCE (SIZE (1..maxNrofZP-CSI-RS-ResourceSets)) OF ZP-CSI-RS-ResourceSet
                                                                                                                  OPTIONAL,   -- Need N
    sp-ZP-CSI-RS-ResourceSetsToReleaseList  SEQUENCE (SIZE (1..maxNrofZP-CSI-RS-ResourceSets)) OF ZP-CSI-RS-ResourceSetId
                                                                                                                  OPTIONAL,   -- Need N
    p-ZP-CSI-RS-ResourceSet                 SetupRelease { ZP-CSI-RS-ResourceSet }
                                                                                                                  OPTIONAL,   -- Need M
    ...
}
RateMatchPatternGroup ::=               SEQUENCE (SIZE (1..maxNrofRateMatchPatternsPerGroup)) OF CHOICE {
    cellLevel                               RateMatchPatternId,
    bwpLevel                                RateMatchPatternId
}

-- TAG-PDSCH-CONFIG-STOP
-- ASN1STOP
```

PDSCH-Config field descriptions
aperiodic-ZP-CSI-RS-ResourceSetsToAddModList AddMod/Release lists for configuring aperiodically triggered zero-power CSI-RS resource sets. Each set contains a ZP-CSI-RS-ResourceSetId and the IDs of one or more ZP-CSI-RS-Resources (the actual resources are defined in the zp-CSI-RS-ResourceToAddModList). The network configures the UE with at most 3 aperiodic ZP-CSI-RS-ResourceSets and it uses only the ZP-CSI-RS-ResourceSetId 1 to 3. The network triggers a set by indicating its ZP-CSI-RS-ResourceSetId in the DCI payload. The DCI codepoint '01' triggers the resource set with ZP-CSI-RS-ResourceSetId 1, the DCI codepoint '10' triggers the resource set with ZP-CSI-RS-ResourceSetId 2, and the DCI codepoint '11' triggers the resource set with ZP-CSI-RS-ResourceSetId 3 (see TS 38.214 [19], clause 5.1.4.2)
dataScramblingIdentityPDSCH Identifier used to initialize data scrambling (c_init) for PDSCH. If the field is absent, the UE applies the physical cell ID. (see TS 38.211 [16], clause 7.3.1.1).
dmrs-DownlinkForPDSCH-MappingTypeA DMRS configuration for PDSCH transmissions using PDSCH mapping type A (chosen dynamically via PDSCH-TimeDomainResourceAllocation). Only the fields dmrs-Type, dmrs-AdditionalPosition and maxLength may be set differently for mapping type A and B.
dmrs-DownlinkForPDSCH-MappingTypeB DMRS configuration for PDSCH transmissions using PDSCH mapping type B (chosen dynamically via PDSCH-TimeDomainResourceAllocation). Only the fields dmrs-Type, dmrs-AdditionalPosition and maxLength may be set differently for mapping type A and B.
maxNrofCodeWordsScheduledByDCI Maximum number of code words that a single DCI may schedule. This changes the number of MCS/RV/NDI bits in the DCI message from 1 to 2.
mcs-Table Indicates which MCS table the UE shall use for PDSCH. (see TS 38.214 [19], clause 5.1.3.1). If the field is absent the UE applies the value 64QAM.
pdsch-AggregationFactor Number of repetitions for data (see TS 38.214 [19], clause 5.1.2.1). When the field is absent the UE applies the value 1
pdsch-TimeDomainAllocationList List of time-domain configurations for timing of DL assignment to DL data (see table 5.1.2.1.1-1 in TS 38.214 [19])
prb-BundlingType Indicates the PRB bundle type and bundle size(s) (see TS 38.214 [19], clause 5.1.2.3). If *dynamic* is chosen, the actual *bundleSizeSet1 or bundleSizeSet2* to use is indicated via DCI. Constraints on *bundleSize(Set)* setting depending on *vrb-ToPRB-Interleaver* and *rbg-Size* settings are described in TS 38.214 [19], clause 5.1.2.3. If a *bundleSize(Set)* value is absent, the UE applies the value *n2*.
p-ZP-CSI-RS-ResourceSet A set of periodically occurring ZP-CSI-RS-Resources (the actual resources are defined in the zp-CSI-RS-ResourceToAddModList). The network uses the ZP-CSI-RS-ResourceSetId=0 for this set.
rateMatchPatternGroup1 The IDs of a first group of RateMatchPatterns defined in PDSCH-Config->rateMatchPatternToAddModList (BWP level) or in ServingCellConfig ->rateMatchPatternToAddModList (cell level). These patterns can be activated dynamically by DCI (see TS 38.214 [19], clause 5.1.4.1).
rateMatchPatternGroup2 The IDs of a second group of RateMatchPatterns defined in PDSCH-Config->rateMatchPatternToAddModList (BWP level) or in ServingCellConfig ->rateMatchPatternToAddModList (cell level). These patterns can be activated dynamically by DCI (see TS 38.214 [19], clause 5.1.4.1).
rateMatchPatternToAddModList Resources patterns which the UE should rate match PDSCH around. The UE rate matches around the union of all resources indicated in the nested bitmaps (see TS 38.214 [19], clause 5.1.4.1). FFS: RAN1 indicates that there should be a set of patterns per cell and one per BWP => Having both seems unnecessary.
rbg-Size Selection between config 1 and config 2 for RBG size for PDSCH. The UE ignores this field if *resourceAllocation* is set to *resourceAllocationType1* (see TS 38.214 [19], clause 5.1.2.2.1).
resourceAllocation Configuration of resource allocation type 0 and resource allocation type 1 for non-fallback DCI (see TS 38.214 [19], clause 5.1.2.2).
sp-ZP-CSI-RS-ResourceSetsToAddModList AddMod/Release lists for configuring semi-persistent zero-power CSI-RS resource sets. Each set contains a *ZP-CSI-RS-ResourceSetId* and the IDs of one or more *ZP-CSI-RS-Resources* (the actual resources are defined in the *zp-CSI-RS-ResourceToAddModList*) (see TS 38.214 [19], clause 5.1.4.2).

tci-StatesToAddModList A list of Transmission Configuration Indicator (TCI) states indicating a transmission configuration which includes QCL-relationships between the DL RSs in one RS set and the PDSCH DMRS ports (see TS 38.214 [19], clause 5.1.4).
vrb-ToPRB-Interleaver Interleaving unit configurable between 2 and 4 PRBs (see TS 38.211 [16], clause 7.3.1.6). When the field is absent, the UE performs non-interleaved VRB-to-PRB mapping.
zp-CSI-RS-ResourceToAddModList A list of Zero-Power (ZP) CSI-RS resources used for PDSCH rate-matching. Each resource in this list may be referred to from only one type of resource set, i.e., aperiodic, semi-persistent or periodic (see TS 38.214 [19]).

– *PDSCH-ConfigCommon*

The IE *PDSCH-ConfigCommon* is used to configure cell specific PDSCH parameters.

PDSCH-ConfigCommon information element

```
-- ASN1START
-- TAG-PDSCH-CONFIGCOMMON-START

PDSCH-ConfigCommon ::=                  SEQUENCE {
    pdsch-TimeDomainAllocationList                  PDSCH-TimeDomainResourceAllocationList          OPTIONAL,   -- Need R
    ...
}

-- TAG-PDSCH-CONFIGCOMMON-STOP
-- ASN1STOP
```

PDSCH-ConfigCommon field descriptions
pdsch-TimeDomainAllocationList List of time-domain configurations for timing of DL assignment to DL data (see table 5.1.2.1.1-1 in TS 38.214 [19]).

– *PDSCH-ServingCellConfig*

The IE *PDSCH-ServingCellConfig* is used to configure UE specific PDSCH parameters that are common across the UE's BWPs of one serving cell.

PDSCH-ServingCellConfig information element

```
-- ASN1START
-- TAG-PDSCH-SERVINGCELLCONFIG-START

PDSCH-ServingCellConfig ::=             SEQUENCE {
    codeBlockGroupTransmission              SetupRelease { PDSCH-CodeBlockGroupTransmission }       OPTIONAL,   -- Need M
    xOverhead                               ENUMERATED { xOh6, xOh12, xOh18 }                       OPTIONAL,   -- Need S
    nrofHARQ-ProcessesForPDSCH              ENUMERATED {n2, n4, n6, n10, n12, n16}                  OPTIONAL,   -- Need S
    pucch-Cell                              ServCellIndex                                           OPTIONAL,   -- Cond SCellAddOnly
    ...,
    [[
```

```
    maxMIMO-Layers                          INTEGER (1..8)                                          OPTIONAL,   -- Need M
    processingType2Enabled                  BOOLEAN                                                 OPTIONAL    -- Need M
    ]]
}

PDSCH-CodeBlockGroupTransmission ::=    SEQUENCE {
    maxCodeBlockGroupsPerTransportBlock     ENUMERATED {n2, n4, n6, n8},
    codeBlockGroupFlushIndicator            BOOLEAN,
    ...
}

-- TAG-PDSCH-SERVINGCELLCONFIG-STOP
-- ASN1STOP
```

PDSCH-CodeBlockGroupTransmission field descriptions
codeBlockGroupFlushIndicator Indicates whether CBGFI for CBG based (re)transmission in DL is enabled (true). (see TS 38.212 [17], clause 7.3.1.2.2)
maxCodeBlockGroupsPerTransportBlock Maximum number of code-block-groups (CBGs) per TB. In case of multiple CW, the maximum CBG is 4 (see TS 38.213 [13], clause 9.1.1)

PDSCH-ServingCellConfig field descriptions
codeBlockGroupTransmission Enables and configures code-block-group (CBG) based transmission (see TS 38.213 [13], clause 9.1.1)
maxMIMO-Layers Indicates the maximum MIMO layer to be used for PDSCH in all BWPs of this serving cell. (see FFS_section, section FFS_Section)
nrofHARQ-ProcessesForPDSCH The number of HARQ processes to be used on the PDSCH of a serving cell. n2 corresponds to 2 HARQ processes, n4 to 4 HARQ processes and so on. If the field is absent, the UE uses 8 HARQ processes (see TS 38.214 [19], clause 5.1).
processingType2Enabled Enables configuration of advanced processing time capability 2 for PDSCH (see 38.214 [19], clause 5.3).
pucch-Cell The ID of the serving cell (of the same cell group) to use for PUCCH. If the field is absent, the UE sends the HARQ feedback on the PUCCH of the SpCell of this cell group.
xOverhead Accounts for overhead from CSI-RS, CORESET, etc. If the field is absent, the UE applies value xOh0 (see TS 38.214 [19], clause 5.1.3.2).

Conditional Presence	**Explanation**
SCellAddOnly	It is optionally present, Need M, for (non-PUCCH) SCells when adding a new SCell. The field is absent when reconfiguring SCells. The field is also absent for the SpCells as well as for a PUCCH SCell.

– *PDSCH-TimeDomainResourceAllocationList*

The IE *PDSCH-TimeDomainResourceAllocation* is used to configure a time domain relation between PDCCH and PDSCH. The PDSCH-TimeDomainResourceAllocationList contains one or more of such PDSCH-TimeDomainResourceAllocations. The network indicates in the DL assignment which of the configured time domain allocations the UE shall apply for that DL assignment. The UE determines the bit width of the DCI field based on the number of entries in the PDSCH-TimeDomainResourceAllocationList. Value 0 in the DCI field refers to the first element in this list, value 1 in the DCI field refers to the second element in this list, and so on.

***PDSCH-TimeDomainResourceAllocationList* information element**

```
-- ASN1START
-- TAG-PDSCH-TIMEDOMAINRESOURCEALLOCATIONLIST-START


PDSCH-TimeDomainResourceAllocationList ::=  SEQUENCE (SIZE(1..maxNrofDL-Allocations)) OF PDSCH-TimeDomainResourceAllocation

PDSCH-TimeDomainResourceAllocation ::=  SEQUENCE {
    k0                                      INTEGER(0..32)                                                      OPTIONAL,   -- Need S
    mappingType                             ENUMERATED {typeA, typeB},
    startSymbolAndLength                    INTEGER (0..127)
}

-- TAG-PDSCH-TIMEDOMAINRESOURCEALLOCATIONLIST-STOP
-- ASN1STOP
```

***PDSCH-TimeDomainResourceAllocation* field descriptions**
k0 Slot offset between DCI and its scheduled PDSCH (see TS 38.214 [19], clause 5.1.2.1) When the field is absent the UE applies the value 0.
mappingType PDSCH mapping type. (see TS 38.214 [19], clause 5.3)
startSymbolAndLength An index giving valid combinations of start symbol and length (jointly encoded) as start and length indicator (SLIV). The network configures the field so that the allocation does not cross the slot boundary (see TS 38.214 [19], clause 5.1.2.1)

– *PHR-Config*

The IE *PHR-Config* is used to configure parameters for power headroom reporting.

***PHR-Config* information element**

```
-- ASN1START
-- TAG-PHR-CONFIG-START

PHR-Config ::=                      SEQUENCE {
    phr-PeriodicTimer                   ENUMERATED {sf10, sf20, sf50, sf100, sf200,sf500, sf1000, infinity},
    phr-ProhibitTimer                   ENUMERATED {sf0, sf10, sf20, sf50, sf100,sf200, sf500, sf1000},
    phr-Tx-PowerFactorChange            ENUMERATED {dB1, dB3, dB6, infinity},
    multiplePHR                         BOOLEAN,
    dummy                               BOOLEAN,
    phr-Type2OtherCell                  BOOLEAN,
    phr-ModeOtherCG                     ENUMERATED {real, virtual},
    ...
}
```

```
-- TAG-PHR-CONFIG-STOP
-- ASN1STOP
```

***PHR-Config* field descriptions**
dummy This field is not used in this version of the specification and the UE ignores the received value.
multiplePHR Indicates if power headroom shall be reported using the Single Entry PHR MAC control element or Multiple Entry PHR MAC control element defined in TS 38.321 [3]. True means to use Multiple Entry PHR MAC control element and False means to use the Single Entry PHR MAC control element defined in TS 38.321 [3].The network configures this field to *true* for MR-DC and UL CA for NR, and to *false* in all other cases.
phr-ModeOtherCG Indicates the mode (i.e. real or virtual) used for the PHR of the activated cells that are part of the other Cell Group (i.e. MCG or SCG), when DC is configured. If the UE is configured with only one cell group (no DC), it ignores the field.
phr-PeriodicTimer Value in number of subframes for PHR reporting as specified in TS 38.321 [3]. sf10 corresponds to 10 subframes, sf20 corresponds to 20 subframes, and so on.
phr-ProhibitTimer Value in number of subframes for PHR reporting as specified in TS 38.321 [3]. sf0 corresponds to 0 subframe, sf10 corresponds to 10 subframes, sf20 corresponds to 20 subframes, and so on.
phr-Tx-PowerFactorChange Value in dB for PHR reporting as specified in TS 38.321 [3]. Value dB1 corresponds to 1 dB, dB3 corresponds to 3 dB and so on. The same value applies for each serving cell (although the associated functionality is performed independently for each cell).
phr-Type2OtherCell If set to true, the UE shall report a PHR type 2 for the SpCell of the other MAC entity. See TS 38.321 [3], clause 5.4.6. Network sets this field to *false* if the UE is not configured with an E-UTRA MAC entity.

– *PhysCellId*

The *PhysCellId* identifies the physical cell identity (PCI).

PhysCellId information element

```
-- ASN1START
-- TAG-PHYS-CELL-ID-START

PhysCellId ::=                      INTEGER (0..1007)

-- TAG-PHYS-CELL-ID-STOP
-- ASN1STOP
```

– *PhysicalCellGroupConfig*

The IE *PhysicalCellGroupConfig* is used to configure cell-group specific L1 parameters.

PhysicalCellGroupConfig information element

```
-- ASN1START
-- TAG-PHYSICALCELLGROUPCONFIG-START

PhysicalCellGroupConfig ::=         SEQUENCE {
    harq-ACK-SpatialBundlingPUCCH       ENUMERATED {true}                                                   OPTIONAL,   -- Need S
    harq-ACK-SpatialBundlingPUSCH       ENUMERATED {true}                                                   OPTIONAL,   -- Need S
    p-NR-FR1                            P-Max                                                               OPTIONAL,   -- Need R
    pdsch-HARQ-ACK-Codebook             ENUMERATED {semiStatic, dynamic},
    tpc-SRS-RNTI                        RNTI-Value                                                          OPTIONAL,   -- Need R
    tpc-PUCCH-RNTI                      RNTI-Value                                                          OPTIONAL,   -- Need R
    tpc-PUSCH-RNTI                      RNTI-Value                                                          OPTIONAL,   -- Need R
    sp-CSI-RNTI                         RNTI-Value                                                          OPTIONAL,   -- Cond SP-CSI-Report
    cs-RNTI                             SetupRelease { RNTI-Value }                                         OPTIONAL,   -- Need M
    ...,
    [[
    mcs-C-RNTI                          RNTI-Value                                                          OPTIONAL,   -- Need R
    p-UE-FR1                            P-Max                                                               OPTIONAL    -- Cond MCG-Only
    ]],
    [[
    xScale                              ENUMERATED {dB0, dB6, spare2, spare1}                               OPTIONAL  -- Cond SCG-Only
    ]]
}

-- TAG-PHYSICALCELLGROUPCONFIG-STOP
-- ASN1STOP
```

PhysicalCellGroupConfig field descriptions
cs-RNTI RNTI value for downlink SPS (see SPS-Config) and uplink configured grant (see ConfiguredGrantConfig).
harq-ACK-SpatialBundlingPUCCH Enables spatial bundling of HARQ ACKs. It is configured per cell group (i.e. for all the cells within the cell group) for PUCCH reporting of HARQ-ACK. It is only applicable when more than 4 layers are possible to schedule. When the field is absent, the spatial bundling is disabled (see TS 38.213 [13], clause 9.1.2.1).
harq-ACK-SpatialBundlingPUSCH Enables spatial bundling of HARQ ACKs. It is configured per cell group (i.e. for all the cells within the cell group) for PUSCH reporting of HARQ-ACK. It is only applicable when more than 4 layers are possible to schedule. When the field is absent, the spatial bundling is disabled (see TS 38.213 [13], clauses 9.1.2.2 and 9.1.3.2).
mcs-C-RNTI RNTI to indicate use of qam64LowSE for grant-based transmissions. When the MCS-C-RNTI is configured, RNTI scrambling of DCI CRC is used to choose the corresponding MCS table.
p-NR-FR1 The maximum total transmit power to be used by the UE in this NR cell group across all serving cells in frequency range 1 (FR1). The maximum transmit power that the UE may use may be additionally limited by *p-Max* (configured in FrequencyInfoUL) and by *p-UE-FR1* (configured total for all serving cells operating on FR1).
p-UE-FR1 The maximum total transmit power to be used by the UE across all serving cells in frequency range 1 (FR1) across all cell groups. The maximum transmit power that the UE may use may be additionally limited by p-Max (configured in FrequencyInfoUL) and by p-NR-FR1 (configured for the cell group).
pdsch-HARQ-ACK-Codebook The PDSCH HARQ-ACK codebook is either semi-static or dynamic. This is applicable to both CA and none CA operation (see TS 38.213 [13], clauses 9.1.2 and 9.1.3).
sp-CSI-RNTI RNTI for Semi-Persistent CSI reporting on PUSCH (see CSI-ReportConfig) (see TS 38.214 [19], clause 5.2.1.5.2)
tpc-PUCCH-RNTI RNTI used for PUCCH TPC commands on DCI (see TS 38.213 [13], clause 10.1).
tpc-PUSCH-RNTI RNTI used for PUSCH TPC commands on DCI (see TS 38.213 [13], clause 10.1)
tpc-SRS-RNTI RNTI used for SRS TPC commands on DCI (see TS 38.213 [13], clause 10.1)
xScale The UE is allowed to drop NR only if the power scaling applied to NR results in a difference between scaled and unscaled NR UL of more than *xScale* dB (see TS 38.101-3 [34]). If the value is not configured for dynamic power sharing, the UE assumes default value of 6 dB

Conditional Presence	**Explanation**
MCG-Only	This field is optionally present, Need R, in the PhysicalCellGroupConfig of the MCG. It is absent otherwise.
SP-CSI-Report	The field is mandatory present, Need R, when at least one *CSI-ReportConfig* with *reportConfigType* set to *semiPersistentOnPUSCH* is configured; otherwise it is optionally present, need M.
SCG-Only	This field is optionally present, Need S, in the PhysicalCellGroupConfig of the SCG in case of EN-DC as defined in TS 38.101-3 [34]. It is absent otherwise. FFS for NR-NR DC and multiple NR uplinks.

– *PLMN-Identity*

The IE *PLMN-Identity* identifies a Public Land Mobile Network. Further information regarding how to set the IE is specified in TS 23.003 [21].

PLMN-Identity information element

```
-- ASN1START
-- TAG-PLMN-IDENTITY-INFORMATION-START

PLMN-Identity ::=                   SEQUENCE {
    mcc                                 MCC                     OPTIONAL,                   -- Cond MCC
    mnc                                 MNC
}

MCC ::=                             SEQUENCE (SIZE (3)) OF MCC-MNC-Digit

MNC ::=                             SEQUENCE (SIZE (2..3)) OF MCC-MNC-Digit

MCC-MNC-Digit ::=                   INTEGER (0..9)


-- TAG-PLMN-IDENTITY-INFORMATION-STOP
-- ASN1STOP
```

***PLMN-Identity* field descriptions**
mcc The first element contains the first MCC digit, the second element the second MCC digit and so on. If the field is absent, it takes the same value as the mcc of the immediately preceding IE PLMN-Identity. See TS 23.003 [21].
mnc The first element contains the first MNC digit, the second element the second MNC digit and so on. See TS 23.003 [21].

Conditional Presence	Explanation
MCC	This field is mandatory present when PLMN-Identity is not used in a list or if it is the first entry of PLMN-Identity in a list. Otherwise it is optional, Need S.

– *PLMN-IdentityInfoList*

Includes a list of PLMN identity information.

PLMN-IdentityInfoList information element

```
-- ASN1START
-- TAG-PLMN-IDENTITY-LIST-START

PLMN-IdentityInfoList ::=               SEQUENCE (SIZE (1..maxPLMN)) OF PLMN-IdentityInfo

PLMN-IdentityInfo ::=                   SEQUENCE {
    plmn-IdentityList                           SEQUENCE (SIZE (1..maxPLMN)) OF PLMN-Identity,
    trackingAreaCode                            TrackingAreaCode                                OPTIONAL,       -- Need R
    ranac                                       RAN-AreaCode                                    OPTIONAL,       -- Need R
    cellIdentity                                CellIdentity,
```

```
    cellReservedForOperatorUse                  ENUMERATED {reserved, notReserved},
    ...
}
-- TAG-PLMN-IDENTITY-LIST-STOP
-- ASN1STOP
```

PLMN-IdentityInfo field descriptions
cellReservedForOperatorUse Indicates whether the cell is reserved for operator use (per PLMN), as defined in TS 38.304 [20].
trackingAreaCode Indicates Tracking Area Code to which the cell indicated by cellIdentity field belongs. The presence of the field indicates that the cell supports at least standalone operation (per PLMN); the absence of the field indicates that the cell only supports EN-DC functionality (per PLMN).

– *PRB-Id*

The *PRB-Id* identifies a Physical Resource Block (PRB) position within a carrier.

PRB-Id information element

```
-- ASN1START
-- TAG-PRB-ID-START

PRB-Id ::=                          INTEGER (0..maxNrofPhysicalResourceBlocks-1)

-- TAG-PRB-ID-STOP
-- ASN1STOP
```

– *PTRS-DownlinkConfig*

The IE *PTRS-DownlinkConfig* is used to configure downlink phase tracking reference signals (PTRS) (see TS 38.214 [19] clause 5.1.6.3)

PTRS-DownlinkConfig information element

```
-- ASN1START
-- TAG-PTRS-DOWNLINKCONFIG-START

PTRS-DownlinkConfig ::=             SEQUENCE {
    frequencyDensity                    SEQUENCE (SIZE (2)) OF INTEGER (1..276)                          OPTIONAL,   -- Need S
    timeDensity                         SEQUENCE (SIZE (3)) OF INTEGER (0..29)                           OPTIONAL,   -- Need S
    epre-Ratio                          INTEGER (0..3)                                                   OPTIONAL,   -- Need S
    resourceElementOffset               ENUMERATED { offset01, offset10, offset11 }                      OPTIONAL,   -- Need S
    ...
}

-- TAG-PTRS-DOWNLINKCONFIG-STOP
-- ASN1STOP
```

***PTRS-DownlinkConfig* field descriptions**
epre-Ratio EPRE ratio between PTRS and PDSCH. Value 0 correspond to the codepoint "00" in table 4.1-2. Value 1 corresponds to codepoint "01" If the field is not provided, the UE applies value 0 (see TS 38.214 [19], clause 4.1)
frequencyDensity Presence and frequency density of DL PT-RS as a function of Scheduled BW. If the field is absent, the UE uses K_PT-RS = 2 (see TS 38.214 [19], clause 5.1.6.3, Table 5.1.6.3-2)
resourceElementOffset Indicates the subcarrier offset for DL PTRS. If the field is absent, the UE applies the value offset00 (see TS 38.214 [19], clause 6.4.1.2.2.1).
timeDensity Presence and time density of DL PT-RS as a function of MCS. The value 29 is only applicable for MCS Table 5.1.3.1-1 (TS 38.214 [19]). If the field is absent, the UE uses L_PT-RS = 1 (see TS 38.214 [19], clause 5.1.6.3, Table 5.1.6.3-1)

– *PTRS-UplinkConfig*

The IE *PTRS-UplinkConfig* is used to configure uplink Phase-Tracking-Reference-Signals (PTRS).

***PTRS-UplinkConfig* information element**

```
-- ASN1START
-- TAG-PTRS-UPLINKCONFIG-START

PTRS-UplinkConfig ::=                   SEQUENCE {
    transformPrecoderDisabled               SEQUENCE {
        frequencyDensity                    SEQUENCE (SIZE (2)) OF INTEGER (1..276)                OPTIONAL,   -- Need S
        timeDensity                         SEQUENCE (SIZE (3)) OF INTEGER (0..29)                 OPTIONAL,   -- Need S
        maxNrofPorts                        ENUMERATED {n1, n2},
        resourceElementOffset               ENUMERATED {offset01, offset10, offset11 }             OPTIONAL,   -- Need S
        ptrs-Power                          ENUMERATED {p00, p01, p10, p11}
    }                                                                                              OPTIONAL,   -- Need R
    transformPrecoderEnabled                SEQUENCE {
        sampleDensity                           SEQUENCE (SIZE (5)) OF INTEGER (1..276),
        timeDensityTransformPrecoding           ENUMERATED {d2}                                    OPTIONAL    -- Need S
    }                                                                                              OPTIONAL,   -- Need R
    ...
}

-- TAG-PTRS-UPLINKCONFIG-STOP
-- ASN1STOP
```

PTRS-UplinkConfig field descriptions
frequencyDensity Presence and frequency density of UL PT-RS for CP-OFDM waveform as a function of scheduled BW If the field is absent, the UE uses K_PT-RS = 2 (see TS 38.214 [19], clause 6.1).
maxNrofPorts The maximum number of UL PTRS ports for CP-OFDM (see TS 38.214 [19], clause 6.2.3.1).
ptrs-Power UL PTRS power boosting factor per PTRS port (see TS 38.214 [19], clause 6.1, table 6.2.3.1.3).
resourceElementOffset Indicates the subcarrier offset for UL PTRS for CP-OFDM. If the field is absent, the UE applies the value offset00 (see TS 38.211 [16], clause 6.4.1.2.2).
sampleDensity Sample density of PT-RS for DFT-s-OFDM, pre-DFT, indicating a set of thresholds T={NRBn, n=0,1,2,3,4}, that indicates dependency between presence of PT-RS and scheduled BW and the values of X and K the UE should use depending on the scheduled BW, see TS 38.214 [19], clause 6.1, table 6.2.3.2-1.
timeDensity Presence and time density of UL PT-RS for CP-OFDM waveform as a function of MCS If the field is absent, the UE uses L_PT-RS = 1 (see TS 38.214 [19], clause 6.1).
timeDensityTransformPrecoding Time density (OFDM symbol level) of PT-RS for DFT-s-OFDM. If the field is absent, the UE applies value d1 (see TS 38.214 [19], clause 6.1).
transformPrecoderDisabled Configuration of UL PTRS without transform precoder (with CP-OFDM).
transformPrecoderEnabled Configuration of UL PTRS with transform precoder (DFT-S-OFDM).

– *PUCCH-Config*

The IE *PUCCH-Config* is used to configure UE specific PUCCH parameters (per BWP).

PUCCH-Config information element

```
-- ASN1START
-- TAG-PUCCH-CONFIG-START

PUCCH-Config ::=                        SEQUENCE {
    resourceSetToAddModList                 SEQUENCE (SIZE (1..maxNrofPUCCH-ResourceSets)) OF PUCCH-ResourceSet          OPTIONAL, -- Need N
    resourceSetToReleaseList                SEQUENCE (SIZE (1..maxNrofPUCCH-ResourceSets)) OF PUCCH-ResourceSetId        OPTIONAL, -- Need N
    resourceToAddModList                    SEQUENCE (SIZE (1..maxNrofPUCCH-Resources)) OF PUCCH-Resource                OPTIONAL, -- Need N
    resourceToReleaseList                   SEQUENCE (SIZE (1..maxNrofPUCCH-Resources)) OF PUCCH-ResourceId              OPTIONAL, -- Need N
    format1                                 SetupRelease { PUCCH-FormatConfig }                                          OPTIONAL, -- Need M
    format2                                 SetupRelease { PUCCH-FormatConfig }                                          OPTIONAL, -- Need M
    format3                                 SetupRelease { PUCCH-FormatConfig }                                          OPTIONAL, -- Need M
    format4                                 SetupRelease { PUCCH-FormatConfig }                                          OPTIONAL, -- Need M

    schedulingRequestResourceToAddModList   SEQUENCE (SIZE (1..maxNrofSR-Resources)) OF SchedulingRequestResourceConfig   OPTIONAL, -- Need N
    schedulingRequestResourceToReleaseList  SEQUENCE (SIZE (1..maxNrofSR-Resources)) OF SchedulingRequestResourceId       OPTIONAL, -- Need N
    multi-CSI-PUCCH-ResourceList            SEQUENCE (SIZE (1..2)) OF PUCCH-ResourceId                                   OPTIONAL, -- Need M
    dl-DataToUL-ACK                         SEQUENCE (SIZE (1..8)) OF INTEGER (0..15)                                    OPTIONAL, -- Need M

    spatialRelationInfoToAddModList         SEQUENCE (SIZE (1..maxNrofSpatialRelationInfos)) OF PUCCH-SpatialRelationInfo OPTIONAL, -- Need N
    spatialRelationInfoToReleaseList        SEQUENCE (SIZE (1..maxNrofSpatialRelationInfos)) OF PUCCH-SpatialRelationInfoId
```

```
                                                                                                      OPTIONAL, -- Need N
    pucch-PowerControl                      PUCCH-PowerControl                                        OPTIONAL, -- Need M
    ...
}

PUCCH-FormatConfig ::=                  SEQUENCE {
    interslotFrequencyHopping               ENUMERATED {enabled}                                    OPTIONAL,   -- Need R
    additionalDMRS                          ENUMERATED {true}                                       OPTIONAL,   -- Need R
    maxCodeRate                             PUCCH-MaxCodeRate                                       OPTIONAL,   -- Need R
    nrofSlots                               ENUMERATED {n2,n4,n8}                                   OPTIONAL,   -- Need S
    pi2BPSK                                 ENUMERATED {enabled}                                    OPTIONAL,   -- Need R
    simultaneousHARQ-ACK-CSI                ENUMERATED {true}                                       OPTIONAL    -- Need R
}

PUCCH-MaxCodeRate ::=                   ENUMERATED {zeroDot08, zeroDot15, zeroDot25, zeroDot35, zeroDot45, zeroDot60, zeroDot80}

-- A set with one or more PUCCH resources
PUCCH-ResourceSet ::=                   SEQUENCE {
    pucch-ResourceSetId                     PUCCH-ResourceSetId,
    resourceList                        SEQUENCE (SIZE (1..maxNrofPUCCH-ResourcesPerSet)) OF PUCCH-ResourceId,
    maxPayloadMinus1                        INTEGER (4..256)                                        OPTIONAL    -- Need R
}

PUCCH-ResourceSetId ::=                 INTEGER (0..maxNrofPUCCH-ResourceSets-1)

PUCCH-Resource ::=                      SEQUENCE {
    pucch-ResourceId                        PUCCH-ResourceId,
    startingPRB                             PRB-Id,
    intraSlotFrequencyHopping               ENUMERATED { enabled }                                  OPTIONAL,   -- Need R
    secondHopPRB                            PRB-Id                                                  OPTIONAL,   -- Need R
    format                                  CHOICE {
        format0                                 PUCCH-format0,
        format1                                 PUCCH-format1,
        format2                                 PUCCH-format2,
        format3                                 PUCCH-format3,
        format4                                 PUCCH-format4
    }
}

PUCCH-ResourceId ::=                    INTEGER (0..maxNrofPUCCH-Resources-1)


PUCCH-format0 ::=                               SEQUENCE {
    initialCyclicShift                              INTEGER(0..11),
    nrofSymbols                                     INTEGER (1..2),
    startingSymbolIndex                             INTEGER(0..13)
}

PUCCH-format1 ::=                               SEQUENCE {
    initialCyclicShift                              INTEGER(0..11),
    nrofSymbols                                     INTEGER (4..14),
    startingSymbolIndex                             INTEGER(0..10),
    timeDomainOCC                                   INTEGER(0..6)
}
```

```
PUCCH-format2 ::=                               SEQUENCE {
    nrofPRBs                                        INTEGER (1..16),
    nrofSymbols                                     INTEGER (1..2),
    startingSymbolIndex                             INTEGER(0..13)
}

PUCCH-format3 ::=                               SEQUENCE {
    nrofPRBs                                        INTEGER (1..16),
    nrofSymbols                                     INTEGER (4..14),
    startingSymbolIndex                             INTEGER(0..10)
}

PUCCH-format4 ::=                               SEQUENCE {
    nrofSymbols                                     INTEGER (4..14),
    occ-Length                                      ENUMERATED {n2,n4},
    occ-Index                                       ENUMERATED {n0,n1,n2,n3},
    startingSymbolIndex                             INTEGER(0..10)
}

-- TAG-PUCCH-CONFIG-STOP
-- ASN1STOP
```

***PUCCH-Config* field descriptions**
dl-DataToUL-ACK List of timing for given PDSCH to the DL ACK (see TS 38.213 [13], clause 9.1.2).
format1 Parameters that are common for all PUCCH resources of format 1.
format2 Parameters that are common for all PUCCH resources of format 2.
format3 Parameters that are common for all PUCCH resources of format 3.
format4. Parameters that are common for all PUCCH resources of format 4
resourceSetToAddModList Lists for adding and releasing PUCCH resource sets (see TS 38.213 [13], clause 9.2).
resourceToAddModList, resourceToReleaseList Lists for adding and releasing PUCCH resources applicable for the UL BWP and serving cell in which the PUCCH-Config is defined. The resources defined herein are referred to from other parts of the configuration to determine which resource the UE shall use for which report.
spatialRelationInfoToAddModList Configuration of the spatial relation between a reference RS and PUCCH. Reference RS can be SSB/CSI-RS/SRS. If the list has more than one element, MAC-CE selects a single element (see TS 38.321 [3], clause 5.18.8 and TS 38.213 [13], clause 9.2.2).

***PUCCH-format3* field descriptions**
nrofPRBs The supported values are 1,2,3,4,5,6,8,9,10,12,15 and 16.

***PUCCH-FormatConfig* field descriptions**
additionalDMRS If the field is present, the UE enables 2 DMRS symbols per hop of a PUCCH Format 3 or 4 if both hops are more than X symbols when FH is enabled (X=4). And it enables 4 DMRS symbols for a PUCCH Format 3 or 4 with more than 2X+1 symbols when FH is disabled (X=4). The field is not applicable for format 1 and 2. See TS 38.213 [13], clause 9.2.2.
interslotFrequencyHopping If the field is present, the UE enables inter-slot frequency hopping when PUCCH Format 1, 3 or 4 is repeated over multiple slots. For long PUCCH over multiple slots, the intra and inter slot frequency hopping cannot be enabled at the same time for a UE. The field is not applicable for format 2. See TS 38.213 [13], clause 9.2.6.
maxCodeRate Max coding rate to determine how to feedback UCI on PUCCH for format 2, 3 or 4. The field is not applicable for format 1. See TS 38.213 [13], clause 9.2.5.
nrofSlots Number of slots with the same PUCCH F1, F3 or F4. When the field is absent the UE applies the value n1. The field is not applicable for format 2. See TS 38.213 [13], clause 9.2.6.
pi2BPSK If the field is present, the UE uses pi/2 BPSK for UCI symbols instead of QPSK for PUCCH. The field is not applicable for format 1 and 2. See TS 38.213 [13], clause 9.2.5.
simultaneousHARQ-ACK-CSI If the field is present, the UE uses simultaneous transmission of CSI and HARQ-ACK feedback with or without SR with PUCCH Format 2, 3 or 4. See TS 38.213 [13], clause 9.2.5. When the field is absent the UE applies the value OFF The field is not applicable for format 1.

***PUCCH-Resource* field descriptions**
format Selection of the PUCCH format (format 0 - 4) and format-specific parameters, see TS 38.213 [13], clause 9.2. format0 and format1 are only allowed for a resource in a first PUCCH resource set. format2, format3 and format4 are only allowed for a resource in non-first PUCCH resource set.
intraSlotFrequencyHopping Enabling intra-slot frequency hopping, applicable for all types of PUCCH formats. For long PUCCH over multiple slots, the intra and inter slot frequency hopping cannot be enabled at the same time for a UE. See TS 38.213 [13], clause 9.2.1.
pucch-ResourceId Identifier of the PUCCH resource.
secondHopPRB Index of first PRB after frequency hopping (for second hop) of PUCCH. This value is applicable for intra-slot frequency hopping. See TS 38.213 [13], clause 9.2.1.

***PUCCH-ResourceSet* field descriptions**
maxPayloadMinus1 Maximum number of payload bits minus 1 that the UE may transmit using this PUCCH resource set. In a PUCCH occurrence, the UE chooses the first of its PUCCH-ResourceSet which supports the number of bits that the UE wants to transmit. The field is not present in the first set (Set0) since the maximum Size of Set0 is specified to be 3 bits. The field is not present in the last configured set since the UE derives its maximum payload size as specified in TS 38.213 [13]. This field can take integer values that are multiples of 4 (see TS 38.213 [13], clause 9.2).
resourceList PUCCH resources of format0 and format1 are only allowed in the first PUCCH resource set, i.e., in a PUCCH-ResourceSet with pucch-ResourceSetId = 0. This set may contain between 1 and 32 resources. PUCCH resources of format2, format3 and format4 are only allowed in a PUCCH-ResourceSet with pucch-ResourceSetId > 0. If present, these sets contain between 1 and 8 resources each. The UE chooses a PUCCH-Resource from this list as specified in TS 38.213 [13], clause 9.2.3. Note that this list contains only a list of resource IDs. The actual resources are configured in PUCCH-Config.

– *PUCCH-ConfigCommon*

The *PUCCH-ConfigCommon* IE is used to configure the cell specific PUCCH parameters.

PUCCH-ConfigCommon information element

```
-- ASN1START
-- TAG-PUCCH-CONFIGCOMMON-START

PUCCH-ConfigCommon ::=              SEQUENCE {
    pucch-ResourceCommon                INTEGER (0..15)                                     OPTIONAL,   -- Cond InitialBWP-Only
    pucch-GroupHopping                  ENUMERATED { neither, enable, disable },
    hoppingId                           INTEGER (0..1023)                                   OPTIONAL,   -- Need R
    p0-nominal                          INTEGER (-202..24)                                  OPTIONAL,   -- Need R
    ...
}

-- TAG-PUCCH-CONFIGCOMMON-STOP
-- ASN1STOP
```

PUCCH-ConfigCommon field descriptions
hoppingId Cell-specific scrambling ID for group hopping and sequence hopping if enabled. Corresponds to L1 parameter 'HoppingID' (see TS 38.211 [16], clause 6.3.2.2)
p0-nominal Power control parameter P0 for PUCCH transmissions. Value in dBm. Only even values (step size 2) allowed (see TS 38.213 [13], clause 7.2)
pucch-GroupHopping Configuration of group- and sequence hopping for all the PUCCH formats 0, 1, 3 and 4. "neither" implies neither group or sequence hopping is enabled. "enable" enables group hopping and disables sequence hopping. "disable" disables group hopping and enables sequence hopping (see TS 38.211 [16], clause 6.3.2.2)
pucch-ResourceCommon An entry into a 16-row table where each row configures a set of cell-specific PUCCH resources/parameters. The UE uses those PUCCH resources only during initial access on the initial uplink BWP. Once the network provides a dedicated PUCCH-Config for that bandwidth part the UE applies that one instead of the one provided in this field (see TS 38.213 [13], clause 9.2)

Conditional Presence	Explanation
InitialBWP-Only	The field is mandatory present in the *PUCCH-ConfigCommon* of the initial BWP (BWP#0) in SIB1. It is absent in other BWPs.

– *PUCCH-PathlossReferenceRS-Id*

The IE *PUCCH-PathlossReferenceRS-Id* is an ID for a reference signal (RS) configured as PUCCH pathloss reference (see TS 38.213 [13], clause 7.2).

PUCCH-PathlossReferenceRS-Id information element

```
-- ASN1START
-- TAG-PUCCH-PATHLOSSREFERENCERS-ID-START

PUCCH-PathlossReferenceRS-Id ::=            INTEGER (0..maxNrofPUCCH-PathlossReferenceRSs-1)
```

```
-- TAG-PUCCH-PATHLOSSREFERENCERS-ID-STOP
-- ASN1STOP
```

– *PUCCH-PowerControl*

The IE *PUCCH-PowerControl* is used to configure UE-specific parameters for the power control of PUCCH.

PUCCH-PowerControl information element

```
-- ASN1START
-- TAG-PUCCH-POWERCONTROL-START
PUCCH-PowerControl ::=              SEQUENCE {
    deltaF-PUCCH-f0                     INTEGER (-16..15)                                                       OPTIONAL, -- Need R
    deltaF-PUCCH-f1                     INTEGER (-16..15)                                                       OPTIONAL, -- Need R
    deltaF-PUCCH-f2                     INTEGER (-16..15)                                                       OPTIONAL, -- Need R
    deltaF-PUCCH-f3                     INTEGER (-16..15)                                                       OPTIONAL, -- Need R
    deltaF-PUCCH-f4                     INTEGER (-16..15)                                                       OPTIONAL, -- Need R
    p0-Set                              SEQUENCE (SIZE (1..maxNrofPUCCH-P0-PerSet)) OF P0-PUCCH                 OPTIONAL, -- Need M
    pathlossReferenceRSs                SEQUENCE (SIZE (1..maxNrofPUCCH-PathlossReferenceRSs)) OF PUCCH-PathlossReferenceRS
                                                                                                                OPTIONAL, -- Need M
    twoPUCCH-PC-AdjustmentStates        ENUMERATED {twoStates}                                                  OPTIONAL, -- Need S
    ...
}

P0-PUCCH ::=                            SEQUENCE {
    p0-PUCCH-Id                             P0-PUCCH-Id,
    p0-PUCCH-Value                          INTEGER (-16..15)
}

P0-PUCCH-Id ::=                         INTEGER (1..8)

PUCCH-PathlossReferenceRS ::=                   SEQUENCE {
    pucch-PathlossReferenceRS-Id                PUCCH-PathlossReferenceRS-Id,
    referenceSignal                             CHOICE {
        ssb-Index                                   SSB-Index,
        csi-RS-Index                                NZP-CSI-RS-ResourceId
    }
}

-- TAG-PUCCH-POWERCONTROL-STOP
-- ASN1STOP
```

P0-PUCCH field descriptions
p0-PUCCH-Value P0 value for PUCCH with 1dB step size.

PUCCH-PowerControl field descriptions
deltaF-PUCCH-f0 deltaF for PUCCH format 0 with 1dB step size (see TS 38.213 [13], clause 7.2)
deltaF-PUCCH-f1 deltaF for PUCCH format 1 with 1dB step size (see TS 38.213 [13], clause 7.2)
deltaF-PUCCH-f2 deltaF for PUCCH format 2 with 1dB step size (see TS 38.213 [13], clause 7.2)
deltaF-PUCCH-f3 deltaF for PUCCH format 3 with 1dB step size (see TS 38.213 [13], clause 7.2)
deltaF-PUCCH-f4 deltaF for PUCCH format 4 with 1dB step size (see TS 38.213 [13], clause 7.2)
p0-Set A set with dedicated P0 values for PUCCH, i.e., {P01, P02,... } (see TS 38.213 [13], clause 7.2)
pathlossReferenceRSs A set of Reference Signals (e.g. a CSI-RS config or a SS block) to be used for PUCCH pathloss estimation. Up to maxNrofPUCCH-PathlossReference-RSs may be configured. When the field is absent, the UE uses the SSB as reference signal (see TS 38.213 [13], clause 7.2).
twoPUCCH-PC-AdjustmentStates Number of PUCCH power control adjustment states maintained by the UE (i.e., g(i)). If the field is present (n2) the UE maintains two power control states (i.e., g(i,0) and g(i,1)). If the field is absent, it maintains one power control state (i.e., g(i,0)) (see TS 38.213 [13], clause 7.2)

– *PUCCH-SpatialRelationInfo*

The IE *PUCCH-SpatialRelationInfo* is used to configure the spatial setting for PUCCH transmission and the parameters for PUCCH power control, see TS 38.213, [13], clause 9.2.2.

PUCCH-SpatialRelationInfo information element

```
-- ASN1START
-- TAG-PUCCH-SPATIALRELATIONINFO-START

PUCCH-SpatialRelationInfo ::=           SEQUENCE {
    pucch-SpatialRelationInfoId         PUCCH-SpatialRelationInfoId,
    servingCellId                           ServCellIndex                                                       OPTIONAL,   -- Need S
    referenceSignal                         CHOICE {
        ssb-Index                               SSB-Index,
        csi-RS-Index                                NZP-CSI-RS-ResourceId,
        srs                                     SEQUENCE {
                                                    resource                            SRS-ResourceId,
                                                    uplinkBWP                           BWP-Id
                                                }
    },
    pucch-PathlossReferenceRS-Id            PUCCH-PathlossReferenceRS-Id,
    p0-PUCCH-Id                             P0-PUCCH-Id,
    closedLoopIndex                         ENUMERATED { i0, i1 }
}

PUCCH-SpatialRelationInfoId ::=         INTEGER (1..maxNrofSpatialRelationInfos)
```

```
-- TAG-PUCCH-SPATIALRELATIONINFO-STOP
-- ASN1STOP
```

PUCCH-SpatialRelationInfo field descriptions
servingCellId If the field is absent, the UE applies the ServCellId of the serving cell in which this PUCCH-SpatialRelationInfo is configured

– *PUCCH-TPC-CommandConfig*

The IE *PUCCH-TPC-CommandConfig* is used to configure the UE for extracting TPC commands for PUCCH from a group-TPC messages on DCI.

PUCCH-TPC-CommandConfig information element

```
-- ASN1START
-- TAG-PUCCH-TPC-COMMANDCONFIG-START

PUCCH-TPC-CommandConfig ::=             SEQUENCE {
    tpc-IndexPCell                          INTEGER (1..15)                                 OPTIONAL,   -- Cond PDCCH-OfSpcell
    tpc-IndexPUCCH-SCell                    INTEGER (1..15)                                 OPTIONAL,   -- Cond PDCCH-ofSpCellOrPUCCH-Scell
    ...
}

-- TAG-PUCCH-TPC-COMMANDCONFIG-STOP
-- ASN1STOP
```

PUCCH-TPC-CommandConfig field descriptions
tpc-IndexPCell An index determining the position of the first bit of TPC command (applicable to the SpCell) inside the DCI format 2-2 payload.
tpc-IndexPUCCH-SCell An index determining the position of the first bit of TPC command (applicable to the PUCCH SCell) inside the DCI format 2-2 payload.

Conditional Presence	Explanation
PDCCH-OfSpcell	The field is mandatory present, need R, if the *PUCCH-TPC-CommandConfig* is provided in the *PDCCH-Config* for the SpCell. Otherwise, the field is absent.
PDCCH-ofSpCellOrPUCCH-Scell	The field is mandatory present, need R, if the *PUCCH-TPC-CommandConfig* is provided in the *PDCCH-Config* for the PUCCH-SCell. The field is optionally present, need R, if the UE is configured with a PUCCH SCell in this cell group and if the *PUCCH-TPC-CommandConfig* is provided in the *PDCCH-Config* for the SpCell. Otherwise, the field is absent.

– *PUSCH-Config*

The IE *PUSCH-Config* is used to configure the UE specific PUSCH parameters applicable to a particular BWP.

***PUSCH-Config* information element**

```
-- ASN1START
-- TAG-PUSCH-CONFIG-START

PUSCH-Config ::=                        SEQUENCE {
    dataScramblingIdentityPUSCH             INTEGER (0..1023)                                                   OPTIONAL,   -- Need S
    txConfig                                ENUMERATED {codebook, nonCodebook}                                  OPTIONAL,   -- Need S
    dmrs-UplinkForPUSCH-MappingTypeA        SetupRelease { DMRS-UplinkConfig }                                  OPTIONAL,   -- Need M
    dmrs-UplinkForPUSCH-MappingTypeB        SetupRelease { DMRS-UplinkConfig }                                  OPTIONAL,   -- Need M

    pusch-PowerControl                      PUSCH-PowerControl                                                  OPTIONAL,   -- Need M
    frequencyHopping                        ENUMERATED {intraSlot, interSlot}                                   OPTIONAL,   -- Need S
    frequencyHoppingOffsetLists             SEQUENCE (SIZE (1..4)) OF INTEGER (1.. maxNrofPhysicalResourceBlocks-1)     OPTIONAL,   -- Need M
    resourceAllocation                      ENUMERATED { resourceAllocationType0, resourceAllocationType1, dynamicSwitch},
    pusch-TimeDomainAllocationList          SetupRelease { PUSCH-TimeDomainResourceAllocationList }             OPTIONAL,   -- Need M
    pusch-AggregationFactor                 ENUMERATED { n2, n4, n8 }                                           OPTIONAL,   -- Need S
    mcs-Table                               ENUMERATED {qam256, qam64LowSE}                                     OPTIONAL,   -- Need S
    mcs-TableTransformPrecoder              ENUMERATED {qam256, qam64LowSE}                                     OPTIONAL,   -- Need S
    transformPrecoder                       ENUMERATED {enabled, disabled}                                      OPTIONAL,   -- Need S
    codebookSubset                          ENUMERATED {fullyAndPartialAndNonCoherent, partialAndNonCoherent,
                                                            nonCoherent}                                OPTIONAL, -- Cond codebookBased
    maxRank                                 INTEGER (1..4)                                              OPTIONAL, -- Cond codebookBased
    rbg-Size                                ENUMERATED { config2}                                       OPTIONAL, -- Need S
    uci-OnPUSCH                             SetupRelease { UCI-OnPUSCH}                                 OPTIONAL, -- Need M
    tp-pi2BPSK                              ENUMERATED {enabled}                                        OPTIONAL, -- Need S
    ...
}

UCI-OnPUSCH ::=                         SEQUENCE {
    betaOffsets                             CHOICE {
            dynamic                             SEQUENCE (SIZE (4)) OF BetaOffsets,
            semiStatic                          BetaOffsets
    }                                                                                                           OPTIONAL, -- Need M
    scaling                                 ENUMERATED { f0p5, f0p65, f0p8, f1 }
}

-- TAG-PUSCH-CONFIG-STOP
-- ASN1STOP
```

***PUSCH-Config* field descriptions**
codebookSubset Subset of PMIs addressed by TPMI, where PMIs are those supported by UEs with maximum coherence capabilities (see TS 38.214 [19], clause 6.1.1.1).
dataScramblingIdentityPUSCH Identifier used to initalite data scrambling (c_init) for PUSCH. If the field is absent, the UE applies the physical cell ID. (see TS 38.211 [16], clause 6.3.1.1).
dmrs-UplinkForPUSCH-MappingTypeA DMRS configuration for PUSCH transmissions using PUSCH mapping type A (chosen dynamically via PUSCH-TimeDomainResourceAllocation). Only the fields dmrs-Type, dmrs-AdditionalPosition and maxLength may be set differently for mapping type A and B.
dmrs-UplinkForPUSCH-MappingTypeB DMRS configuration for PUSCH transmissions using PUSCH mapping type B (chosen dynamically via PUSCH-TimeDomainResourceAllocation).Only the fields dmrs-Type, dmrs-AdditionalPosition and maxLength may be set differently for mapping type A and B.
frequencyHopping The value *intraSlot* enables 'Intra-slot frequency hopping' and the value *interSlot* enables 'Inter-slot frequency hopping'. If the field is absent, frequency hopping is not configured (see TS 38.214 [19], clause 6.3).
frequencyHoppingOffsetLists Set of frequency hopping offsets used when frequency hopping is enabled for granted transmission (not msg3) and type 2 (see TS 38.214 [19], clause 6.3).
maxRank Subset of PMIs addressed by TRIs from 1 to ULmaxRank (see TS 38.214 [19], clause 6.1.1.1).
mcs-Table Indicates which MCS table the UE shall use for PUSCH without transform precoder (see TS 38.214 [19], clause 6.1.4.1). If the field is absent the UE applies the value 64QAM
mcs-TableTransformPrecoder Indicates which MCS table the UE shall use for PUSCH with transform precoding (see TS 38.214 [19], clause 6.1.4.1) If the field is absent the UE applies the value 64QAM
pusch-AggregationFactor Number of repetitions for data (see TS 38.214 [19], clause 6.1.2.1). If the field is absent the UE applies the value 1.
pusch-TimeDomainAllocationList List of time domain allocations for timing of UL assignment to UL data (see TS 38.214 [19], table 6.1.2.1.1-1).
rbg-Size Selection between configuration 1 and configuration 2 for RBG size for PUSCH. The UE does not apply this field if *resourceAllocation* is set to *resourceAllocationType1*. Otherwise, the UE applies the value *config1* when the field is absent (see TS 38.214 [19], clause 6.1.2.2.1).
resourceAllocation Configuration of resource allocation type 0 and resource allocation type 1 for non-fallback DCI (see TS 38.214 [19], clause 6.1.2).
tp-pi2BPSK Enables pi/2-BPSK modulation with transform precoding if the field is present and disables it otherwise.
transformPrecoder The UE specific selection of transformer precoder for PUSCH (see TS 38.214 [19], clause 6.1.3). When the field is absent the UE applies the value msg3-transformPrecoder.
txConfig Whether UE uses codebook based or non-codebook based transmission (see TS 38.214 [19], clause 6.1.1). If the field is absent, the UE transmits PUSCH on one antenna port, see TS 38.214 [19], clause 6.1.1.

UCI-OnPUSCH field descriptions
betaOffsets Selection between and configuration of dynamic and semi-static beta-offset. If the field is absent or released, the UE applies the value 'semiStatic' and the BetaOffsets according to FFS [BetaOffsets and/or clause 9.x.x) (see TS 38.213 [13], clause 9.3).
scaling Indicates a scaling factor to limit the number of resource elements assigned to UCI on PUSCH. Value f0p5 corresponds to 0.5, value f0p65 corresponds to 0.65, and so on. The value configured herein is applicable for PUSCH with configured grant (see TS 38.212 [17], clause 6.3).

Conditional Presence	Explanation
codebookBased	The field is mandatory present if *txConfig* is set to codebook and absent otherwise.

– *PUSCH-ConfigCommon*

The IE *PUSCH-ConfigCommon* IE is used to configure the cell specific PUSCH parameters.

***PUSCH-Config* information element**

```
-- ASN1START
-- TAG-PUSCH-CONFIGCOMMON-START

PUSCH-ConfigCommon ::=                  SEQUENCE {
    groupHoppingEnabledTransformPrecoding   ENUMERATED {enabled}                                        OPTIONAL,   -- Need R
    pusch-TimeDomainAllocationList          PUSCH-TimeDomainResourceAllocationList                  OPTIONAL,   -- Need R
    msg3-DeltaPreamble                      INTEGER (-1..6)                                             OPTIONAL,   -- Need R
    p0-NominalWithGrant                     INTEGER (-202..24)                                          OPTIONAL,   -- Need R
    ...
}

-- TAG-PUSCH-CONFIGCOMMON-STOP
-- ASN1STOP
```

PUSCH-ConfigCommon field descriptions
groupHoppingEnabledTransformPrecoding Sequence-group hopping can be enabled or disabled by means of this cell-specific parameter. Corresponds to L1 parameter 'Group-hopping-enabled-Transform-precoding' (see TS 38.211 [16], clause 6.4.1.1.1.2). This field is Cell specific
msg3-DeltaPreamble Power offset between msg3 and RACH preamble transmission. Actual value = field value * 2 [dB] (see TS 38.213 [13], clause 7.1)
p0-NominalWithGrant P0 value for PUSCH with grant (except msg3). Value in dBm. Only even values (step size 2) allowed (see TS 38.213 [13], clause 7.1) This field is cell specific
pusch-TimeDomainAllocationList List of time domain allocations for timing of UL assignment to UL data (see TS 38.214 [19], table 6.1.2.1.1-1).

– *PUSCH-PowerControl*

The IE *PUSCH-PowerControl* is used to configure UE specific power control parameter for PUSCH.

***PUSCH-PowerControl* information element**

```
-- ASN1START
-- TAG-PUSCH-POWERCONTROL-START

PUSCH-PowerControl ::=              SEQUENCE {
    tpc-Accumulation                    ENUMERATED { disabled }                                             OPTIONAL, -- Need S
    msg3-Alpha                          Alpha                                                               OPTIONAL, -- Need S
    p0-NominalWithoutGrant              INTEGER (-202..24)                                                  OPTIONAL, -- Need M
    p0-AlphaSets                        SEQUENCE (SIZE (1..maxNrofP0-PUSCH-AlphaSets)) OF P0-PUSCH-AlphaSet OPTIONAL, -- Need M
    pathlossReferenceRSToAddModList     SEQUENCE (SIZE (1..maxNrofPUSCH-PathlossReferenceRSs)) OF PUSCH-PathlossReferenceRS
                                                                                                            OPTIONAL, -- Need N
    pathlossReferenceRSToReleaseList    SEQUENCE (SIZE (1..maxNrofPUSCH-PathlossReferenceRSs)) OF PUSCH-PathlossReferenceRS-Id
                                                                                                            OPTIONAL,  -- Need N
    twoPUSCH-PC-AdjustmentStates        ENUMERATED {twoStates}                                              OPTIONAL, -- Need S
    deltaMCS                            ENUMERATED {enabled}                                                OPTIONAL, -- Need S
    sri-PUSCH-MappingToAddModList       SEQUENCE (SIZE (1..maxNrofSRI-PUSCH-Mappings)) OF SRI-PUSCH-PowerControl    OPTIONAL, -- Need N
    sri-PUSCH-MappingToReleaseList      SEQUENCE (SIZE (1..maxNrofSRI-PUSCH-Mappings)) OF SRI-PUSCH-PowerControlId  OPTIONAL  -- Need N
}

P0-PUSCH-AlphaSet ::=               SEQUENCE {
    p0-PUSCH-AlphaSetId                 P0-PUSCH-AlphaSetId,
    p0                                  INTEGER (-16..15)                                                   OPTIONAL, -- Need S
    alpha                               Alpha                                                               OPTIONAL  -- Need S
}

P0-PUSCH-AlphaSetId ::=             INTEGER (0..maxNrofP0-PUSCH-AlphaSets-1)

PUSCH-PathlossReferenceRS ::=       SEQUENCE {
    pusch-PathlossReferenceRS-Id        PUSCH-PathlossReferenceRS-Id,
    referenceSignal                     CHOICE {
        ssb-Index                           SSB-Index,
        csi-RS-Index                        NZP-CSI-RS-ResourceId
    }
}

PUSCH-PathlossReferenceRS-Id ::=    INTEGER (0..maxNrofPUSCH-PathlossReferenceRSs-1)


SRI-PUSCH-PowerControl ::=          SEQUENCE {
    sri-PUSCH-PowerControlId            SRI-PUSCH-PowerControlId,
    sri-PUSCH-PathlossReferenceRS-Id    PUSCH-PathlossReferenceRS-Id,
    sri-P0-PUSCH-AlphaSetId             P0-PUSCH-AlphaSetId,
    sri-PUSCH-ClosedLoopIndex           ENUMERATED { i0, i1 }
}

SRI-PUSCH-PowerControlId ::=        INTEGER (0..maxNrofSRI-PUSCH-Mappings-1)

BetaOffsets ::=                     SEQUENCE {
```

```
    betaOffsetACK-Index1                INTEGER(0..31)                                                          OPTIONAL, -- Need S
    betaOffsetACK-Index2                INTEGER(0..31)                                                          OPTIONAL, -- Need S
    betaOffsetACK-Index3                INTEGER(0..31)                                                          OPTIONAL, -- Need S
    betaOffsetCSI-Part1-Index1          INTEGER(0..31)                                                          OPTIONAL, -- Need S
    betaOffsetCSI-Part1-Index2          INTEGER(0..31)                                                          OPTIONAL, -- Need S
    betaOffsetCSI-Part2-Index1          INTEGER(0..31)                                                          OPTIONAL, -- Need S
    betaOffsetCSI-Part2-Index2          INTEGER(0..31)                                                          OPTIONAL  -- Need S
}

-- TAG-PUSCH-POWERCONTROL-STOP
-- ASN1STOP
```

BetaOffsets field descriptions
betaOffsetACK-Index1 Up to 2 bits HARQ-ACK (see TS 38.213 [13], clause 9.3) When the field is absent the UE applies the value 11
betaOffsetACK-Index2 Up to 11 bits HARQ-ACK (see TS 38.213 [13], clause 9.3) When the field is absent the UE applies the value 11
betaOffsetACK-Index3 Above 11 bits HARQ-ACK (see TS 38.213 [13], clause 9.3) When the field is absent the UE applies the value 11
betaOffsetCSI-Part1-Index1 Up to 11 bits of CSI part 1 bits (see TS 38.213 [13], clause 9.3) When the field is absent the UE applies the value 13
betaOffsetCSI-Part1-Index2 Above 11 bits of CSI part 1 bits (see TS 38.213 [13], clause 9.3) When the field is absent the UE applies the value 13
betaOffsetCSI-Part2-Index1 Up to 11 bits of CSI part 2 bits (see TS 38.213 [13], clause 9.3) When the field is absent the UE applies the value 13
betaOffsetCSI-Part2-Index2 Above 11 bits of CSI part 2 bits (see TS 38.213 [13], clause 9.3) When the field is absent the UE applies the value 13

P0-PUSCH-AlphaSet field descriptions
alpha alpha value for PUSCH with grant (except msg3) (see TS 38.213 [13], clause 7.1) When the field is absent the UE applies the value 1
p0 P0 value for PUSCH with grant (except msg3) in steps of 1dB (see TS 38.213 [13], clause 7.1)

PUSCH-PowerControl field descriptions
deltaMCS Indicates whether to apply delta MCS. When the field is absent, the UE applies Ks = 0 in delta_TFC formula for PUSCH (see TS 38.213 [13], clause 7.1)
msg3-Alpha Dedicated alpha value for msg3 PUSCH (see TS 38.213 [13], clause 7.1). When the field is absent the UE applies the value 1.
p0-AlphaSets configuration {p0-pusch, alpha} sets for PUSCH (except msg3), i.e., { {p0,alpha,index1}, {p0,alpha,index2},...} (see TS 38.213 [13], clause 7.1). When no set is configured, the UE uses the P0-nominal for msg3 PUSCH, P0-UE is set to 0 and alpha is set according to msg3-Alpha configured for msg3 PUSCH.
p0-NominalWithoutGrant P0 value for UL grant-free/SPS based PUSCH. Value in dBm. Only even values (step size 2) allowed (see TS 38.213 [13], clause 7.1)
pathlossReferenceRSToAddModList A set of Reference Signals (e.g. a CSI-RS config or a SS block) to be used for PUSCH path loss estimation. Up to maxNrofPUSCH-PathlossReferenceRSs may be configured (see TS 38.213 [13], clause 7.1)
sri-PUSCH-MappingToAddModList A list of SRI-PUSCH-PowerControl elements among which one is selected by the SRI field in DCI (see TS 38.213 [13], clause 7.1)
tpc-Accumulation If enabled, UE applies TPC commands via accumulation. If not enabled, UE applies the TPC command without accumulation. If the field is absent, TPC accumulation is enabled (see TS 38.213 [13], clause 7.1)
twoPUSCH-PC-AdjustmentStates Number of PUSCH power control adjustment states maintained by the UE (i.e., fc(i)). If the field is present (n2) the UE maintains two power control states (i.e., fc(i,0) and fc(i,1)). If the field is absent, it maintains one power control state (i.e., fc(i,0)) (see TS 38.213 [13], clause 7.1)

SRI-PUSCH-PowerControl field descriptions
sri-P0-PUSCH-AlphaSetId The ID of a P0-PUSCH-AlphaSet as configured in p0-AlphaSets in PUSCH-PowerControl.
sri-PUSCH-ClosedLoopIndex The index of the closed power control loop associated with this SRI-PUSCH-PowerControl
sri-PUSCH-PathlossReferenceRS-Id The ID of PUSCH-PathlossReferenceRS as configured in the pathlossReferenceRSToAddModList in PUSCH-PowerControl.
sri-PUSCH-PowerControlId The ID of this SRI-PUSCH-PowerControl configuration. It is used as the codepoint (payload) in the SRI DCI field.

– *PUSCH-ServingCellConfig*

The IE *PUSCH-ServingCellConfig* is used to configure UE specific PUSCH parameters that are common across the UE's BWPs of one serving cell.

PUSCH-ServingCellConfig information element

```
-- ASN1START
-- TAG-PUSCH-SERVINGCELLCONFIG-START

PUSCH-ServingCellConfig ::=             SEQUENCE {
    codeBlockGroupTransmission              SetupRelease { PUSCH-CodeBlockGroupTransmission }       OPTIONAL,   -- Need M
    rateMatching                            ENUMERATED {limitedBufferRM}                            OPTIONAL,   -- Need S
    xOverhead                               ENUMERATED {xoh6, xoh12, xoh18}                         OPTIONAL,   -- Need S
    ...,
```

```
    [[
    maxMIMO-Layers                          INTEGER (1..4)                                          OPTIONAL,   -- Need M
    processingType2Enabled                  BOOLEAN                                                 OPTIONAL    -- Need M
    ]]
}

PUSCH-CodeBlockGroupTransmission ::=    SEQUENCE {
    maxCodeBlockGroupsPerTransportBlock     ENUMERATED {n2, n4, n6, n8},
    ...
}

-- TAG-PUSCH-SERVINGCELLCONFIG-STOP
-- ASN1STOP
```

***PUSCH-CodeBlockGroupTransmission* field descriptions**
maxCodeBlockGroupsPerTransportBlock Maximum number of code-block-groups (CBGs) per TB (see 38.xxx, section x.x.x, FFS_Ref).

***PUSCH-ServingCellConfig* field descriptions**
codeBlockGroupTransmission Enables and configures code-block-group (CBG) based transmission (see TS 38.214 [19], clause 5.1.5).
maxMIMO-Layers Indicates the maximum MIMO layer to be used for PUSCH in all BWPs of this serving cell (see FFS_section, section FFS_Section). If present, the network sets *maxRank* to the same value.
processingType2Enabled Enables configuration of advanced processing time capability 2 for PUSCH (see 38.214 [19], clause 6.4).
rateMatching Enables LBRM (Limited buffer rate-matching). When the field is absent the UE applies FBRM (Full buffer rate-matchingLBRM) (see TS 38.212 [17], clause 5.4.2).
xOverhead Accounts for overhead from CSI-RS, CORESET, etc. If the field is absent, the UE applies the value 'xoh0' (see TS 38.214 [19], clause 5.1.3.2).

– *PUSCH-TimeDomainResourceAllocationList*

The IE *PUSCH-TimeDomainResourceAllocation* is used to configure a time domain relation between PDCCH and PUSCH. PUSCH-TimeDomainResourceAllocationList contains one or more of such PUSCH-TimeDomainResourceAllocations. The network indicates in the UL grant which of the configured time domain allocations the UE shall apply for that UL grant. The UE determines the bit width of the DCI field based on the number of entries in the PUSCH-TimeDomainResourceAllocationList. Value 0 in the DCI field refers to the first element in this list, value 1 in the DCI field refers to the second element in this list, and so on.

PUSCH-TimeDomainResourceAllocation information element

```
-- ASN1START
-- TAG-PUSCH-TIMEDOMAINRESOURCEALLOCATIONLIST-START

PUSCH-TimeDomainResourceAllocationList ::=  SEQUENCE (SIZE(1..maxNrofUL-Allocations)) OF PUSCH-TimeDomainResourceAllocation

PUSCH-TimeDomainResourceAllocation ::=  SEQUENCE {
```

```
    k2                                      INTEGER(0..32)          OPTIONAL,   -- Need S
    mappingType                             ENUMERATED {typeA, typeB},
    startSymbolAndLength                    INTEGER (0..127)
}

-- TAG-PUSCH-TIMEDOMAINRESOURCEALLOCATIONLIST-STOP
-- ASN1STOP
```

PUSCH-TimeDomainResourceAllocationList field descriptions
k2 Corresponds to L1 parameter 'K2' (see TS 38.214 [19], clause 6.1.2.1) When the field is absent the UE applies the value 1 when PUSCH SCS is 15/30KHz; 2 when PUSCH SCS is 60KHz and 3 when PUSCH SCS is 120KHz.
mappingType Mapping type (see TS 38.214 [19], clause 6.1.2.1).
startSymbolAndLength An index giving valid combinations of start symbol and length (jointly encoded) as start and length indicator (SLIV). The network configures the field so that the allocation does not cross the slot boundary. (see TS 38.214 [19], clause 6.1.2.1).

– *PUSCH-TPC-CommandConfig*

The IE *PUSCH-TPC-CommandConfig* is used to configure the UE for extracting TPC commands for PUSCH from a group-TPC messages on DCI.

PUSCH-TPC-CommandConfig information element

```
-- ASN1START
-- TAG-PUSCH-TPC-COMMANDCONFIG-START

PUSCH-TPC-CommandConfig ::=         SEQUENCE {
    tpc-Index                           INTEGER (1..15)                                                             OPTIONAL,   -- Cond SUL
    tpc-IndexSUL                        INTEGER (1..15)                                                             OPTIONAL,   -- Cond SUL-Only
    targetCell                          ServCellIndex                                                               OPTIONAL,   -- Need S
    ...
}

-- TAG-PUSCH-TPC-COMMANDCONFIG-STOP
-- ASN1STOP
```

PUSCH-TPC-CommandConfig field descriptions
targetCell The serving cell to which the acquired power control commands are applicable. If the value is absent, the UE applies the TPC commands to the serving cell on which the command has been received.
tpc-Index An index determining the position of the first bit of TPC command inside the DCI format 2-2 payload.
tpc-IndexSUL An index determining the position of the first bit of TPC command inside the DCI format 2-2 payload.

Conditional Presence	Explanation
SUL-Only	The field is optionally present, Need R, if this serving cell is configured with a supplementary uplink (SUL). It is absent otherwise.
SUL	The field is optionally present, Need R, if this serving cell is configured with a supplementary uplink (SUL). It is mandatory present otherwise.

– *Q-OffsetRange*

The IE *Q-OffsetRange* is used to indicate a cell, beam or measurement object specific offset to be applied when evaluating candidates for cell re-selection or when evaluating triggering conditions for measurement reporting. The value in dB. Value dB-24 corresponds to -24 dB, dB-22 corresponds to -22 dB and so on.

Q-OffsetRange information element

```
-- ASN1START
-- TAG-Q-OFFSET-START

Q-OffsetRange ::=                  ENUMERATED {
                                          dB-24, dB-22, dB-20, dB-18, dB-16, dB-14,
                                          dB-12, dB-10, dB-8, dB-6, dB-5, dB-4, dB-3,
                                          dB-2, dB-1, dB0, dB1, dB2, dB3, dB4, dB5,
                                          dB6, dB8, dB10, dB12, dB14, dB16, dB18,
                                          dB20, dB22, dB24}

-- TAG-Q-OFFSET-STOP
-- ASN1STOP
```

– *Q-QualMin*

The IE *Q-QualMin* is used to indicate for cell selection/ re-selection the required minimum received RSRQ level in the (NR) cell. Corresponds to parameter $Q_{qualmin}$ in TS 38.304 [20]. Actual value $Q_{qualmin}$ = field value [dB].

Q-QualMin information element

```
-- ASN1START
-- TAG-Q-QUALMIN-START

Q-QualMin ::=                      INTEGER (-43..-12)

-- TAG-Q-QUALMIN-STOP
-- ASN1STOP
```

– *Q-RxLevMin*

The IE *Q-RxLevMin* is used to indicate for cell selection/ re-selection the required minimum received RSRP level in the (NR) cell. Corresponds to parameter $Q_{rxlevmin}$ in TS 38.304 [20]. Actual value $Q_{rxlevmin}$ = field value * 2 [dBm].

Q-RxLevMin information element

```
-- ASN1START
-- TAG-Q-RXLEVMIN-START

Q-RxLevMin ::=                      INTEGER (-70..-22)

-- TAG-Q-RXLEVMIN-STOP
-- ASN1STOP
```

– *QuantityConfig*

The IE *QuantityConfig* specifies the measurement quantities and layer 3 filtering coefficients for NR and inter-RAT measurements.

QuantityConfig information element

```
-- ASN1START
-- TAG-QUANTITY-CONFIG-START


QuantityConfig ::=                  SEQUENCE {
    quantityConfigNR-List               SEQUENCE (SIZE (1..maxNrofQuantityConfig)) OF QuantityConfigNR          OPTIONAL,   -- Need M
    ...,
    [[
    quantityConfigEUTRA                 FilterConfig                                                            OPTIONAL    -- Need M
    ]]
}

QuantityConfigNR::=                 SEQUENCE {
    quantityConfigCell                  QuantityConfigRS,
    quantityConfigRS-Index              QuantityConfigRS                                                        OPTIONAL    -- Need M
}

QuantityConfigRS ::=                SEQUENCE {
    ssb-FilterConfig                    FilterConfig,
    csi-RS-FilterConfig                 FilterConfig
}

FilterConfig ::=                    SEQUENCE {
    filterCoefficientRSRP               FilterCoefficient                                       DEFAULT fc4,
    filterCoefficientRSRQ               FilterCoefficient                                       DEFAULT fc4,
    filterCoefficientRS-SINR            FilterCoefficient                                       DEFAULT fc4
}

-- TAG-QUANTITY-CONFIG-STOP
-- ASN1STOP
```

***QuantityConfigNR* field descriptions**
quantityConfigCell Specifies L3 filter configurations for cell measurement results for the configurable RS Types (e.g. SS/PBCH block and CSI-RS) and the configurable measurement quantities (e.g. RSRP, RSRQ and SINR).
quantityConfigRS-Index Specifies L3 filter configurations for measurement results per RS index for the configurable RS Types (e.g. SS/PBCH block and CSI-RS) and the configurable measurement quantities (e.g. RSRP, RSRQ and SINR).

***QuantityConfigRS* field descriptions**
csi-RS-FilterConfig CSI-RS basedL3 filter configurations: Specifies L3 filter configurations for CSI-RSRP, CSI-RSRQ and CSI-SINR measurement results from the L1 filter(s), as defined in TS 38.215 [9].
ssb-FilterConfig SS Block based L3 filter configurations: Specifies L3 filter configurations for SS-RSRP, SS-RSRQ and SS-SINR measurement results from the L1 filter(s), as defined in TS 38.215 [9].

– *RACH-ConfigCommon*

The *RACH-ConfigCommon* IE is used to specify the cell specific random-access parameters.

RACH-ConfigCommon information element

```
-- ASN1START
-- TAG-RACH-CONFIG-COMMON-START

RACH-ConfigCommon ::=                   SEQUENCE {
    rach-ConfigGeneric                      RACH-ConfigGeneric,
    totalNumberOfRA-Preambles               INTEGER (1..63)                                                         OPTIONAL,   -- Need S
    ssb-perRACH-OccasionAndCB-PreamblesPerSSB   CHOICE {
        oneEighth                               ENUMERATED {n4,n8,n12,n16,n20,n24,n28,n32,n36,n40,n44,n48,n52,n56,n60,n64},
        oneFourth                               ENUMERATED {n4,n8,n12,n16,n20,n24,n28,n32,n36,n40,n44,n48,n52,n56,n60,n64},
        oneHalf                                 ENUMERATED {n4,n8,n12,n16,n20,n24,n28,n32,n36,n40,n44,n48,n52,n56,n60,n64},
        one                                     ENUMERATED {n4,n8,n12,n16,n20,n24,n28,n32,n36,n40,n44,n48,n52,n56,n60,n64},
        two                                     ENUMERATED {n4,n8,n12,n16,n20,n24,n28,n32},
        four                                    INTEGER (1..16),
        eight                                   INTEGER (1..8),
        sixteen                                 INTEGER (1..4)
    }                                                                                                               OPTIONAL,   -- Need M

    groupBconfigured                        SEQUENCE {
        ra-Msg3SizeGroupA                       ENUMERATED {b56, b144, b208, b256, b282, b480, b640,
                                                            b800, b1000, b72, spare6, spare5,spare4, spare3, spare2, spare1},
        messagePowerOffsetGroupB                ENUMERATED { minusinfinity, dB0, dB5, dB8, dB10, dB12, dB15, dB18},
        numberOfRA-PreamblesGroupA              INTEGER (1..64)
    }                                                                                                               OPTIONAL,   -- Need R
    ra-ContentionResolutionTimer            ENUMERATED { sf8, sf16, sf24, sf32, sf40, sf48, sf56, sf64},
    rsrp-ThresholdSSB                       RSRP-Range                                                              OPTIONAL,   -- Need R
    rsrp-ThresholdSSB-SUL                   RSRP-Range                                                              OPTIONAL,   -- Cond SUL
```

```
    prach-RootSequenceIndex                 CHOICE {
        l839                                    INTEGER (0..837),
        l139                                    INTEGER (0..137)
    },
    msg1-SubcarrierSpacing                  SubcarrierSpacing                                                       OPTIONAL,   -- Cond L139
    restrictedSetConfig                     ENUMERATED {unrestrictedSet, restrictedSetTypeA, restrictedSetTypeB},
    msg3-transformPrecoder                  ENUMERATED {enabled}                                                    OPTIONAL,   -- Need R
    ...
}

-- TAG-RACH-CONFIG-COMMON-STOP
-- ASN1STOP
```

***RACH-ConfigCommon* field descriptions**
messagePowerOffsetGroupB Threshold for preamble selection. Value in dB. Value minusinfinity corresponds to –infinity. Value dB0 corresponds to 0 dB, dB5 corresponds to 5 dB and so on. (see TS 38.321 [3], clause 5.1.2)
msg1-SubcarrierSpacing Subcarrier spacing of PRACH (see TS 38.211 [16], clause 5.3.2). Only the values 15 or 30 kHz (<6GHz), 60 or 120 kHz (>6GHz) are applicable (see TS 38.211 [16], section FFS_Section). If absent, the UE applies the SCS as derived from the *prach-ConfigurationIndex* in *RACH-ConfigGeneric* (see tables Table 6.3.3.1-1 and Table 6.3.3.2-2, TS 38.211 [16]). The value also applies to contention free random access (RACH-ConfigDedicated), to SI-request and to contention-based beam failure recovery (CB-BFR). But it does not apply for contention free beam failure recovery (CF-BFR) (see BeamFailureRecoveryConfig).
msg3-transformPrecoder Enables the transform precoder for Msg3 transmission. If the field is absent, the UE disables the transformer precoder (see TS 38.213 [13], clause 8.3)
numberOfRA-PreamblesGroupA The number of CB preambles per SSB in group A. This determines implicitly the number of CB preambles per SSB available in group B. (see TS 38.321 [3], clause 5.1.1). The setting should be consistent with the setting of *ssb-perRACH-OccasionAndCB-PreamblesPerSSB*.
prach-RootSequenceIndex PRACH root sequence index (see TS 38.211 [16], clause 6.3.3.1). The value range depends on whether L=839 or L=139. The short/long preamble format indicated in this IE should be consistent with the one indicated in prach-ConfigurationIndex in the RACH-ConfigDedicated (if configured).
ra-ContentionResolutionTimer The initial value for the contention resolution timer (see TS 38.321 [3], clause 5.1.5). Value *sf8* corresponds to 8 subframes, value *sf16* corresponds to 16 subframes, and so on.
ra-Msg3SizeGroupA Transport Blocks size threshold in bit below which the UE shall use a contention-based RA preamble of group A. (see TS 38.321 [3], clause 5.1.2)
rach-ConfigGeneric Generic RACH parameters
restrictedSetConfig Configuration of an unrestricted set or one of two types of restricted sets, see TS 38.211 [16], clause 6.3.3.1.
rsrp-ThresholdSSB UE may select the SS block and corresponding PRACH resource for path-loss estimation and (re)transmission based on SS blocks that satisfy the threshold (see TS 38.213 [13])
rsrp-ThresholdSSB-SUL The UE selects SUL carrier to perform random access based on this threshold (see TS 38.321 [3], clause 5.1.1). The value applies to all the BWPs.
ssb-perRACH-OccasionAndCB-PreamblesPerSSB The meaning of this field is twofold: the CHOICE conveys the information about the number of SSBs per RACH occasion (L1 parameter 'SSB-per-rach-occasion'). Value oneEight corresponds to one SSB associated with 8 RACH occasions, value oneFourth corresponds to one SSB associated with 4 RACH occasions, and so on. The ENUMERATED part indicates the number of Contention Based preambles per SSB (L1 parameter 'CB-preambles-per-SSB'). Value n4 corresponds to 4 Contention Based preambles per SSB, value n8 corresponds to 8 Contention Based preambles per SSB, and so on. The total number of CB preambles in a RACH occasion is given by CB-preambles-per-SSB * max(1, SSB-per-rach-occasion).
totalNumberOfRA-Preambles Total number of preambles used for contention based and contention free random access in the RACH resources defined in RACH-ConfigCommon, excluding preambles used for other purposes (e.g. for SI request). If the field is absent, the all 64 preambles are available for RA. The setting should be consistent with the setting of ssb-perRACH-OccasionAndCB-PreamblesPerSSB, i.e. it should be a multiple of the number of SSBs per RACH occasion.

Conditional Presence	Explanation
L139	The field is mandatory present if prach-RootSequenceIndex L=139, otherwise the field is absent.
SUL	The field is mandatory present in *initialUplinkBWP* in *supplementaryUplink*; otherwise, the field is absent.

– *RACH-ConfigDedicated*

The IE *RACH-ConfigDedicated* is used to specify the dedicated random access parameters.

***RACH-ConfigDedicated* information element**

```
-- ASN1START
-- TAG-RACH-CONFIG-DEDICATED-START

RACH-ConfigDedicated ::=        SEQUENCE {
    cfra                            CFRA                                                                    OPTIONAL, -- Need S
    ra-Prioritization               RA-Prioritization                                                       OPTIONAL, -- Need N
    ...
}

CFRA ::=                    SEQUENCE {
    occasions                       SEQUENCE {
        rach-ConfigGeneric              RACH-ConfigGeneric,
        ssb-perRACH-Occasion            ENUMERATED {oneEighth, oneFourth, oneHalf, one, two, four, eight, sixteen}  OPTIONAL  -- Cond SSB-CFRA
    }                                                                                                       OPTIONAL, -- Need S
    resources                       CHOICE {
        ssb                             SEQUENCE {
            ssb-ResourceList                SEQUENCE (SIZE(1..maxRA-SSB-Resources)) OF CFRA-SSB-Resource,
            ra-ssb-OccasionMaskIndex        INTEGER (0..15)
        },
        csirs                           SEQUENCE {
            csirs-ResourceList              SEQUENCE (SIZE(1..maxRA-CSIRS-Resources)) OF CFRA-CSIRS-Resource,
            rsrp-ThresholdCSI-RS            RSRP-Range
        }
    },
    ...,
    [[
    totalNumberOfRA-Preambles-v1530 INTEGER (1..63)                             OPTIONAL        -- Cond Occasions
    ]]
}

CFRA-SSB-Resource ::=           SEQUENCE {
    ssb                             SSB-Index,
    ra-PreambleIndex                INTEGER (0..63),
    ...
}

CFRA-CSIRS-Resource ::=         SEQUENCE {
    csi-RS                          CSI-RS-Index,
    ra-OccasionList                 SEQUENCE (SIZE(1..maxRA-OccasionsPerCSIRS)) OF INTEGER (0..maxRA-Occasions-1),
    ra-PreambleIndex                INTEGER (0..63),
```

```
    ...
}

-- TAG-RACH-CONFIG-DEDICATED-STOP
-- ASN1STOP
```

CFRA-CSIRS-Resource field descriptions
csi-RS The ID of a CSI-RS resource defined in the measurement object associated with this serving cell.
ra-OccasionList RA occasions that the UE shall use when performing CF-RA upon selecting the candidate beam identified by this CSI-RS. The network ensures that the RA occasion indexes provided herein are also configured by prach-ConfigurationIndex and msg1-FDM. Each RACH occasion is sequentially numbered, first, in increasing order of frequency resource indexes for frequency multiplexed PRACH occasions; second, in increasing order of time resource indexes for time multiplexed PRACH occasions within a PRACH slot and Third, in increasing order of indexes for PRACH slots.
ra-PreambleIndex The RA preamble index to use in the RA occasions associated with this CSI-RS.

CFRA field descriptions
occasions RA occasions for contention free random access. If the field is absent, the UE uses the RA occasions configured in RACH-ConfigCommon in the first active UL BWP.
ra-ssb-OccasionMaskIndex Explicitly signalled PRACH Mask Index for RA Resource selection in TS 36.321. The mask is valid for all SSB resources signalled in ssb-ResourceList
rach-ConfigGeneric Configuration of contention free random access occasions for CFRA. The UE shall ignore *preambleReceivedTargetPower*, *preambleTransMax*, *powerRampingStep*, *ra-ResponseWindow* signaled within this field and use the corresponding values provided in *RACH-ConfigCommon*.
ssb-perRACH-Occasion Number of SSBs per RACH occasion (L1 parameter 'SSB-per-rach-occasion').
totalNumberOfRA-Preambles Total number of preambles used for contention free random access in the RACH resources defined in CFRA, excluding preambles used for other purposes (e.g. for SI request). If the field is absent but the field occasions is present, the UE may assume all the 64 preambles are for RA. The setting should be consistent with the setting of ssb-perRACH-Occasion, if present, i.e. it should be a multiple of the number of SSBs per RACH occasion.

CFRA-SSB-Resource field descriptions
ra-PreambleIndex The preamble index that the UE shall use when performing CF-RA upon selecting the candidate beams identified by this SSB.
ssb The ID of an SSB transmitted by this serving cell.

***RACH-ConfigDedicated* field descriptions**
cfra Parameters for contention free random access to a given target cell. If the field is absent, the UE performs contention based random access.
ra-prioritization Parameters which apply for prioritized random access procedure to a given target cell (see TS 38.321 [3], clause 5.1.1).

Conditional Presence	Explanation
SSB-CFRA	The field is mandatory present if the field resources in CFRA is set to ssb; otherwise it is not present.
Occasions	The field is optionally present if the field *occasions* is present, Need S; otherwise it is not present.

– *RACH-ConfigGeneric*

The *RACH-ConfigGeneric* IE is used to specify the random-access parameters both for regular random access as well as for beam failure recovery.

***RACH-ConfigGeneric* information element**

```
-- ASN1START
-- TAG-RACH-CONFIG-GENERIC-START

RACH-ConfigGeneric ::=              SEQUENCE {
    prach-ConfigurationIndex            INTEGER (0..255),
    msg1-FDM                            ENUMERATED {one, two, four, eight},
    msg1-FrequencyStart                 INTEGER (0..maxNrofPhysicalResourceBlocks-1),
    zeroCorrelationZoneConfig           INTEGER(0..15),
    preambleReceivedTargetPower         INTEGER (-202..-60),
    preambleTransMax                    ENUMERATED {n3, n4, n5, n6, n7, n8, n10, n20, n50, n100, n200},
    powerRampingStep                    ENUMERATED {dB0, dB2, dB4, dB6},
    ra-ResponseWindow                   ENUMERATED {sl1, sl2, sl4, sl8, sl10, sl20, sl40, sl80},
    ...
}

-- TAG-RACH-CONFIG-GENERIC-STOP
-- ASN1STOP
```

***RACH-ConfigGeneric* field descriptions**
msg1-FDM The number of PRACH transmission occasions FDMed in one time instance. (see TS 38.211 [16], clause 6.3.3.2)
msg1-FrequencyStart Offset of lowest PRACH transmission occasion in frequency domain with respective to PRB 0. The value is configured so that the corresponding RACH resource is entirely within the bandwidth of the UL BWP. (see TS 38.211 [16], clause 6.3.3.2).
powerRampingStep Power ramping steps for PRACH (see TS 38.321 [3],5.1.3).
prach-ConfigurationIndex PRACH configuration index. For prach-ConfigurationIndex configured under beamFailureRecovery-Config, the prach-ConfigurationIndex can only correspond to the short preamble format, (see TS 38.211 [16], clause 6.3.3.2).
preambleReceivedTargetPower The target power level at the network receiver side (see TS 38.213 [13], clause 7.4, TS 38.321 [3], clauses 5.1.2, 5.1.3). Only multiples of 2 dBm may be chosen (e.g. -202, -200, -198, ...).
preambleTransMax Max number of RA preamble transmission performed before declaring a failure (see TS 38.321 [3], clauses 5.1.4, 5.1.5).
ra-ResponseWindow Msg2 (RAR) window length in number of slots. The network configures a value lower than or equal to 10 ms (see TS 38.321 [3], clause 5.1.4). UE ignores the field if included in *SCellConfig*.
zeroCorrelationZoneConfig N-CS configuration, see Table 6.3.3.1-5 in TS 38.211 [16]

– *RA-Prioritization*

The IE *RA-Prioritization* is used to configure prioritized random access.

RA-Prioritization **information element**

```
-- ASN1START
-- TAG-RA-PRIORITIZATION-START

RA-Prioritization ::=           SEQUENCE {
    powerRampingStepHighPriority        ENUMERATED {dB0, dB2, dB4, dB6},
    scalingFactorBI                 ENUMERATED {zero, dot25, dot5, dot75}                                   OPTIONAL,   -- Need R
    ...
}

-- TAG-RA-PRIORITIZATION-STOP
-- ASN1STOP
```

RA-Prioritization field descriptions
powerRampingStepHighPrioritiy Power ramping step applied for prioritized random access procedure.
scalingFactorBI Scaling factor for the backoff indicator (BI) for the prioritized random access procedure. (see TS 38.321 [3], clause 5.1.4). Value *zero* corresponds to 0, value *dot25* corresponds to 0.25 and so on.

– *RadioBearerConfig*

The IE *RadioBearerConfig* is used to add, modify and release signalling and/or data radio bearers. Specifically, this IE carries the parameters for PDCP and, if applicable, SDAP entities for the radio bearers.

RadioBearerConfig information element

```
-- ASN1START
-- TAG-RADIO-BEARER-CONFIG-START

RadioBearerConfig ::=                   SEQUENCE {
    srb-ToAddModList                        SRB-ToAddModList                                        OPTIONAL,   -- Cond HO-Conn
    srb3-ToRelease                          ENUMERATED{true}                                        OPTIONAL,   -- Need N
    drb-ToAddModList                        DRB-ToAddModList                                        OPTIONAL,   -- Cond HO-toNR
    drb-ToReleaseList                       DRB-ToReleaseList                                       OPTIONAL,   -- Need N
    securityConfig                          SecurityConfig                                          OPTIONAL,   -- Need M
    ...
}

SRB-ToAddModList ::=                    SEQUENCE (SIZE (1..2)) OF SRB-ToAddMod
SRB-ToAddMod ::=                        SEQUENCE {
    srb-Identity                            SRB-Identity,
    reestablishPDCP                         ENUMERATED{true}                                        OPTIONAL,   -- Need N
    discardOnPDCP                           ENUMERATED{true}                                        OPTIONAL,   -- Need N
    pdcp-Config                             PDCP-Config                                             OPTIONAL,   -- Cond PDCP
    ...
}

DRB-ToAddModList ::=                    SEQUENCE (SIZE (1..maxDRB)) OF DRB-ToAddMod
DRB-ToAddMod ::=                        SEQUENCE {
    cnAssociation                           CHOICE {
        eps-BearerIdentity                      INTEGER (0..15),                                            -- EPS-DRB-Setup
        sdap-Config                             SDAP-Config                                                 -- 5GC
    }                                                                                               OPTIONAL,   -- Cond DRBSetup
    drb-Identity                            DRB-Identity,
    reestablishPDCP                         ENUMERATED{true}                                        OPTIONAL,   -- Need N
    recoverPDCP                             ENUMERATED{true}                                        OPTIONAL,   -- Need N
    pdcp-Config                             PDCP-Config                                             OPTIONAL,   -- Cond PDCP
    ...
}
DRB-ToReleaseList ::=                   SEQUENCE (SIZE (1..maxDRB)) OF DRB-Identity

SecurityConfig ::=                      SEQUENCE {
    securityAlgorithmConfig                 SecurityAlgorithmConfig                                 OPTIONAL,   -- Cond RBTermChange
```

```
    keyToUse                          ENUMERATED{master, secondary}                          OPTIONAL,   -- Cond RBTermChange
    ...
}


-- TAG-RADIO-BEARER-CONFIG-STOP
-- ASN1STOP
```

DRB-ToAddMod field descriptions
cnAssociation Indicates if the bearer is associated with the *eps-bearerIdentity* (when connected to EPC) or *sdap-Config* (when connected to 5GC).
drb-Identity In case of DC, the DRB identity is unique within the scope of the UE, i.e. an MCG DRB cannot use the same value as a split DRB. For a split DRB the same identity is used for the MCG and SCG parts of the configuration.
eps-BearerIdentity The EPS bearer ID determines the EPS bearer when NR connects to EPC using EN-DC.
reestablishPDCP Indicates that PDCP should be re-established. Network sets this to TRUE whenever the security key used for this radio bearer changes. Key change could for example be due to termination point change for the bearer, reconfiguration with sync, resuming an RRC connection, or the first reconfiguration after reestablishment. It is also applicable for LTE procedures when NR PDCP is configured.
recoverPDCP Indicates that PDCP should perform recovery according to TS 38.323 [5].
sdap-Config The SDAP configuration determines how to map QoS flows to DRBs when NR connects to the 5GC and presence/absence of UL/DL SDAP headers.

RadioBearerConfig field descriptions
securityConfig Indicates the security algorithm and key to use for the signalling and data radio bearers configured with the list in this *radioBearerConfig*. When the field is not included after security has been activated, the UE shall continue to use the currently configured *keyToUse* and security algorithm for the radio bearers reconfigured with the lists in this *radioBearerConfig* except for mobility from NR to E-UTRA/5GC. The field is not included when configuring SRB1 before security is activated.
srb3-ToRelease Release SRB3. SRB3 release can only be done over SRB1 and only at SCG release and reconfiguration with sync.

SecurityConfig field descriptions
keyToUse Indicates if the bearers configured with the list in this radioBearerConfig is using the master key or the secondary key for deriving ciphering and/or integrity protection keys. For EN-DC, network should not configure SRB1 and SRB2 with secondary key and SRB3 with the master key. When the field is not included, the UE shall continue to use the currently configured *keyToUse* for the radio bearers reconfigured with the lists in this *radioBearerConfig* except for mobility from NR to E-UTRA/5GC. If EN-DC is not configured, this field is set to master.
securityAlgorithmConfig Indicates the security algorithm for the signalling and data radio bearers configured with the list in this *radioBearerConfig*. When the field is not included, the UE shall continue to use the currently configured security algorithm for the radio bearers reconfigured with the lists in this *radioBearerConfig* except for mobility from NR to E-UTRA/5GC.

***SRB-ToAddMod* field descriptions**
discardOnPDCP Indicates that PDCP should discard stored SDU and PDU according to TS 38.323 [5].
reestablishPDCP Indicates that PDCP should be re-established. Network sets this to TRUE whenever the security key used for this radio bearer changes. Key change could for example be due to reconfig with sync, for SRB2 when resuming an RRC connection, or at the first reconfiguration after RRC connection reestablishment in NR. For LTE SRBs using NR PDCP, it could be for handover, RRC connection reestablishment or resume.
srb-Identity Value 1 is applicable for SRB1 only. Value 2 is applicable for SRB2 only. Value 3 is applicable for SRB3 only.

Conditional Presence	Explanation
RBTermChange	The field is mandatory present in case of set up of signalling and data radio bearer and change of termination point for the radio bearer between MN and SN. It is optionally present otherwise, Need S.
PDCP	The field is mandatory present if the corresponding DRB is being setup or corresponding RB is reconfigured with NR PDCP; otherwise the field is optionally present, need M.
DRBSetup	The field is mandatory present if the corresponding DRB is being setup; otherwise the field is optionally present, need M.
HO-Conn	The field is mandatory present in case of inter-system handover from E-UTRA (connected to EPC) to E-UTRA (connected to 5GC) or NR, or when the *fullConfig* is included in the *RRCReconfiguration* message, or in case of *RRCSetup*; otherwise the field is optionally present, need N. Upon *RRCSetup*, only SRB1 can be present.
HO-toNR	The field is mandatory present in case of inter-system handover from E-UTRA (connected to EPC) to E-UTRA (connected to 5GC) or NR, or when the *fullConfig* is included in the *RRCReconfiguration* message. In case of *RRCSetup*, the field is not present; otherwise the field is optionally present, need N.

– *RadioLinkMonitoringConfig*

The *RadioLinkMonitoringConfig* IE is used to configure radio link monitoring for detection of beam- and/or cell radio link failure. See also TS 38.321 [3], clause 5.1.1.

RadioLinkMonitoringConfig information element

```
-- ASN1START
-- TAG-RADIOLINKMONITORINGCONFIG-START

RadioLinkMonitoringConfig ::=       SEQUENCE {
    failureDetectionResourcesToAddModList   SEQUENCE (SIZE(1..maxNrofFailureDetectionResources)) OF RadioLinkMonitoringRS OPTIONAL, -- Need N
    failureDetectionResourcesToReleaseList  SEQUENCE (SIZE(1..maxNrofFailureDetectionResources)) OF RadioLinkMonitoringRS-Id
                                                                                                     OPTIONAL, -- Need N
    beamFailureInstanceMaxCount             ENUMERATED {n1, n2, n3, n4, n5, n6, n8, n10}             OPTIONAL, -- Need R
    beamFailureDetectionTimer               ENUMERATED {pbfd1, pbfd2, pbfd3, pbfd4, pbfd5, pbfd6, pbfd8, pbfd10}         OPTIONAL, -- Need R
    ...
}

RadioLinkMonitoringRS ::=           SEQUENCE {
    radioLinkMonitoringRS-Id                RadioLinkMonitoringRS-Id,
    purpose                             ENUMERATED {beamFailure, rlf, both},
    detectionResource                   CHOICE {
        ssb-Index                           SSB-Index,
        csi-RS-Index                        NZP-CSI-RS-ResourceId
```

```
    },
    ...
}

-- TAG-RADIOLINKMONITORINGCONFIG-STOP
-- ASN1STOP
```

***RadioLinkMonitoringConfig* field descriptions**
beamFailureDetectionTimer Timer for beam failure detection (see TS 38.321 [3], clause 5.17). See also the *BeamFailureRecoveryConfig* IE. Value in number of "$Q_{out,LR}$ reporting periods of Beam Failure Detection" Reference Signal (see TS 38.213 [13], clause 6). Value pbfd1 corresponds to 1 $Q_{out,LR}$ reporting period of Beam Failure Detection Reference Signal, value pbfd2 corresponds to 2 $Q_{out,LR}$ reporting periods of Beam Failure Detection Reference Signal and so on.
beamFailureInstanceMaxCount This field determines after how many beam failure events the UE triggers beam failure recovery (see TS 38.321 [3], clause 5.17). Value n1 corresponds to 1 beam failure instance, n2 corresponds to 2 beam failure instances and so on.
failureDetectionResourcesToAddModList A list of reference signals for detecting beam failure and/or cell level radio link failure (RLF). The limits of the reference signals that the network can configure are specified in TS 38.213 [13], Table 5-1. The network configures at most two detectionResources per BWP for the purpose "beamFailure" or "both". If no RSs are provided for the purpose of beam failure detection, the UE performs beam monitoring based on the activated TCI-State for PDCCH as described in TS 38.213 [13], clause 6. If no RSs are provided in this list for the purpose of RLF detection, the UE performs Cell-RLM based on the activated TCI-State of PDCCH as described in TS 38.213 [13], clause 5. The network ensures that the UE has a suitable set of reference signals for performing cell-RLM.

***RadioLinkMonitoringRS* field descriptions**
detectionResource A reference signal that the UE shall use for radio link monitoring or beam failure detection (depending on the indicated *purpose*).
purpose Determines whether the UE shall monitor the associated reference signal for the purpose of cell- and/or beam failure detection.

– *RadioLinkMonitoringRSId*

The IE *RadioLinkMonitoringRSId* is used to identify one *RadioLinkMonitoringRS*.

***RadioLinkMonitoringRSId* information element**

```
-- ASN1START
-- TAG-RADIOLINKMONITORINGRSID-START

RadioLinkMonitoringRS-Id ::=            INTEGER (0..maxNrofFailureDetectionResources-1)

-- TAG-RADIOLINKMONITORINGRSID-STOP
-- ASN1STOP
```

– *RAN-AreaCode*

The IE *RAN-AreaCode* is used to identify a RAN area within the scope of a tracking area.

***RAN-AreaCode* information element**

```
-- ASN1START
-- TAG-RAN-AREACODE-START

RAN-AreaCode ::=                INTEGER (0..255)

-- TAG-RAN-AREACODE-STOP
-- ASN1STOP
```

– *RateMatchPattern*

The IE *RateMatchPattern* is used to configure one rate matching pattern for PDSCH, see TS 38.214 [19], clause 5.1.4.1.

***RateMatchPattern* information element**

```
-- ASN1START
-- TAG-RATEMATCHPATTERN-START

RateMatchPattern ::=                SEQUENCE {
    rateMatchPatternId                  RateMatchPatternId,

    patternType                         CHOICE {
        bitmaps                             SEQUENCE {
            resourceBlocks                      BIT STRING (SIZE (275)),
            symbolsInResourceBlock              CHOICE {
                oneSlot                             BIT STRING (SIZE (14)),
                twoSlots                            BIT STRING (SIZE (28))
            },
            periodicityAndPattern               CHOICE {
                n2                                  BIT STRING (SIZE (2)),
                n4                                  BIT STRING (SIZE (4)),
                n5                                  BIT STRING (SIZE (5)),
                n8                                  BIT STRING (SIZE (8)),
                n10                                 BIT STRING (SIZE (10)),
                n20                                 BIT STRING (SIZE (20)),
                n40                                 BIT STRING (SIZE (40))
            }                                                                                                   OPTIONAL,   -- Need S
            ...
        },
        controlResourceSet                  ControlResourceSetId
    },
    subcarrierSpacing                   SubcarrierSpacing                                                   OPTIONAL,   -- Cond CellLevel
    dummy                               ENUMERATED { dynamic, semiStatic },
    ...
}
```

```
-- TAG-RATEMATCHPATTERN-STOP
-- ASN1STOP
```

RateMatchPattern field descriptions
bitmaps Indicates rate matching pattern by a pair of bitmaps resourceBlocks and symbolsInResourceBlock to define the rate match pattern within one or two slots, and a third bitmap periodicityAndPattern to define the repetition pattern with which the pattern defined by the above bitmap pair occurs
controlResourceSet This ControlResourceSet is used as a PDSCH rate matching pattern, i.e., PDSCH reception rate matches around it. In frequency domain, the resource is determined by the frequency domain resource of the CORESET with the corresponding CORESET ID. Time domain resource is determined by the parameters of the associated search space of the CORESET.
periodicityAndPattern A time domain repetition pattern at which the pattern defined by symbolsInResourceBlock and resourceBlocks recurs. This slot pattern repeats itself continuously. Absence of this field indicates the value n1, i.e., the symbolsInResourceBlock recurs every 14 symbols (see TS 38.214 [19], clause 5.1.4.1)
resourceBlocks A resource block level bitmap in the frequency domain. A bit in the bitmap set to 1 indicates that the UE shall apply rate matching in the corresponding resource block in accordance with the symbolsInResourceBlock bitmap. If used as cell-level rate matching pattern, the bitmap identifies "common resource blocks (CRB)". If used as BWP-level rate matching pattern, the bitmap identifies "physical resource blocks" inside the BWP. The first/ leftmost bit corresponds to resource block 0, and so on (see TS 38.214 [19], clause 5.1.4.1)
subcarrierSpacing The SubcarrierSpacing for this resource pattern. If the field is absent, the UE applies the SCS of the associated BWP. The value kHz15 corresponds to µ=0, kHz30 to µ=1, and so on. Only the values 15 or 30 kHz (<6GHz), 60 or 120 kHz (>6GHz) are applicable (see TS 38.214 [19], clause 5.1.4.1)
symbolsInResourceBlock A symbol level bitmap in time domain. It indicates with a bit set to true that the UE shall rate match around the corresponding symbol. The first/left-most bit in the bitmap corresponds to the first symbol in the slot, and so on. This pattern recurs (in time domain) with the configured periodicityAndPattern (see TS 38.214 [19], clause 5.1.4.1)

Conditional Presence	**Explanation**
CellLevel	The field is mandatory present if the RateMatchPattern is defined on cell level. The field is absent when the RateMatchPattern is defined on BWP level. If the RateMatchPattern is defined on BWP level, the UE applies the SCS of the BWP.

– *RateMatchPatternId*

The IE *RateMatchPatternId* identifies one RateMatchMattern (see TS 38.214 [19], clause 5.1.4.2).

RateMatchPatternId information element

```
-- ASN1START
-- TAG-RATEMATCHPATTERNID-START

RateMatchPatternId ::=              INTEGER (0..maxNrofRateMatchPatterns-1)

-- TAG-RATEMATCHPATTERNID-STOP
-- ASN1STOP
```

– *RateMatchPatternLTE-CRS*

The IE *RateMatchPatternLTE-CRS* is used to configure a pattern to rate match around LTE CRS. See TS 38214 Clause 5.1.4.2.

RateMatchPatternLTE-CRS information element

```
-- ASN1START
-- TAG-RATEMATCHPATTERNLTE-CRS-START

RateMatchPatternLTE-CRS ::=         SEQUENCE {
    carrierFreqDL                       INTEGER (0..16383),
    carrierBandwidthDL                  ENUMERATED {n6, n15, n25, n50, n75, n100, spare2, spare1},
    mbsfn-SubframeConfigList            EUTRA-MBSFN-SubframeConfigList                                                OPTIONAL,   -- Need M
    nrofCRS-Ports                       ENUMERATED {n1, n2, n4},
    v-Shift                             ENUMERATED {n0, n1, n2, n3, n4, n5}
}

-- TAG-RATEMATCHPATTERNLTE-CRS-STOP
-- ASN1STOP
```

***RateMatchPatternLTE-CRS* field descriptions**
carrierBandwidthDL BW of the LTE carrier in number of PRBs (see TS 38.214 [19], clause 5.1.4.2).
carrierFreqDL Center of the LTE carrier (see TS 38.214 [19], clause 5.1.4.2).
mbsfn-SubframeConfigList LTE MBSFN subframe configuration (see TS 38.214 [19], clause 5.1.4.2) FFS_ASN1: Import the LTE MBSFN-SubframeConfigList.
nrofCRS-Ports Number of LTE CRS antenna port to rate-match around (see TS 38.214 [19], clause 5.1.4.2).
v-Shift Shifting value v-shift in LTE to rate match around LTE CRS (see TS 38.214 [19], clause 5.1.4.2).

– *RejectWaitTime*

The IE is used to provide the value in seconds for timer T302.

RejectWaitTime information element

```
-- ASN1START
-- TAG-REJECT-WAIT-TIME-START

RejectWaitTime ::=                  INTEGER (1..16)

-- TAG-REJECT-WAIT-TIME-STOP
```

```
-- ASN1STOP
```

– *ReportConfigId*

The IE *ReportConfigId* is used to identify a measurement reporting configuration.

***ReportConfigId* information element**

```
-- ASN1START
-- TAG-REPORT-CONFIG-ID-START

ReportConfigId ::=                          INTEGER (1..maxReportConfigId)

-- TAG-REPORT-CONFIG-ID-STOP
-- ASN1STOP
```

– *ReportConfigInterRAT*

The IE *ReportConfigInterRAT* specifies criteria for triggering of an inter-RAT measurement reporting event. The inter-RAT measurement reporting events for E-UTRA are labelled B*N* with *N* equal to 1, 2 and so on.

Event B1: Neighbour becomes better than absolute threshold;

Event B2: PCell becomes worse than absolute threshold1 AND Neighbour becomes better than another absolute threshold2;

***ReportConfigInterRAT* information element**

```
-- ASN1START
-- TAG-REPORT-CONFIG-INTER-RAT-START

ReportConfigInterRAT ::=                    SEQUENCE {
    reportType                                  CHOICE {
        periodical                                  PeriodicalReportConfigInterRAT,
        eventTriggered                              EventTriggerConfigInterRAT,
        reportCGI                                   ReportCGI-EUTRA,
        ...
    }
}

ReportCGI-EUTRA ::=                         SEQUENCE {
    cellForWhichToReportCGI         EUTRA-PhysCellId,
    ...
}

EventTriggerConfigInterRAT ::=              SEQUENCE {
    eventId                                     CHOICE {
        eventB1                                     SEQUENCE {
            b1-ThresholdEUTRA                           MeasTriggerQuantityEUTRA,
            reportOnLeave                               BOOLEAN,
```

```
            hysteresis                                  Hysteresis,
            timeToTrigger                               TimeToTrigger,
            ...
        },
        eventB2                                     SEQUENCE {
            b2-Threshold1                               MeasTriggerQuantity,
            b2-Threshold2EUTRA                          MeasTriggerQuantityEUTRA,
            reportOnLeave                               BOOLEAN,
            hysteresis                                  Hysteresis,
            timeToTrigger                               TimeToTrigger,
            ...
        },
        ...
    },
    rsType                              NR-RS-Type,

    reportInterval                              ReportInterval,
    reportAmount                        ENUMERATED {r1, r2, r4, r8, r16, r32, r64, infinity},
    reportQuantity                      MeasReportQuantity,
    maxReportCells                              INTEGER (1..maxCellReport),
    ...

}

PeriodicalReportConfigInterRAT ::=              SEQUENCE {
    reportInterval                                  ReportInterval,
    reportAmount                                    ENUMERATED {r1, r2, r4, r8, r16, r32, r64, infinity},
    reportQuantity                                  MeasReportQuantity,
    maxReportCells                                  INTEGER (1..maxCellReport),
    ...
}

MeasTriggerQuantityEUTRA::=                         CHOICE {
    rsrp                                        RSRP-RangeEUTRA,
    rsrq                                        RSRQ-RangeEUTRA,
    sinr                                        SINR-RangeEUTRA
}

RSRP-RangeEUTRA ::=                 INTEGER (0..97)
RSRQ-RangeEUTRA ::=                 INTEGER (0..34)
SINR-RangeEUTRA ::=                 INTEGER (0..127)

-- TAG-REPORT-CONFIG-INTER-RAT-STOP
-- ASN1STOP
```

***EventTriggerConfigInterRAT* field descriptions**
b2-Threshold1 NR threshold to be used in inter RAT measurement report triggering condition for event b2.
bN-ThresholdEUTRA E-UTRA threshold value associated with the selected trigger quantity (RSRP, RSRQ, SINR) to be used in inter RAT measurement report triggering condition for event number bN.
eventId Choice of inter RAT event triggered reporting criteria.
maxReportCells Max number of non-serving cells to include in the measurement report.
reportAmount *Number* of measurement reports applicable for *eventTriggered* as well as for *periodical* report types
reportOnLeave Indicates whether or not the UE shall initiate the measurement reporting procedure when the leaving condition is met for a cell in cellsTriggeredList, as specified in 5.5.4.1.
reportQuantity The cell measurement quantities to be included in the measurement report.
timeToTrigger Time during which specific criteria for the event needs to be met in order to trigger a measurement report.

***PeriodicalReportConfigInterRAT* field descriptions**
maxReportCells Max number of non-serving cells to include in the measurement report.
reportAmount *Number* of measurement reports applicable for *eventTriggered* as well as for *periodical* report types
reportQuantityCell The cell measurement quantities to be included in the measurement report.

***MeasTriggerQuantityEUTRA* field descriptions**
EUTRA-RSRP Corresponds to *RSRP-Range* in TS 36.331 [10].
EUTRA-RSRQ Corresponds to *RSRQ-Range* in TS 36.331 [10].
EUTRA-SINR Corresponds to *RS-SINR-Range* in TS 36.331 [10].

– *ReportConfigNR*

The IE *ReportConfigNR* specifies criteria for triggering of an NR measurement reporting event. Measurement reporting events are based on cell measurement results, which can either be derived based on SS/PBCH block or CSI-RS. These events are labelled AN with N equal to 1, 2 and so on.

Event A1: Serving becomes better than absolute threshold;

Event A2: Serving becomes worse than absolute threshold;

Event A3: Neighbour becomes amount of offset better than PCell/PSCell;

Event A4: Neighbour becomes better than absolute threshold;

Event A5: PCell/PSCell becomes worse than absolute threshold1 AND Neighbour/SCell becomes better than another absolute threshold2.

Event A6: Neighbour becomes amount of offset better than SCell.

ReportConfigNR information element

```
-- ASN1START
-- TAG-REPORT-CONFIG-START

ReportConfigNR ::=                          SEQUENCE {
    reportType                                  CHOICE {
        periodical                                  PeriodicalReportConfig,
        eventTriggered                              EventTriggerConfig,
        ...,
        reportCGI                                   ReportCGI
    }
}

ReportCGI ::=                     SEQUENCE {
    cellForWhichToReportCGI          PhysCellId,
        ...
}

EventTriggerConfig::=                       SEQUENCE {
    eventId                                     CHOICE {
        eventA1                                     SEQUENCE {
            a1-Threshold                                MeasTriggerQuantity,
            reportOnLeave                               BOOLEAN,
            hysteresis                                  Hysteresis,
            timeToTrigger                               TimeToTrigger
        },
        eventA2                                     SEQUENCE {
            a2-Threshold                                MeasTriggerQuantity,
            reportOnLeave                               BOOLEAN,
            hysteresis                                  Hysteresis,
            timeToTrigger                               TimeToTrigger
        },
        eventA3                                     SEQUENCE {
            a3-Offset                                   MeasTriggerQuantityOffset,
            reportOnLeave                               BOOLEAN,
            hysteresis                                  Hysteresis,
            timeToTrigger                               TimeToTrigger,
            useWhiteCellList                            BOOLEAN
        },
        eventA4                                     SEQUENCE {
            a4-Threshold                                MeasTriggerQuantity,
            reportOnLeave                               BOOLEAN,
            hysteresis                                  Hysteresis,
            timeToTrigger                               TimeToTrigger,
```

```
            useWhiteCellList                            BOOLEAN
        },
        eventA5                                     SEQUENCE {
            a5-Threshold1                               MeasTriggerQuantity,
            a5-Threshold2                               MeasTriggerQuantity,
            reportOnLeave                               BOOLEAN,
            hysteresis                                  Hysteresis,
            timeToTrigger                               TimeToTrigger,
            useWhiteCellList                            BOOLEAN
        },
        eventA6                                     SEQUENCE {
            a6-Offset                                   MeasTriggerQuantityOffset,
            reportOnLeave                               BOOLEAN,
            hysteresis                                  Hysteresis,
            timeToTrigger                               TimeToTrigger,
            useWhiteCellList                            BOOLEAN
        },
        ...
    },

    rsType                                      NR-RS-Type,

    reportInterval                              ReportInterval,
    reportAmount                                ENUMERATED {r1, r2, r4, r8, r16, r32, r64, infinity},

    reportQuantityCell                          MeasReportQuantity,
    maxReportCells                              INTEGER (1..maxCellReport),

    reportQuantityRS-Indexes                     MeasReportQuantity                                 OPTIONAL,   -- Need R
    maxNrofRS-IndexesToReport                    INTEGER (1..maxNrofIndexesToReport)                OPTIONAL,   -- Need R
    includeBeamMeasurements                     BOOLEAN,
    reportAddNeighMeas                          ENUMERATED {setup}                                  OPTIONAL,   -- Need R
    ...
}

PeriodicalReportConfig ::=                  SEQUENCE {
    rsType                                      NR-RS-Type,

    reportInterval                              ReportInterval,
    reportAmount                                ENUMERATED {r1, r2, r4, r8, r16, r32, r64, infinity},

    reportQuantityCell                          MeasReportQuantity,
    maxReportCells                              INTEGER (1..maxCellReport),

    reportQuantityRS-Indexes                     MeasReportQuantity                                 OPTIONAL,   -- Need R
    maxNrofRS-IndexesToReport                    INTEGER (1..maxNrofIndexesToReport)                OPTIONAL,   -- Need R
    includeBeamMeasurements                     BOOLEAN,
    useWhiteCellList                            BOOLEAN,
    ...
}

NR-RS-Type ::=                              ENUMERATED {ssb, csi-rs}

MeasTriggerQuantity ::=                     CHOICE {
```

```
    rsrp                                        RSRP-Range,
    rsrq                                        RSRQ-Range,
    sinr                                        SINR-Range
}

MeasTriggerQuantityOffset ::=               CHOICE {
    rsrp                                        INTEGER (-30..30),
    rsrq                                        INTEGER (-30..30),
    sinr                                        INTEGER (-30..30)
}


MeasReportQuantity ::=                      SEQUENCE {
    rsrp                                        BOOLEAN,
    rsrq                                        BOOLEAN,
    sinr                                        BOOLEAN
}


-- TAG-REPORT-CONFIG-STOP
-- ASN1STOP
```

ReportConfigNR field descriptions
reportType Type of the configured measurement report. In EN-DC, network does not configure report of type *reportCGI* using SRB3.

***EventTriggerConfig* field descriptions**
a3-Offset/a6-Offset Offset value(s) to be used in NR measurement report triggering condition for event a3/a6. The actual value is field value * 0.5 dB.
aN-ThresholdM Threshold value associated to the selected trigger quantity (e.g. RSRP, RSRQ, SINR) per RS Type (e.g. SS/PBCH block, CSI-RS) to be used in NR measurement report triggering condition for event number aN. If multiple thresholds are defined for event number aN, the thresholds are differentiated by M. The network configures aN-Threshold1 only for events A1, A2, A4, A5 and a5-Threshold2 only for event A5.
eventId Choice of NR event triggered reporting criteria.
maxNrofRS-IndexesToReport Max number of RS indexes to include in the measurement report for A1-A6 events.
maxReportCells Max number of non-serving cells to include in the measurement report.
reportAddNeighMeas Indicates that the UE shall include the best neighbour cells per serving frequency.
reportAmount *Number* of measurement reports applicable for *eventTriggered* as well as for *periodical* report types
reportOnLeave Indicates whether or not the UE shall initiate the measurement reporting procedure when the leaving condition is met for a cell in cellsTriggeredList, as specified in 5.5.4.1.
reportQuantityCell The cell measurement quantities to be included in the measurement report.
reportQuantityRS-Indexes Indicates which measurement information per RS index the UE shall include in the measurement report.
timeToTrigger Time during which specific criteria for the event needs to be met in order to trigger a measurement report.
useWhiteCellList Indicates whether only the cells included in the white-list of the associated measObject are applicable as specified in 5.5.4.1.

***PeriodicalReportConfig* field descriptions**
maxNrofRS-IndexesToReport Max number of RS indexes to include in the measurement report.
maxReportCells Max number of non-serving cells to include in the measurement report.
reportAmount *Number* of measurement reports applicable for *eventTriggered* as well as for *periodical* report types
reportQuantityCell The cell measurement quantities to be included in the measurement report.
reportQuantityRS-Indexes Indicates which measurement information per RS index the UE shall include in the measurement report.
useWhiteCellList Indicates whether only the cells included in the white-list of the associated measObject are applicable as specified in 5.5.4.1.

– *ReportConfigToAddModList*

The IE *ReportConfigToAddModList* concerns a list of reporting configurations to add or modify.

ReportConfigToAddModList information element

```
-- ASN1START
-- TAG-REPORT-CONFIG-TO-ADD-MOD-LIST-START

ReportConfigToAddModList ::=        SEQUENCE (SIZE (1..maxReportConfigId)) OF ReportConfigToAddMod

ReportConfigToAddMod ::=            SEQUENCE {
    reportConfigId                      ReportConfigId,
    reportConfig                        CHOICE {
        reportConfigNR                      ReportConfigNR,
        ...,
        reportConfigInterRAT                ReportConfigInterRAT
    }
}

-- TAG-REPORT-CONFIG-TO-ADD-MOD-LIST-STOP
-- ASN1STOP
```

– *ReportInterval*

The *ReportInterval* indicates the interval between periodical reports. The *ReportInterval* is applicable if the UE performs periodical reporting (i.e. when *reportAmount* exceeds 1), for *triggerTypeevent* as well as for *triggerTypeperiodical*. Value ms120 corresponds to 120 ms, ms240 corresponds to 240 ms and so on, while value min1 corresponds to 1 min, min6 corresponds to 6 min and so on.

***ReportInterval* information element**

```
-- ASN1START
-- TAG-REPORTINTERVAL-START

ReportInterval ::=                  ENUMERATED {ms120, ms240, ms480, ms640, ms1024, ms2048, ms5120, ms10240, ms20480, ms40960,
                                                 min1,min6, min12, min30 }

-- TAG-REPORTINTERVAL-STOP
-- ASN1STOP
```

– *ReselectionThreshold*

ReselectionThreshold is used to indicate an Rx level threshold for cell reselection. Actual value of threshold = field value * 2 [dB].

***ReselectionThreshold* information element**

```
-- ASN1START
-- TAG-RESELECTION-THRESHOLD-START
```

```
ReselectionThreshold ::=                INTEGER (0..31)

-- TAG-RESELECTION-THRESHOLD-STOP
-- ASN1STOP
```

– *ReselectionThresholdQ*

The IE *ReselectionThresholdQ* is used to indicate a quality level threshold for cell reselection. Actual value of threshold = field value [dB].

***ReselectionThresholdQ* information element**

```
-- ASN1START
-- TAG-RESELECTION-THRESHOLDQ-START

ReselectionThresholdQ ::=           INTEGER (0..31)

-- TAG-RESELECTION-THRESHOLDQ-STOP
-- ASN1STOP
```

– *ResumeCause*

The IE *ResumeCause* is used to indicate the resume cause in *RRCResumeRequest* and *RRCResumeRequest1*.

***ResumeCause* information element**

```
-- ASN1START
-- TAG-RESUME-CAUSE-START

ResumeCause ::=             ENUMERATED {emergency, highPriorityAccess, mt-Access, mo-Signalling,
                                        mo-Data, mo-VoiceCall, mo-VideoCall, mo-SMS, rna-Update, mps-PriorityAccess, mcs-PriorityAccess,
spare1, spare2, spare3, spare4, spare5 }

-- TAG-RESUME-CAUSE-STOP
-- ASN1STOP
```

– *RLC-BearerConfig*

The IE *RLC-BearerConfig* is used to configure an RLC entity, a corresponding logical channel in MAC and the linking to a PDCP entity (served radio bearer).

***RLC-BearerConfig* information element**

```
-- ASN1START
-- TAG-RLC-BEARERCONFIG-START

RLC-BearerConfig ::=                    SEQUENCE {
    logicalChannelIdentity                  LogicalChannelIdentity,
```

```
    servedRadioBearer                           CHOICE {
        srb-Identity                                SRB-Identity,
        drb-Identity                                DRB-Identity
    }                                                                                       OPTIONAL,   -- Cond LCH-SetupOnly
    reestablishRLC                              ENUMERATED {true}                           OPTIONAL,   -- Need N
    rlc-Config                                  RLC-Config                                  OPTIONAL,   -- Cond LCH-Setup
    mac-LogicalChannelConfig                    LogicalChannelConfig                        OPTIONAL,   -- Cond LCH-Setup
    ...
}

-- TAG-RLC-BEARERCONFIG-STOP
-- ASN1STOP
```

***RLC-BearerConfig* field descriptions**
logicalChannelIdentity ID used commonly for the MAC logical channel and for the RLC bearer.
reestablishRLC Indicates that RLC should be re-established. Network sets this to *TRUE* whenever the security key used for the radio bearer associated with this RLC entity changes. For SRB2 and DRBs, it is also set to *TRUE* during the resumption of the RRC connection or the first reconfiguration after reestablishment.
rlc-Config Determines the RLC mode (UM, AM) and provides corresponding parameters. RLC mode reconfiguration can only be performed by DRB release/addition or full configuration
servedRadioBearer Associates the RLC Bearer with an SRB or a DRB. The UE shall deliver DL RLC SDUs received via the RLC entity of this RLC bearer to the PDCP entity of the servedRadioBearer. Furthermore, the UE shall advertise and deliver uplink PDCP PDUs of the uplink PDCP entity of the servedRadioBearer to the uplink RLC entity of this RLC bearer unless the uplink scheduling restrictions ('moreThanOneRLC' in PDCP-Config and the restrictions in LogicalChannelConfig) forbid it to do so.

Conditional Presence	Explanation
LCH-Setup	This field is mandatory present, Need M, upon creation of a new logical channel. It is optionally present otherwise.
LCH-SetupOnly	This field is mandatory present, Need M, upon creation of a new logical channel. It is absent otherwise.

– *RLC-Config*

The IE *RLC-Config* is used to specify the RLC configuration of SRBs and DRBs.

***RLC-Config* information element**

```
-- ASN1START
-- TAG-RLC-CONFIG-START

RLC-Config ::=                          CHOICE {
    am                                      SEQUENCE {
        ul-AM-RLC                               UL-AM-RLC,
        dl-AM-RLC                               DL-AM-RLC
    },
    um-Bi-Directional                       SEQUENCE {
        ul-UM-RLC                               UL-UM-RLC,
        dl-UM-RLC                               DL-UM-RLC
```

```
    },
    um-Uni-Directional-UL           SEQUENCE {
        ul-UM-RLC                       UL-UM-RLC
    },
    um-Uni-Directional-DL           SEQUENCE {
        dl-UM-RLC                       DL-UM-RLC
    },
    ...
}

UL-AM-RLC ::=                   SEQUENCE {
    sn-FieldLength                  SN-FieldLengthAM                                    OPTIONAL,   -- Cond Reestab
    t-PollRetransmit                T-PollRetransmit,
    pollPDU                         PollPDU,
    pollByte                        PollByte,
    maxRetxThreshold                ENUMERATED { t1, t2, t3, t4, t6, t8, t16, t32 }
}

DL-AM-RLC ::=                   SEQUENCE {
    sn-FieldLength                  SN-FieldLengthAM                                    OPTIONAL,   -- Cond Reestab
    t-Reassembly                    T-Reassembly,
    t-StatusProhibit                T-StatusProhibit
}

UL-UM-RLC ::=                   SEQUENCE {
    sn-FieldLength                  SN-FieldLengthUM                                    OPTIONAL    -- Cond Reestab
}

DL-UM-RLC ::=                   SEQUENCE {
    sn-FieldLength                  SN-FieldLengthUM                                    OPTIONAL,   -- Cond Reestab
    t-Reassembly                    T-Reassembly
}

T-PollRetransmit ::=            ENUMERATED {
                                    ms5, ms10, ms15, ms20, ms25, ms30, ms35,
                                    ms40, ms45, ms50, ms55, ms60, ms65, ms70,
                                    ms75, ms80, ms85, ms90, ms95, ms100, ms105,
                                    ms110, ms115, ms120, ms125, ms130, ms135,
                                    ms140, ms145, ms150, ms155, ms160, ms165,
                                    ms170, ms175, ms180, ms185, ms190, ms195,
                                    ms200, ms205, ms210, ms215, ms220, ms225,
                                    ms230, ms235, ms240, ms245, ms250, ms300,
                                    ms350, ms400, ms450, ms500, ms800, ms1000,
                                    ms2000, ms4000, spare5, spare4, spare3,
                                    spare2, spare1}


PollPDU ::=                     ENUMERATED {
                                    p4, p8, p16, p32, p64, p128, p256, p512, p1024, p2048, p4096, p6144, p8192, p12288, p16384, p20480,
                                    p24576, p28672, p32768, p40960, p49152, p57344, p65536, infinity, spare8, spare7, spare6, spare5, spare4,
                                    spare3, spare2, spare1}

PollByte ::=                    ENUMERATED {
                                    kB1, kB2, kB5, kB8, kB10, kB15, kB25, kB50, kB75,
```

```
                                    kB100, kB125, kB250, kB375, kB500, kB750, kB1000,
                                    kB1250, kB1500, kB2000, kB3000, kB4000, kB4500,
                                    kB5000, kB5500, kB6000, kB6500, kB7000, kB7500,
                                    mB8, mB9, mB10, mB11, mB12, mB13, mB14, mB15,
                                    mB16, mB17, mB18, mB20, mB25, mB30, mB40, infinity,
                                    spare20, spare19, spare18, spare17, spare16,
                                    spare15, spare14, spare13, spare12, spare11,
                                    spare10, spare9, spare8, spare7, spare6, spare5,
                                    spare4, spare3, spare2, spare1}

T-Reassembly ::=                ENUMERATED {
                                    ms0, ms5, ms10, ms15, ms20, ms25, ms30, ms35,
                                    ms40, ms45, ms50, ms55, ms60, ms65, ms70,
                                    ms75, ms80, ms85, ms90, ms95, ms100, ms110,
                                    ms120, ms130, ms140, ms150, ms160, ms170,
                                    ms180, ms190, ms200, spare1}

T-StatusProhibit ::=            ENUMERATED {
                                    ms0, ms5, ms10, ms15, ms20, ms25, ms30, ms35,
                                    ms40, ms45, ms50, ms55, ms60, ms65, ms70,
                                    ms75, ms80, ms85, ms90, ms95, ms100, ms105,
                                    ms110, ms115, ms120, ms125, ms130, ms135,
                                    ms140, ms145, ms150, ms155, ms160, ms165,
                                    ms170, ms175, ms180, ms185, ms190, ms195,
                                    ms200, ms205, ms210, ms215, ms220, ms225,
                                    ms230, ms235, ms240, ms245, ms250, ms300,
                                    ms350, ms400, ms450, ms500, ms800, ms1000,
                                    ms1200, ms1600, ms2000, ms2400, spare2, spare1}

SN-FieldLengthUM ::=            ENUMERATED {size6, size12}
SN-FieldLengthAM ::=            ENUMERATED {size12, size18}

-- TAG-RLC-CONFIG-STOP
-- ASN1STOP
```

***RLC-Config* field descriptions**
maxRetxThreshold Parameter for RLC AM in TS 38.322 [4]. Value t1 corresponds to 1 retransmission, t2 to 2 retransmissions and so on.
pollByte Parameter for RLC AM in TS 38.322 [4]. Value kB25 corresponds to 25 kBytes, kB50 to 50 kBytes and so on. infinity corresponds to an infinite amount of kBytes.
pollPDU Parameter for RLC AM in TS 38.322 [4]. Value p4 corresponds to 4 PDUs, p8 to 8 PDUs and so on. infinity corresponds to an infinite number of PDUs.
sn-FieldLength Indicates the RLC SN field size, see TS 38.322 [4], in bits. Value size6 means 6 bits, size12 means 12 bits, size18 means 18 bits. The value of sn-FieldLength for a DRB shall be changed only using reconfiguration with sync. The network configures only *size12* in *SN-FieldLengthAM* for SRB.
t-PollRetransmit Timer for RLC AM in TS 38.322 [4], in milliseconds. Value ms5 means 5ms, ms10 means 10ms and so on.
t-Reassembly Timer for reassembly in TS 38.322 [4], in milliseconds. Value ms0 means 0ms, ms5 means 5ms and so on.
t-StatusProhibit Timer for status reporting in TS 38.322 [4], in milliseconds. Value ms0 means 0ms, ms5 means 5ms and so on.

Conditional Presence	Explanation
Reestab	The field is mandatory present at bearer setup. It is optionally present, need M, at RLC re-establishment. Otherwise it is not present.

– *RLF-TimersAndConstants*

Editor's Note: FFS / TODO: Insert the RLF timers and related functionality. Check what is needed for EN-DC.

The *RLF-TimersAndConstants* IE is used to configure UE specific timers and constants.

RLF-TimersAndConstants information element

```
-- ASN1START
-- TAG-RLF-TIMERS-AND-CONSTANTS-START

RLF-TimersAndConstants ::=          SEQUENCE {
    t310                                ENUMERATED {ms0, ms50, ms100, ms200, ms500, ms1000, ms2000, ms4000, ms6000},
    n310                                ENUMERATED {n1, n2, n3, n4, n6, n8, n10, n20},
    n311                                ENUMERATED {n1, n2, n3, n4, n5, n6, n8, n10},
    ...,
    [[
    t311-v1530                          ENUMERATED {ms1000, ms3000, ms5000, ms10000, ms15000, ms20000, ms30000}
    ]]
}

-- TAG-RLF-TIMERS-AND-CONSTANTS-STOP
-- ASN1STOP
```

***RLF-TimersAndConstants* field descriptions**
n3xy Constants are described in clause 7.3. n1 corresponds with 1, n2 corresponds to 2 and so on.
t3xy Timers are described in clause 7.1. Value ms0 corresponds with 0 ms, ms50 corresponds to 50 ms and so on.

– *RNTI-Value*

The IE *RNTI-Value* represents a Radio Network Temporary Identity.

***RNTI-Value* information element**

```
-- ASN1START
-- TAG-RNTI-VALUE-START

RNTI-Value ::=                      INTEGER (0..65535)

-- TAG-RNTI-VALUE-STOP
-- ASN1STOP
```

– *RSRP-Range*

The IE *RSRP-Range* specifies the value range used in RSRP measurements and thresholds. Integer value for RSRP measurements according to mapping table in TS 38.133 [14].

***RSRP-Range* information element**

```
-- ASN1START
-- TAG-RSRP-RANGE-START

RSRP-Range ::=                      INTEGER(0..127)

-- TAG-RSRP-RANGE-STOP
-- ASN1STOP
```

– *RSRQ-Range*

The IE *RSRQ-Range* specifies the value range used in RSRQ measurements and thresholds. Integer value for RSRQ measurements is according to mapping table in TS 38.133 [14].

***RSRQ-Range* information element**

```
-- ASN1START
-- TAG-RSRQ-RANGE-START

RSRQ-Range ::=                      INTEGER(0..127)
```

```
-- TAG-RSRQ-RANGE-STOP
-- ASN1STOP
```

– *SCellIndex*

The IE *SCellIndex* concerns a short identity, used to identify an SCell or PSCell. The value range is shared across the Cell Groups.

***SCellIndex* information element**

```
-- ASN1START
-- TAG-SCELL-INDEX-START

SCellIndex ::=                      INTEGER (1..31)

-- TAG-SCELL-INDEX-STOP
-- ASN1STOP
```

– *SchedulingRequestConfig*

The IE *SchedulingRequestConfig* is used to configure the parameters, for the dedicated scheduling request (SR) resources.

***SchedulingRequestConfig* information element**

```
-- ASN1START
-- TAG-SCHEDULING-REQUEST-CONFIG-START

SchedulingRequestConfig ::=         SEQUENCE {
    schedulingRequestToAddModList       SEQUENCE (SIZE (1..maxNrofSR-ConfigPerCellGroup)) OF SchedulingRequestToAddMod   OPTIONAL, -- Need N
    schedulingRequestToReleaseList      SEQUENCE (SIZE (1..maxNrofSR-ConfigPerCellGroup)) OF SchedulingRequestId         OPTIONAL  -- Need N
}

SchedulingRequestToAddMod ::=       SEQUENCE {
    schedulingRequestId     SchedulingRequestId,

    sr-ProhibitTimer                    ENUMERATED {ms1, ms2, ms4, ms8, ms16, ms32, ms64, ms128}                            OPTIONAL, -- Need S
    sr-TransMax                         ENUMERATED { n4, n8, n16, n32, n64, spare3, spare2, spare1}
}


-- TAG-SCHEDULING-REQUEST-CONFIG-STOP
-- ASN1STOP
```

***SchedulingRequestConfig* field descriptions**
schedulingRequestToAddModList List of Scheduling Request configurations to add or modify.
schedulingRequestToReleaseList List of Scheduling Request configurations to release

***SchedulingRequestToAddMod* field descriptions**
schedulingRequestId Used to modify a SR configuration and to indicate, in LogicalChannelConfig, the SR configuration to which a logical channel is mapped and to indicate, in SchedulingRequestresourceConfig, the SR configuration for which a scheduling request resource is used.
sr-ProhibitTimer Timer for SR transmission on PUCCH in TS 38.321 [3]. Value in ms. ms1 corresponds to 1ms, ms2 corresponds to 2ms, and so on. When the field is absent, the UE applies the value 0.
sr-TransMax Maximum number of SR transmissions as described in TS 38.321 [3]. n4 corresponds to 4, n8 corresponds to 8, and so on.

– *SchedulingRequestId*

The IE *SchedulingRequestId* is used to identify a Scheduling Request instance in the MAC layer.

SchedulingRequestId information element

```
-- ASN1START
-- TAG-SCHEDULINGREQUESTID-START

SchedulingRequestId ::=             INTEGER (0..7)

-- TAG-SCHEDULINGREQUESTID-STOP
-- ASN1STOP
```

– *SchedulingRequestResourceConfig*

The IE *SchedulingRequestResourceConfig* determines physical layer resources on PUCCH where the UE may send the dedicated scheduling request (D-SR) (see TS 38.213 [13], clause 9.2.4).

SchedulingRequestResourceConfig information element

```
-- ASN1START
-- TAG-SCHEDULING-REQUEST-RESOURCE-CONFIG-START

SchedulingRequestResourceConfig ::=     SEQUENCE {
    schedulingRequestResourceId             SchedulingRequestResourceId,
    schedulingRequestID                     SchedulingRequestId,
    periodicityAndOffset                    CHOICE {
        sym2                                    NULL,
        sym6or7                                 NULL,
```

```
        sl1                                     NULL,                       -- Recurs in every slot
        sl2                                     INTEGER (0..1),
        sl4                                     INTEGER (0..3),
        sl5                                     INTEGER (0..4),
        sl8                                     INTEGER (0..7),
        sl10                                    INTEGER (0..9),
        sl16                                    INTEGER (0..15),
        sl20                                    INTEGER (0..19),
        sl40                                    INTEGER (0..39),
        sl80                                    INTEGER (0..79),
        sl160                                   INTEGER (0..159),
        sl320                                   INTEGER (0..319),
        sl640                                   INTEGER (0..639)
    }                                                                                                   OPTIONAL,   -- Need M
    resource                                PUCCH-ResourceId                                            OPTIONAL    -- Need M
}

-- TAG-SCHEDULING-REQUEST-RESOURCE-CONFIG-STOP
-- ASN1STOP
```

SchedulingRequestResourceConfig field descriptions
periodicityAndOffset SR periodicity and offset in number of symbols or slots (see TS 38.213 [13], clause 9.2.4) The following periodicities may be configured depending on the chosen subcarrier spacing: SCS = 15 kHz: 2sym, 7sym, 1sl, 2sl, 4sl, 5sl, 8sl, 10sl, 16sl, 20sl, 40sl, 80sl SCS = 30 kHz: 2sym, 7sym, 1sl, 2sl, 4sl, 8sl, 10sl, 16sl, 20sl, 40sl, 80sl, 160sl SCS = 60 kHz: 2sym, 7sym/6sym, 1sl, 2sl, 4sl, 8sl, 16sl, 20sl, 40sl, 80sl, 160sl, 320sl SCS = 120 kHz: 2sym, 7sym, 1sl, 2sl, 4sl, 8sl, 16sl, 40sl, 80sl, 160sl, 320sl, 640sl sym6or7 corresponds to 6 symbols if extended cyclic prefix and a SCS of 60 kHz are configured, otherwise it corresponds to 7 symbols. For periodicities 2sym, 7sym and sl1 the UE assumes an offset of 0 slots.
resource ID of the PUCCH resource in which the UE shall send the scheduling request. The actual PUCCH-Resource is configured in PUCCH-Config of the same UL BWP and serving cell as this SchedulingRequestResourceConfig. The network configures a PUCCH-Resource of PUCCH-format0 or PUCCH-format1 (other formats not supported) (see TS 38.213 [13], clause 9.2.4)
schedulingRequestID The ID of the SchedulingRequestConfig that uses this scheduling request resource.

– *SchedulingRequestResourceId*

The IE *SchedulingRequestResourceId* is used to identify scheduling request resources on PUCCH.

SchedulingRequestResourceId information element

```
-- ASN1START
-- TAG-SCHEDULINGREQUESTRESOURCEID-START

SchedulingRequestResourceId ::=     INTEGER (1..maxNrofSR-Resources)
```

```
-- TAG-SCHEDULINGREQUESTRESOURCEID-STOP
-- ASN1STOP
```

– *ScramblingId*

The IE *ScramblingID* is used for scrambling channels and reference signals.

```
-- ASN1START
-- TAG-SCRAMBLING-ID-START

ScramblingId ::=                    INTEGER(0..1023)

-- TAG-SCRAMBLING-ID-STOP
-- ASN1STOP
```

– *SCS-SpecificCarrier*

The IE *SCS-SpecificCarrier* provides parameters determining the location and width of the actual carrier. It is defined specifically for a numerology (subcarrier spacing (SCS)) and in relation (frequency offset) to Point A.

```
-- ASN1START
-- TAG-SCS-SPECIFIC-CARRIER-START

SCS-SpecificCarrier ::=             SEQUENCE {
    offsetToCarrier                     INTEGER (0..2199),
    subcarrierSpacing                   SubcarrierSpacing,
    carrierBandwidth                    INTEGER (1..maxNrofPhysicalResourceBlocks),
    ...,
    [[
    txDirectCurrentLocation-v1530   INTEGER (0..4095)                                       OPTIONAL            -- Need S
    ]]
}

-- TAG-SCS-SPECIFIC-CARRIER-STOP
-- ASN1STOP
```

***SCS-SpecificCarrier* field descriptions**
carrierBandwidth Width of this carrier in number of PRBs (using the subcarrierSpacing defined for this carrier) (see TS 38.211 [16], clause 4.4.2).
offsetToCarrier Offset in frequency domain between Point A (lowest subcarrier of common RB 0) and the lowest usable subcarrier on this carrier in number of PRBs (using the subcarrierSpacing defined for this carrier). The maximum value corresponds to 275*8-1. See TS 38.211 [16], clause 4.4.2.
txDirectCurrentLocation Indicates the downlink Tx Direct Current location for the carrier. A value in the range 0..3299 indicates the subcarrier index within the carrier. The values in the value range 3301..4095 are reserved and ignored by the UE. If this field is absent, the UE assumes the default value of 3300 (i.e. "Outside the carrier"). (see TS 38.211 [16], clause 4.4.2).
subcarrierSpacing Subcarrier spacing of this carrier. It is used to convert the offsetToCarrier into an actual frequency. Only the values 15 or 30 kHz (<6GHz), 60 or 120 kHz (>6GHz) are applicable. The network configures all SCSs of configured BWPs configured in this serving cell.

Conditional Presence	Explanation
OnePerServCell	This field must be present for exactly one SCS-SpecificCarrier of a serving cell.

– *SDAP-Config*

The IE *SDAP-Config* is used to set the configurable SDAP parameters for a data radio bearer. All configured instances of SDAP-Config with the same value of pdu-Session correspond to the same SDAP entity as specified in TS 37.324 [24].

SDAP-Config information element

```
-- ASN1START
-- TAG-SDAP-CONFIG-START

SDAP-Config ::=                     SEQUENCE {
    pdu-Session                         PDU-SessionID,
    sdap-HeaderDL                       ENUMERATED {present, absent},
    sdap-HeaderUL                       ENUMERATED {present, absent},
    defaultDRB                          BOOLEAN,
    mappedQoS-FlowsToAdd                SEQUENCE (SIZE (1..maxNrofQFIs)) OF QFI                                     OPTIONAL, -- Need N
    mappedQoS-FlowsToRelease            SEQUENCE (SIZE (1..maxNrofQFIs)) OF QFI                                     OPTIONAL, -- Need N
    ...
}

QFI ::=                             INTEGER (0..maxQFI)

PDU-SessionID ::=                   INTEGER (0..255)

-- TAG-SDAP-CONFIG-STOP
-- ASN1STOP
```

SDAP-Config field descriptions
defaultDRB Indicates whether or not this is the default DRB for this PDU session. Among all configured instances of *SDAP-Config* with the same value of *pdu-Session*, this field shall be set to TRUE in at most one instance of SDAP-Config and to FALSE in all other instances.
mappedQoS-FlowsToAdd Indicates the list of QFIs of UL QoS flows of the PDU session to be additionally mapped to this DRB. A QFI value can be included at most once in all configured instances of *SDAP-Config* with the same value of *pdu-Session*. For QoS flow remapping, the QFI value of the remapped QoS flow is only included in *mappedQoS-FlowsToAdd* in *sdap-Config* corresponding to the new DRB and not included in *mappedQoS-FlowsToRelease* in *sdap-Config* corresponding to the old DRB.
mappedQoS-FlowsToRelease Indicates the list of QFIs of QoS flows of the PDU session to be released from existing QoS flow to DRB mapping of this DRB.
pdu-Session Identity of the PDU session whose QoS flows are mapped to the DRB
sdap-HeaderUL Indicates whether or not a SDAP header is present for UL data on this DRB. The field cannot be changed after a DRB is established. The network sets this field to *present* if the field *defaultDRB* is set to *TRUE*.
sdap-HeaderDL Indicates whether or not a SDAP header is present for DL data on this DRB. The field cannot be changed after a DRB is established.

– *SearchSpace*

The IE *SearchSpace* defines how/where to search for PDCCH candidates. Each search space is associated with one *ControlResourceSet*.

SearchSpace information element

```
-- ASN1START
-- TAG-SEARCHSPACE-START

SearchSpace ::=                         SEQUENCE {
    searchSpaceId                           SearchSpaceId,
    controlResourceSetId                    ControlResourceSetId                                            OPTIONAL,   -- Cond SetupOnly
    monitoringSlotPeriodicityAndOffset      CHOICE {
        sl1                                     NULL,
        sl2                                     INTEGER (0..1),
        sl4                                     INTEGER (0..3),
        sl5                                     INTEGER (0..4),
        sl8                                     INTEGER (0..7),
        sl10                                    INTEGER (0..9),
        sl16                                    INTEGER (0..15),
        sl20                                    INTEGER (0..19),
        sl40                                    INTEGER (0..39),
        sl80                                    INTEGER (0..79),
        sl160                                   INTEGER (0..159),
        sl320                                   INTEGER (0..319),
        sl640                                   INTEGER (0..639),
        sl1280                                  INTEGER (0..1279),
        sl2560                                  INTEGER (0..2559)
    }                                                                                                       OPTIONAL,   -- Cond Setup
    duration                                INTEGER (2..2559)                                               OPTIONAL,   -- Need R
    monitoringSymbolsWithinSlot             BIT STRING (SIZE (14))                                          OPTIONAL,   -- Cond Setup
```

```
    nrofCandidates                          SEQUENCE {
        aggregationLevel1                       ENUMERATED {n0, n1, n2, n3, n4, n5, n6, n8},
        aggregationLevel2                       ENUMERATED {n0, n1, n2, n3, n4, n5, n6, n8},
        aggregationLevel4                       ENUMERATED {n0, n1, n2, n3, n4, n5, n6, n8},
        aggregationLevel8                       ENUMERATED {n0, n1, n2, n3, n4, n5, n6, n8},
        aggregationLevel16                      ENUMERATED {n0, n1, n2, n3, n4, n5, n6, n8}
    }                                                                                                   OPTIONAL,   -- Cond Setup
    searchSpaceType                         CHOICE {
        common                                  SEQUENCE {
            dci-Format0-0-AndFormat1-0              SEQUENCE {
                ...
            }                                                                                           OPTIONAL,   -- Need R
            dci-Format2-0                           SEQUENCE {
                nrofCandidates-SFI                      SEQUENCE {
                    aggregationLevel1                       ENUMERATED {n1, n2}                         OPTIONAL,   -- Need R
                    aggregationLevel2                       ENUMERATED {n1, n2}                         OPTIONAL,   -- Need R
                    aggregationLevel4                       ENUMERATED {n1, n2}                         OPTIONAL,   -- Need R
                    aggregationLevel8                       ENUMERATED {n1, n2}                         OPTIONAL,   -- Need R
                    aggregationLevel16                      ENUMERATED {n1, n2}                         OPTIONAL    -- Need R
                },
                ...
            }                                                                                           OPTIONAL,   -- Need R
            dci-Format2-1                           SEQUENCE {
                ...
            }                                                                                           OPTIONAL,   -- Need R
            dci-Format2-2                           SEQUENCE {
                ...
            }                                                                                           OPTIONAL,   -- Need R
            dci-Format2-3                           SEQUENCE {
                dummy1                      ENUMERATED {sl1, sl2, sl4, sl5, sl8, sl10, sl16, sl20}      OPTIONAL,   -- Cond Setup
                dummy2                      ENUMERATED {n1, n2},
                ...
            }                                                                                           OPTIONAL    -- Need R
        },
        ue-Specific                             SEQUENCE {
            dci-Formats                             ENUMERATED {formats0-0-And-1-0, formats0-1-And-1-1},
            ...
        }
    }                                                                                                   OPTIONAL    -- Cond Setup
}

-- TAG-SEARCHSPACE-STOP
-- ASN1STOP
```

SearchSpace field descriptions
common Configures this search space as common search space (CSS) and DCI formats to monitor.
controlResourceSetId The CORESET applicable for this SearchSpace. Value 0 identifies the common CORESET#0 configured in MIB and in ServingCellConfigCommon. Values 1..maxNrofControlResourceSets-1 identify CORESETs configured in System Information or by dedicated signalling. The CORESETs with non-zero controResourceSetId locate in the same BWP as this SearchSpace.
dummy1, dummy2 This field is not used in the specification. If received it shall be ignored by the UE.
dci-Format0-0-AndFormat1-0 If configured, the UE monitors the DCI formats 0_0 and 1_0 according to TS 38.213 [13], clause 10.1.
dci-Format2-0 If configured, UE monitors the DCI format 2_0 according to TS 38.213 [13], clause 10.1, 11.1.1.
dci-Format2-1 If configured, UE monitors the DCI format 2_1 according to TS 38.213 [13], clause 10.1, 11.2.
dci-Format2-2 If configured, UE monitors the DCI format 2_2 according to TS 38.213 [13], clause 10.1, 11.3.
dci-Format2-3 If configured, UE monitors the DCI format 2_3 according to TS 38.213 [13], clause 10.1, 11.4
dci-Formats Indicates whether the UE monitors in this USS for DCI formats 0-0 and 1-0 or for formats 0-1 and 1-1.
duration Number of consecutive slots that a SearchSpace lasts in every occasion, i.e., upon every period as given in the periodicityAndOffset. If the field is absent, the UE applies the value 1 slot, except for DCI format 2_0. The UE ignores this field for DCI format 2_0. The maximum valid duration is periodicity-1 (periodicity as given in the monitoringSlotPeriodicityAndOffset).
monitoringSlotPeriodicityAndOffset Slots for PDCCH Monitoring configured as periodicity and offset. If UE is configured to monitor DCI format 2_1, only the values 'sl1', 'sl2' or 'sl4' are applicable. If UE is configured to monitor DCI format 2_0, only the values ′sl1′, ′sl2′, ′sl4′, ′sl5′, ′sl8′, ′sl10′, ′sl16′, and ′sl20′ are applicable (see TS 38.213 [13], clause 10).
monitoringSymbolsWithinSlot The first symbol(s) for PDCCH monitoring in the slots configured for PDCCH monitoring (see *monitoringSlotPeriodicityAndOffset* and *duration*). The most significant (left) bit represents the first OFDM in a slot, and the second most significant (left) bit represents the second OFDM symbol in a slot and so on. The bit(s) set to one identify the first OFDM symbol(s) of the control resource set within a slot. If the cyclic prefix of the BWP is set to extended CP, the last two bits within the bit string shall be ignored by the UE . For DCI format 2_0, the first one symbol applies if the *duration* of CORESET (in the IE *ControlResourceSet*) identified by *controlResourceSetId* indicates 3 symbols, the first two symbols apply if the *duration* of CORESET identified by *controlResourceSetId* indicates 2 symbols, and the first three symbols apply if the *duration* of CORESET identified by *controlResourceSetId* indicates 1 symbol. See TS 38.213 [13], clause 10.
nrofCandidates-SFI The number of PDCCH candidates specifically for format 2-0 for the configured aggregation level. If an aggregation level is absent, the UE does not search for any candidates with that aggregation level. The network configures only one aggregationLevel and the corresponding number of candidates (see TS 38.213 [13], clause 11.1.1).
nrofCandidates Number of PDCCH candidates per aggregation level. The number of candidates and aggregation levels configured here applies to all formats unless a particular value is specified or a format-specific value is provided (see inside searchSpaceType). (see TS 38.213 [13], clause 10)
searchSpaceId Identity of the search space. SearchSpaceId = 0 identifies the searchSpaceZero configured via PBCH (MIB) or ServingCellConfigCommon and may hence not be used in the SearchSpace IE. The searchSpaceId is unique among the BWPs of a Serving Cell.
searchSpaceType Indicates whether this is a common search space (present) or a UE specific search space as well as DCI formats to monitor for.

ue-Specific Configures this search space as UE specific search space (USS). The UE monitors the DCI format with CRC scrambled by C-RNTI, CS-RNTI (if configured), and SP-CSI-RNTI (if configured)

Conditional Presence	Explanation
Setup	This field is mandatory present upon creation of a new SearchSpace. It is optionally present, Need M, otherwise.
SetupOnly	This field is mandatory present upon creation of a new SearchSpace. It is absent otherwise.

– *SearchSpaceId*

The IE *SearchSpaceId* is used to identify Search Spaces. The ID space is used across the BWPs of a Serving Cell. The search space with the *SearchSpaceId* = 0 identifies the search space configured via PBCH (MIB) and in ServingCellConfigCommon (searchSpaceZero). The number of Search Spaces per BWP is limited to 10 including the common and UE specific Search Spaces.

SearchSpaceId information element

```
-- ASN1START
-- TAG-SEARCHSPACEID-START

SearchSpaceId ::=                   INTEGER (0..maxNrofSearchSpaces-1)

-- TAG-SEARCHSPACEID-STOP
-- ASN1STOP
```

– *SearchSpaceZero*

The IE *SearchSpaceZero* is used to configure SearchSpace#0 of the initial BWP (see TS 38.213 [13], clause 13).

SearchSpaceZero information element

```
-- ASN1START
-- TAG-SEARCHSPACEZERO-START

SearchSpaceZero ::=                 INTEGER (0..15)

-- TAG-SEARCHSPACEZERO-STOP
-- ASN1STOP
```

– *SecurityAlgorithmConfig*

The IE *SecurityAlgorithmConfig* is used to configure AS integrity protection algorithm and AS ciphering algorithm for SRBs and DRBs.

SecurityAlgorithmConfig information element

```
-- ASN1START
-- TAG-SECURITY-ALGORITHM-CONFIG-START

SecurityAlgorithmConfig ::=         SEQUENCE {
    cipheringAlgorithm                  CipheringAlgorithm,
    integrityProtAlgorithm              IntegrityProtAlgorithm          OPTIONAL,   -- Need R
    ...
}

IntegrityProtAlgorithm ::=          ENUMERATED {
                                        nia0, nia1, nia2, nia3, spare4, spare3,
                                        spare2, spare1, ...}

CipheringAlgorithm ::=              ENUMERATED {
                                        nea0, nea1, nea2, nea3, spare4, spare3,
                                        spare2, spare1, ...}

-- TAG-SECURITY-ALGORITHM-CONFIG-STOP
-- ASN1STOP
```

***SecurityAlgorithmConfig* field descriptions**
cipheringAlgorithm Indicates the ciphering algorithm to be used for SRBs and DRBs, as specified in TS 33.501 [11]. The algorithms nea0-nea3 are identical to the LTE algorithms eea0-3. The algorithms configured for bearers using master key shall be the same as for all bearers using master key and the algorithms configured for bearers using secondary key shall be the same as for all bearers using secondary key. If EN-DC is not configured, the algorithm shall be the same for all bearers.
integrityProtAlgorithm If EN-DC is not configured, this IE indicates the integrity protection algorithm to be used for SRBs and DRBs, as specified in TS 33.501 [11]. The network does not configure *nia0* for SRBs except for unauthenticated emergency sessions for unauthenticated UEs in LSM (limited service mode) and DRBs. If EN-DC is not configured, this field is mandatory present, and the algorithm shall be the same for all bearers. For EN-DC, this IE indicates the integrity protection algorithm to be used for SRBs, as specified in TS 33.501 [11]. The algorithms nia0-nia3 is identical to the LTE algorithms eia0-3. For EN-DC, the algorithms configured for SRBs using master key shall be the same as for all SRBs using master key and the algorithms configured for bearers using secondary key shall be the same as for all bearers using secondary key. The network does not configure *nia0* for SRB3.

– *ServCellIndex*

The IE *ServCellIndex* concerns a short identity, used to identify a serving cell (i.e. the PCell, the PSCell or an SCell). Value 0 applies for the PCell, while the *SCellIndex* that has previously been assigned applies for SCells.

ServCellIndex information element

```
-- ASN1START
-- TAG-SERV-CELL-INDEX-START

ServCellIndex ::=                   INTEGER (0..maxNrofServingCells-1)

-- TAG-SERV-CELL-INDEX-STOP
```

```
-- ASN1STOP
```

– *ServingCellConfig*

The *ServingCellConfig* IE is used to configure (add or modify) the UE with a serving cell, which may be the SpCell or an SCell of an MCG or SCG. The parameters herein are mostly UE specific but partly also cell specific (e.g. in additionally configured bandwidth parts).

ServingCellConfig information element

```
-- ASN1START
-- TAG-SERVING-CELL-CONFIG-START

ServingCellConfig ::=                   SEQUENCE {
    tdd-UL-DL-ConfigurationDedicated    TDD-UL-DL-ConfigDedicated                                             OPTIONAL,   -- Cond TDD

    initialDownlinkBWP                  BWP-DownlinkDedicated                                                 OPTIONAL,   -- Need M
    downlinkBWP-ToReleaseList           SEQUENCE (SIZE (1..maxNrofBWPs)) OF BWP-Id                            OPTIONAL,   -- Need N
    downlinkBWP-ToAddModList            SEQUENCE (SIZE (1..maxNrofBWPs)) OF BWP-Downlink                      OPTIONAL,   -- Need N
    firstActiveDownlinkBWP-Id           BWP-Id                                                                OPTIONAL,   -- Cond SyncAndCellAdd
    bwp-InactivityTimer                 ENUMERATED {ms2, ms3, ms4, ms5, ms6, ms8, ms10, ms20, ms30,
                                                    ms40,ms50, ms60, ms80,ms100, ms200,ms300, ms500,
                                                    ms750, ms1280, ms1920, ms2560, spare10, spare9, spare8,
                                                    spare7, spare6, spare5, spare4, spare3, spare2, spare1 }    OPTIONAL,   --Need R
    defaultDownlinkBWP-Id               BWP-Id                                                                    OPTIONAL,   -- Need S

    uplinkConfig                        UplinkConfig                                                              OPTIONAL,   -- Need M
    supplementaryUplink                 UplinkConfig                                                              OPTIONAL,   -- Need M

    pdcch-ServingCellConfig             SetupRelease { PDCCH-ServingCellConfig }                                  OPTIONAL,   -- Need M
    pdsch-ServingCellConfig             SetupRelease { PDSCH-ServingCellConfig }                                  OPTIONAL,   -- Need M
    csi-MeasConfig                      SetupRelease { CSI-MeasConfig }                                           OPTIONAL,   -- Need M
    sCellDeactivationTimer              ENUMERATED {ms20, ms40, ms80, ms160, ms200, ms240,
                                                    ms320, ms400, ms480, ms520, ms640, ms720,
                                                    ms840, ms1280, spare2,spare1}           OPTIONAL,   -- Cond ServingCellWithoutPUCCH
    crossCarrierSchedulingConfig        CrossCarrierSchedulingConfig                                          OPTIONAL,   -- Need M
    tag-Id                              TAG-Id,
    ue-BeamLockFunction                 ENUMERATED {enabled}                                                  OPTIONAL,   -- Need R
    pathlossReferenceLinking            ENUMERATED {pCell, sCell}                                             OPTIONAL,   -- Cond SCellOnly
    servingCellMO                       MeasObjectId                                                          OPTIONAL,   -- Cond MeasObject
    ...,
    [[
    lte-CRS-ToMatchAround               SetupRelease { RateMatchPatternLTE-CRS }                                  OPTIONAL,   -- Need M
    rateMatchPatternToAddModList        SEQUENCE (SIZE (1..maxNrofRateMatchPatterns)) OF RateMatchPattern         OPTIONAL,   -- Need N
    rateMatchPatternToReleaseList       SEQUENCE (SIZE (1..maxNrofRateMatchPatterns)) OF RateMatchPatternId       OPTIONAL,   -- Need N
    downlinkChannelBW-PerSCS-List       SEQUENCE (SIZE (1..maxSCSs)) OF SCS-SpecificCarrier                       OPTIONAL    -- Need S
    ]]
}

UplinkConfig ::=                        SEQUENCE {
    initialUplinkBWP                    BWP-UplinkDedicated                                                       OPTIONAL,   -- Need M
    uplinkBWP-ToReleaseList             SEQUENCE (SIZE (1..maxNrofBWPs)) OF BWP-Id                                OPTIONAL,   -- Need N
    uplinkBWP-ToAddModList              SEQUENCE (SIZE (1..maxNrofBWPs)) OF BWP-Uplink                            OPTIONAL,   -- Need N
```

```
    firstActiveUplinkBWP-Id             BWP-Id                                                         OPTIONAL,   -- Cond SyncAndCellAdd

    pusch-ServingCellConfig             SetupRelease { PUSCH-ServingCellConfig }                       OPTIONAL,   -- Need M
    carrierSwitching                    SetupRelease { SRS-CarrierSwitching }                          OPTIONAL,   -- Need M
    ...,
    [[
    powerBoostPi2BPSK                   BOOLEAN                                                        OPTIONAL,   -- Need M
    uplinkChannelBW-PerSCS-List         SEQUENCE (SIZE (1..maxSCSs)) OF SCS-SpecificCarrier            OPTIONAL    -- Need S
    ]]
}

-- TAG-SERVING-CELL-CONFIG-STOP
-- ASN1STOP
```

ServingCellConfig field descriptions
bwp-InactivityTimer The duration in ms after which the UE falls back to the default Bandwidth Part. (see TS 38.321 [3], clause 5.15) The value 0.5 ms is only applicable for carriers >6 GHz. When the network releases the timer configuration, the UE stops the timer without switching to the default BWP.
crossCarrierSchedulingConfig Indicates whether this serving cell is cross-carrier scheduled by another serving cell or whether it cross-carrier schedules another serving cell.
defaultDownlinkBWP-Id The initial bandwidth part is referred to by BWP-Id = 0. ID of the downlink bandwidth part to be used upon expiry of the BWP inactivity timer. This field is UE specific. When the field is absent the UE uses the initial BWP as default BWP. (see TS 38.213 [13], clause 12 and TS 38.321 [3], clause 5.15).
downlinkBWP-ToAddModList List of additional downlink bandwidth parts to be added or modified. (see TS 38.213 [13], clause 12).
downlinkBWP-ToReleaseList List of additional downlink bandwidth parts to be released. (see TS 38.213 [13], clause 12).
downlinkChannelBW-PerSCS-List A set of UE specific carrier configurations for different subcarrier spacings (numerologies). Defined in relation to Point A. Corresponds to L1 parameter 'offset-pointA-set' (see 38.211, clause FFS_clause). If absent, UE uses the configuration indicated in *scs-SpecificCarrierList* in *DownlinkConfigCommon* / *DownlinkConfigCommonSIB*.
firstActiveDownlinkBWP-Id If configured for an SpCell, this field contains the ID of the DL BWP to be activated upon performing the RRC (re-)configuration. If the field is absent, the RRC (re-)configuration does not impose a BWP switch. If configured for an SCell, this field contains the ID of the downlink bandwidth part to be used upon MAC-activation of an SCell. The initial bandwidth part is referred to by BWP-Id = 0. Upon reconfigurationWithSync (PCell handover, PSCelladdition/change), the network sets the *firstActiveDownlinkBWP-Id* and *firstActiveUplinkBWP-Id* to the same value.
initialDownlinkBWP The dedicated (UE-specific) configuration for the initial downlink bandwidth-part. If any of the optional IEs are configured within this IE, the UE considers the initial DL BWP as a RRC configured DL BWP for the UE. Otherwise, the UE does not consider the initial DL BWP as RRC configured DL BWP for the UE.
lte-CRS-ToMatchAround Parameters to determine an LTE CRS pattern that the UE shall rate match around.
pathlossReferenceLinking Indicates whether UE shall apply as pathloss reference either the downlink of PCell or of SCell that corresponds with this uplink (see TS 38.213 [13], clause 7)
pdsch-ServingCellConfig PDSCH related parameters that are not BWP-specific.
rateMatchPatternToAddModList Resources patterns which the UE should rate match PDSCH around. The UE rate matches around the union of all resources indicated in the nested bitmaps. Rate match patterns defined here on cell level apply only to PDSCH of the same numerology. Corresponds to L1 parameter 'Resource-set-cell' (see TS 38.214 [19], clause 5.1.2.2.3)
sCellDeactivationTimer SCell deactivation timer in TS 38.321 [3]. If the field is absent, the UE applies the value infinity.
servingCellMO *measObjectId* of the *MeasObjectNR* in *MeasConfig* which is associated to the serving cell. For this *MeasObjectNR*, the following relationship applies between this MeasObjectNR and *frequencyInfoDL* in *ServingCellConfigCommon* of the serving cell: if *ssbFrequency* is configured, its value is the same as the *absoluteFrequencySSB* and if *csi-rs-ResourceConfigMobility* is configured, the value of its *subcarrierSpacing* is present in one entry of the *scs-SpecificCarrierList*, *csi-RS-CellListMobility* includes an entry corresponding to the serving cell (with *cellId* equal to *physCellId* in *ServingCellConfigCommon*) and the frequency range indicated by the *csi-rs-MeasurementBW* of the entry in *csi-RS-CellListMobility* is included in the frequency range indicated by in the entry of the *scs-SpecificCarrierList*.
tag-Id Timing Advance Group ID, as specified in TS 38.321 [3], which this cell belongs to.
ue-BeamLockFunction Enables the "UE beam lock function (UBF)", which disable changes to the UE beamforming configuration when in NR_RRC_CONNECTED. FFS: Parameter added preliminary based on RAN4 LS in R4-1711823. Decide where to place it (maybe ServingCellConfigCommon or in a BeamManagement IE??)

UplinkConfig ***field descriptions***
carrierSwitching Includes parameters for configuration of carrier based SRS switching (see TS 38.214 [19], clause 6.2.1.3.
firstActiveUplinkBWP-Id If configured for an SpCell, this field contains the ID of the UL BWP to be activated upon performing the RRC (re-)configuration. If the field is absent, the RRC (re-)configuration does not impose a BWP switch. If configured for an SCell, this field contains the ID of the uplink bandwidth part to be used upon MAC-activation of an SCell. The initial bandwidth part is referred to by BandiwdthPartId = 0.
initialUplinkBWP The dedicated (UE-specific) configuration for the initial uplink bandwidth-part. If any of the optional IEs are configured within this IE as part of the IE *uplinkConfig*, the UE considers the initial UL BWP as a RRC configured UL BWP for the UE. Otherwise, the UE does not consider the initial UL BWP as RRC configured UL BWP for the UE.
powerBoostPi2BPSK If this field is set to *TRUE*, the UE determines the maximum output power for PUCCH/PUSCH transmissions that use pi/2 BPSK modulation according to TS 38.101 [15], clause 6.2.4.
pusch-ServingCellConfig PUSCH related parameters that are not BWP-specific.
supplementaryUplink The field is optionally present if *supplementaryUplinkConfig* is configured in ServingCellConfigCommon and absent otherwise.
uplinkBWP-ToReleaseList The additional bandwidth parts for uplink. In case of TDD uplink- and downlink BWP with the same bandwidthPartId are considered as a BWP pair and must have the same center frequency.
uplinkChannelBW-PerSCS-List A set of UE specific carrier configurations for different subcarrier spacings (numerologies). Defined in relation to Point A. Corresponds to L1 parameter 'offset-pointA-set' (see 38.211, clause FFS_clause). If absent, UE uses the configuration indicated in *scs-SpecificCarrierList* in *UplinkConfigCommon* / *UplinkConfigCommonSIB*.
uplinkConfig The field is optionally present if *uplinkConfigCommon* is configured in ServingCellConfigCommon, and absent otherwise.

Conditional Presence	Explanation
MeasObject	This field is mandatory present for the SpCell if the UE has a measConfig, and it is optionally present, Need M, for SCells.
SCellOnly	This field is optionally present, Need R, for SCells. It is absent otherwise.
ServingCellWithoutPUCCH	This field is optionally present, Need S, for SCells except PUCCH SCells. It is absent otherwise.
SyncAndCellAdd	This field is mandatory present, Need N, for a SpCell upon reconfigurationWithSync (PCell handover, PSCelladdition/change) and upon RRCsetup/RRCResume. The field is mandatory present, Need M, for an SCell upon addition. For SpCell, the field is optionally present, Need N, upon reconfiguration without reconfigurationWithSync. In all other cases the field is absent.
TDD	This field is optionally present, Need R, for TDD cells. It is absent otherwise.

– *ServingCellConfigCommon*

The *ServingCellConfigCommon* IE is used to configure cell specific parameters of a UE's serving cell. The IE contains parameters which a UE would typically acquire from SSB, MIB or SIBs when accessing the cell from IDLE. With this IE, the network provides this information in dedicated signalling when configuring a UE with a SCells or with an additional cell group (SCG). It also provides it for SpCells (MCG and SCG) upon reconfiguration with sync.

ServingCellConfigCommon information element

```
-- ASN1START
-- TAG-SERVING-CELL-CONFIG-COMMON-START

ServingCellConfigCommon ::=         SEQUENCE {
    physCellId                          PhysCellId                                                      OPTIONAL,   -- Cond HOAndServCellAdd,
    downlinkConfigCommon                DownlinkConfigCommon                                            OPTIONAL,   -- Cond HOAndServCellAdd

    uplinkConfigCommon                  UplinkConfigCommon                                              OPTIONAL,   -- Need M
    supplementaryUplinkConfig           UplinkConfigCommon                                              OPTIONAL,   -- Need S
    n-TimingAdvanceOffset               ENUMERATED { n0, n25600, n39936 }                               OPTIONAL,   -- Need S
    ssb-PositionsInBurst                CHOICE {
        shortBitmap                         BIT STRING (SIZE (4)),
        mediumBitmap                        BIT STRING (SIZE (8)),
        longBitmap                          BIT STRING (SIZE (64))
    }                                                                                                           OPTIONAL, -- Cond AbsFreqSSB
    ssb-periodicityServingCell          ENUMERATED { ms5, ms10, ms20, ms40, ms80, ms160, spare2, spare1 }   OPTIONAL, -- Need S
    dmrs-TypeA-Position                 ENUMERATED {pos2, pos3},
    lte-CRS-ToMatchAround               SetupRelease { RateMatchPatternLTE-CRS }                            OPTIONAL, -- Need M
    rateMatchPatternToAddModList        SEQUENCE (SIZE (1..maxNrofRateMatchPatterns)) OF RateMatchPattern   OPTIONAL, -- Need N
    rateMatchPatternToReleaseList       SEQUENCE (SIZE (1..maxNrofRateMatchPatterns)) OF RateMatchPatternId OPTIONAL, -- Need N
    subcarrierSpacing                   SubcarrierSpacing                                                   OPTIONAL, -- Cond HOAndServCellAdd
    tdd-UL-DL-ConfigurationCommon       TDD-UL-DL-ConfigCommon                                              OPTIONAL, -- Cond TDD
    ss-PBCH-BlockPower                  INTEGER (-60..50),
    ...
}


-- TAG-SERVING-CELL-CONFIG-COMMON-STOP
-- ASN1STOP
```

ServingCellConfigCommon field descriptions
dmrs-TypeA-Position Position of (first) DM-RS for downlink (see TS 38.211 [16], clause 7.4.1.1.1) and uplink (TS 38.211 [16], clause 6.4.1.1.3).
downlinkConfigCommon The common downlink configuration of the serving cell, including the frequency information configuration and the initial downlink BWP common configuration. The parameters provided herein should match the parameters configured by MIB and SIB1 (if provided) of the serving cell, with the exception of *controlResourceSetZero* and *searchSpaceZero* which can be configured in *ServingCellConfigCommon* even if MIB indicates that they are not present.
longBitmap Bitmap when maximum number of SS/PBCH blocks per half frame equals to 64 as defined in TS 38.213 [13], clause 4.1.
lte-CRS-ToMatchAround Parameters to determine an LTE CRS pattern that the UE shall rate match around.
mediumBitmap Bitmap when maximum number of SS/PBCH blocks per half frame equals to 8 as defined in TS 38.213 [13], clause 4.1.
n-TimingAdvanceOffset The N_TA-Offset to be applied for random access on this serving cell. If the field is absent, the UE applies the value defined for the duplex mode and frequency range of this serving cell. See TS 38.133 [14], table 7.1.2-2.
rateMatchPatternToAddModList Resources patterns which the UE should rate match PDSCH around. The UE rate matches around the union of all resources indicated in the nested bitmaps. Rate match patterns defined here on cell level apply only to PDSCH of the same numerology (see TS 38.214 [19], clause 5.1.4,1).
shortBitmap Bitmap when maximum number of SS/PBCH blocks per half frame equals to 4 as defined in TS 38.213 [13], clause 4.1.
ss-PBCH-BlockPower Average EPRE of the resources elements that carry secondary synchronization signals in dBm that the NW used for SSB transmission. The UE uses it to estimate the RA preamble TX power. (see TS 38.213 [13], clause 7.4)
ssb-periodicityServingCell The SSB periodicity in ms for the rate matching purpose. If the field is absent, the UE applies the value ms5. (see TS 38.213 [13], clause 4.1)
ssb-PositionsInBurst Indicates the time domain positions of the transmitted SS-blocks in an SS-burst as defined in TS 38.213 [13], clause 4.1. The first/ leftmost bit corresponds to SS/PBCH block index 0, the second bit corresponds to SS/PBCH block index 1, and so on. Value 0 in the bitmap indicates that the corresponding SS/PBCH block is not transmitted while value 1 indicates that the corresponding SS/PBCH block is transmitted. The network configures the same pattern in this field as in the corresponding field in ServingCellConfigCommonSIB.
subcarrierSpacing Subcarrier spacing of SSB. Only the values 15 or 30 kHz (<6GHz), 120 or 240 kHz (>6GHz) are applicable.
supplementaryUplinkConfig The network configures this field only if *uplinkConfigCommon* is configured. If this field is absent, the UE shall release the *supplementaryUplinkConfig* and the *supplementaryUplink* configured in *ServingCellConfig* of this serving cell, if configured.
tdd-UL-DL-ConfigurationCommon A cell-specific TDD UL/DL configuration, see TS 38.213 [13], clause 11.1.

Conditional Presence	**Explanation**
AbsFreqSSB	The field is absent when absoluteFrequencySSB in frequencyInfoDL is absent, otherwise the field is mandatory present.
HOAndServCellAdd	This field is mandatory present for inter-cell handover and upon serving cell (PSCell/SCell) addition. Otherwise, the field is absent, Need M.
TDD	The field is optionally present, Need R, for TDD cells; otherwise it is not present.

– *ServingCellConfigCommonSIB*

The *ServingCellConfigCommonSIB* IE is used to configure cell specific parameters of a UE's serving cell in SIB1.

ServingCellConfigCommonSIB information element

```
-- ASN1START
-- TAG-SERVINGCELLCONFIGCOMMONSIB-START

ServingCellConfigCommonSIB ::=      SEQUENCE {
    downlinkConfigCommon                DownlinkConfigCommonSIB,
    uplinkConfigCommon                  UplinkConfigCommonSIB                                           OPTIONAL, -- Need R
    supplementaryUplink                 UplinkConfigCommonSIB                                           OPTIONAL, -- Need R
    n-TimingAdvanceOffset               ENUMERATED { n0, n25600, n39936 }                               OPTIONAL, -- Need S
    ssb-PositionsInBurst                SEQUENCE {
        inOneGroup                          BIT STRING (SIZE (8)),
        groupPresence                       BIT STRING (SIZE (8))                                       OPTIONAL  -- Cond Above6GHzOnly
    },
    ssb-PeriodicityServingCell          ENUMERATED {ms5, ms10, ms20, ms40, ms80, ms160},

    tdd-UL-DL-ConfigurationCommon       TDD-UL-DL-ConfigCommon                                          OPTIONAL, -- Cond TDD
    ss-PBCH-BlockPower                  INTEGER (-60..50),
    ...
}

-- TAG-SERVINGCELLCONFIGCOMMONSIB-STOP
-- ASN1STOP
```

***ServingCellConfigCommonSIB* field descriptions**
groupPresence This field is present when maximum number of SS/PBCH blocks per half frame equals to 64 as defined in TS 38.213 [13], clause 4.1. The first/leftmost bit corresponds to the SS/PBCH index 0-7, the second bit corresponds to SS/PBCH block 8-15, and so on. Value 0 in the bitmap indicates that the SSBs according to inOneGroup are not present. Value 1 indicates that the SS/PBCH blocks are transmitted in accordance with inOneGroup.
inOneGroup When maximum number of SS/PBCH blocks per half frame equals to 4 as defined in TS 38.213 [13], clause 4.1, only the 4 leftmost bits are valid; the UE ignores the 4 rightmost bits. When maximum number of SS/PBCH blocks per half frame equals to 8 as defined in TS 38.213 [13], clause 4.1, all 8 bits are valid. The first/ leftmost bit corresponds to SS/PBCH block index 0, the second bit corresponds to SS/PBCH block index 1, and so on. When maximum number of SS/PBCH blocks per half frame equals to 64 as defined in TS 38.213 [13], clause 4.1, all 8 bit are valid; The first/ leftmost bit corresponds to the first SS/PBCH block index in the group (i.e., to SSB index 0, 8, and so on); the second bit corresponds to the second SS/PBCH block index in the group (i.e., to SSB index 1, 9, and so on), and so on. Value 0 in the bitmap indicates that the corresponding SS/PBCH block is not transmitted while value 1 indicates that the corresponding SS/PBCH block is transmitted.
n-TimingAdvanceOffset The N_TA-Offset to be applied for random access on this serving cell. If the field is absent, the UE applies the value defined for the duplex mode and frequency range of this serving cell. See TS 38.133 [14], table 7.1.2-2.
ssb-PositionsInBurst Time domain positions of the transmitted SS-blocks in an SS-burst as defined in TS 38.213 [13], clause 4.1.

Conditional Presence	Explanation
Above6GHzOnly	This field is present when the carrier frequency is above 6GHz. It is absent, Need R, otherwise.
TDD	The field is optionally present, Need R, for TDD cells; otherwise it is not present.

– *ShortI-RNTI-Value*

The *ShortI-RNTI-Value* IE is used to identify the suspended UE context of a UE in RRC_INACTIVE using fewer bits compared to I-RNTI-Value.

ShortI-RNTI-Value information element

```
-- ASN1START
-- TAG-ShortI-RNTI-VALUE-START

ShortI-RNTI-Value ::=   BIT STRING (SIZE(24))

-- TAG-ShortI-RNTI-VALUE-STOP
-- ASN1STOP
```

– *ShortMAC-I*

The IE *ShortMAC-I* is used to identify and verify the UE at RRC connection re-establishment. The 16 least significant bits of the MAC-I calculated using the security configuration of the source PCell, as specified in 5.3.7.4.

ShortMAC-I information element

```
-- ASN1START
-- TAG-SHORTMAC-I-START

ShortMAC-I ::=                      BIT STRING (SIZE (16))

-- TAG-SHORTMAC-I-STOP
-- ASN1STOP
```

– *SINR-Range*

The IE *SINR-Range* specifies the value range used in SINR measurements and thresholds. Integer value for SINR measurements is according to mapping table in TS 38.133 [14].

SINR-Range information element

```
-- ASN1START
-- TAG-SINR-RANGE-START

SINR-Range ::=                      INTEGER(0..127)

-- TAG-SINR-RANGE-STOP
```

```
-- ASN1STOP
```

– *SI-SchedulingInfo*

The IE *SI-SchedulingInfo* contains information needed for acquisition of SI messages.

***SI-SchedulingInfo* information element**

```
-- ASN1START
-- TAG-OTHER-SI-INFO-START

SI-SchedulingInfo ::=               SEQUENCE {
    schedulingInfoList                  SEQUENCE (SIZE (1..maxSI-Message)) OF SchedulingInfo,
    si-WindowLength                     ENUMERATED {s5, s10, s20, s40, s80, s160, s320, s640, s1280},
    si-RequestConfig                    SI-RequestConfig                                                    OPTIONAL,  -- Cond MSG-1
    si-RequestConfigSUL                 SI-RequestConfig                                                    OPTIONAL,  -- Cond SUL-MSG-1
    systemInformationAreaID             BIT STRING (SIZE (24))                                              OPTIONAL,   -- Need R
    ...
}

SchedulingInfo ::=                  SEQUENCE {
    si-BroadcastStatus                  ENUMERATED {broadcasting, notBroadcasting},
    si-Periodicity                      ENUMERATED {rf8, rf16, rf32, rf64, rf128, rf256, rf512},
    sib-MappingInfo                     SIB-Mapping
}

SIB-Mapping ::=                     SEQUENCE (SIZE (1..maxSIB)) OF SIB-TypeInfo

SIB-TypeInfo ::=                    SEQUENCE {
    type                                ENUMERATED {sibType2, sibType3, sibType4, sibType5, sibType6, sibType7, sibType8, sibType9,
                                                    spare8, spare7, spare6, spare5, spare4, spare3, spare2, spare1,... },
    valueTag                            INTEGER (0..31)                                                      OPTIONAL, -- Cond SIB-TYPE
    areaScope                           ENUMERATED {true}                                                    OPTIONAL -- Need S
}

-- Configuration for Msg1 based SI Request
SI-RequestConfig::=                 SEQUENCE {
    rach-OccasionsSI                    SEQUENCE {
        rach-ConfigSI                       RACH-ConfigGeneric,
        ssb-perRACH-Occasion                ENUMERATED {oneEighth, oneFourth, oneHalf, one, two, four, eight, sixteen}
    }                                                                                                            OPTIONAL,    -- Need R
    si-RequestPeriod                    ENUMERATED {one, two, four, six, eight, ten, twelve, sixteen}            OPTIONAL,    -- Need R
    si-RequestResources                 SEQUENCE (SIZE (1..maxSI-Message)) OF SI-RequestResources
}

SI-RequestResources ::=             SEQUENCE {
    ra-PreambleStartIndex               INTEGER (0..63),
    ra-AssociationPeriodIndex           INTEGER (0..15)                                                          OPTIONAL,    -- Need R
    ra-ssb-OccasionMaskIndex            INTEGER (0..15)                                                          OPTIONAL     -- Need R
}

-- TAG-OTHER-SI-INFO-STOP
```

```
-- ASN1STOP
```

SI-RequestConfig field descriptions
rach-OccasionsSI Configuration of dedicated RACH Occassions for SI. If the field is absent, the UE uses the corresponding parameters configured in rach-ConfigCommon of the initial uplink BWP.
si-RequestPeriod Periodicity of the SI-Request configuration in number of association periods.
si-RequestResources If there is only one entry in the list, the configuration is used for all SI messages for which *si-BroadcastStatus* is set to notBroadcasting. Otherwise the 1st entry in the list corresponds to the first SI message in schedulingInfoList for which *si-BroadcastStatus* is set to notBroadcasting, 2nd entry in the list corresponds to the second SI message in schedulingInfoList for which *si-BroadcastStatus* is set to notBroadcasting and so on. Change of *si-RequestResources* should not result in system information change notification.

SI-RequestResources field descriptions
ra-AssociationPeriodIndex Index of the association period in the si-RequestPeriod in which the UE can send the SI request for SI message(s) corresponding to this *SI-RequestResources*, using the preambles indicated by *ra-PreambleStartIndex* and rach occasions indicated by *ra-ssb-OccasionMaskIndex*.
ra-PreambleStartIndex If N SSBs are associated with a RACH occasion, where N > = 1, for the i-th SSB (i=0, …, N-1) the preamble with preamble index = ra-PreambleStartIndex + i is used for SI request; For N < 1, the preamble with preamble index = ra-PreambleStartIndex is used for SI request.

SchedulingInfo field descriptions
areaScope Indicates that a SIB is area specific. If the field is not present, the SIB is cell specific.
si-Periodicity Periodicity of the SI-message in radio frames. rf8 corresponds to 8 radio frames, rf16 corresponds to 16 radio frames, and so on.
si-RequestConfig Configuration of Msg1 resources that the UE uses for requesting SI-messages for which *si-BroadcastStatus* is set to notBroadcasting. If the field is not present the UE uses Msg3 to request SI-messages for which *si-BroadcastStatus* is set to notBroadcasting (if any).
si-RequestConfigSUL Configuration of Msg1 resources that the UE uses for requesting SI-messages for which *si-BroadcastStatus* is set to notBroadcasting. If the field is not present the UE uses Msg3 to request SI-messages for which *si-BroadcastStatus* is set to notBroadcasting (if any) on supplementary uplink.
si-WindowLength The length of the SI scheduling window. s5 corresponds to 5 slots, s10 to 10 slots and so on.
systemInformationAreaID Indicates the system information area that the cell belongs to, if any. Any SIB with areaScope within the SI is considered to belong to this *systemInformationAreaID*. The systemInformationAreaID is unique within a PLMN.

***SchedulingInfo* field descriptions**
si-BroadcastStatus Indicates if the SI message is being broadcasted or not. Change of *si-BroadcastStatus* should not result in system information change notifications in Short Message transmitted with P-RNTI over DCI (see clause 6.5). The value of the indication is valid until the end of the BCCH modification period when set to broadcasting.

Conditional presence	Explanation
MSG-1	The field is optionally present, Need R, if *si-BroadcastStatus* is set to notBroadcasting for any SI-message included in *SchedulingInfo*. It is absent otherwise.
SIB-TYPE	The field is mandatory present if the SIB type is different from SIB6, SIB7 or SIB8. For SIB6, SIB7 and SIB8 it is not present.
SUL-MSG-1	The field is optionally present, Need R, if this serving cell is configured with a supplementary uplink and if *si-BroadcastStatus* is set to notBroadcasting for any SI-message included in *SchedulingInfo*. It is absent otherwise.

– *SlotFormatCombinationsPerCell*

The IE *SlotFormatCombinationsPerCell* is used to configure the SlotFormatCombinations applicable for one serving cell (see TS 38.213 [13], clause 11.1.1).

SlotFormatCombinationsPerCell information element

```
-- ASN1START
-- TAG-SLOTFORMATCOMBINATIONSPERCELL-START

SlotFormatCombinationsPerCell ::=   SEQUENCE {
    servingCellId                       ServCellIndex,
    subcarrierSpacing                   SubcarrierSpacing,
    subcarrierSpacing2                  SubcarrierSpacing                                                   OPTIONAL, -- Need R
    slotFormatCombinations              SEQUENCE (SIZE (1..maxNrofSlotFormatCombinationsPerSet)) OF SlotFormatCombination OPTIONAL, -- Need M
    positionInDCI                       INTEGER(0..maxSFI-DCI-PayloadSize-1)                                OPTIONAL, -- Need M
    ...
}

SlotFormatCombination ::=           SEQUENCE {
    slotFormatCombinationId             SlotFormatCombinationId,
    slotFormats                         SEQUENCE (SIZE (1..maxNrofSlotFormatsPerCombination)) OF INTEGER (0..255)
}

SlotFormatCombinationId ::=         INTEGER (0..maxNrofSlotFormatCombinationsPerSet-1)

-- TAG-SLOTFORMATCOMBINATIONSPERCELL-STOP
-- ASN1STOP
```

***SlotFormatCombination* field descriptions**
slotFormatCombinationId This ID is used in the DCI payload to dynamically select this SlotFormatCombination, see TS 38.213 [13], clause 11.1.1.
slotFormats Slot formats that occur in consecutive slots in time domain order as listed here (see TS 38.213 [13], clause 11.1.1.

SlotFormatCombinationsPerCell field descriptions
positionInDCI The (starting) position (bit) of the slotFormatCombinationId (SFI-Index) for this serving cell (servingCellId) within the DCI payload (see TS 38.213 [13], clause 11.1.1).
servingCellId The ID of the serving cell for which the slotFormatCombinations are applicable.
slotFormatCombinations A list with SlotFormatCombinations. Each SlotFormatCombination comprises of one or more SlotFormats (see TS 38.211 [16], clause 4.3.2). The total number of slotFormats in the slotFormatCombinations list does not exceed 512.
subcarrierSpacing2 Reference subcarrier spacing for a Slot Format Combination on an FDD or SUL cell (see TS 38.213 [13], clause 11.1.1). For FDD, subcarrierSpacing (SFI-scs) is the reference SCS for DL BWP and subcarrierSpacing2 (SFI-scs2) is the reference SCS for UL BWP. For SUL, subcarrierSpacing (SFI-scs) is the reference SCS for non-SUL carrier and subcarrierSpacing2 (SFI-scs2) is the reference SCS for SUL carrier. The network configures a value that is smaller than or equal to any SCS of configured BWPs of the serving cell that the command applies to. And the network configures a value that is smaller than or equal to the SCS of the serving cell which the UE monitors for SFI indications.
subcarrierSpacing Reference subcarrier spacing for this Slot Format Combination. The network configures a value that is smaller than or equal to any SCS of configured BWPs of the serving cell that the command applies to. And the network configures a value that is smaller than or equal to the SCS of the serving cell which the UE monitors for SFI indications (see TS 38.213 [13], clause 11.1.1).

– *SlotFormatIndicator*

The IE *SlotFormatIndicator* is used to configure monitoring a Group-Common-PDCCH for Slot-Format-Indicators (SFI).

SlotFormatIndicator information element

```
-- ASN1START
-- TAG-SLOTFORMATINDICATOR-START

SlotFormatIndicator ::=     SEQUENCE {
    sfi-RNTI                    RNTI-Value,
    dci-PayloadSize             INTEGER (1..maxSFI-DCI-PayloadSize),
    slotFormatCombToAddModList  SEQUENCE (SIZE(1..maxNrofAggregatedCellsPerCellGroup)) OF SlotFormatCombinationsPerCell OPTIONAL, -- Need N
    slotFormatCombToReleaseList SEQUENCE (SIZE(1..maxNrofAggregatedCellsPerCellGroup)) OF ServCellIndex                 OPTIONAL, -- Need N
    ...
}

-- TAG-SLOTFORMATINDICATOR-STOP
-- ASN1STOP
```

SlotFormatIndicator field descriptions
dci-PayloadSize Total length of the DCI payload scrambled with SFI-RNTI (see TS 38.213 [13], clause 11.1.1)'
sfi-RNTI RNTI used for SFI on the given cell (see TS 38.213 [13], clause 11.1.1).
slotFormatCombToAddModList A list of SlotFormatCombinations for the UE's serving cells (see TS 38.213 [13], clause 11.1.1).

– *S-NSSAI*

The IE *S-NSSAI (Single Network Slice Selection Assistance Information)* identifies a Network Slice end to end and comprises a slice/service type and a slice differentiator, see TS 23.003 [21].

S-NSSAI information element

```
-- ASN1START
-- TAG-S-NSSAI-START

S-NSSAI  ::=                        CHOICE{
    sst                                 BIT STRING (SIZE (8)),
    sst-SD                              BIT STRING (SIZE (32))
}

-- TAG-S-NSSAI-STOP
-- ASN1STOP
```

S-NSSAI field descriptions
sst-SD Indicates the S-NSSAI consists of Slice/Service Type and Slice Differentiator, see TS 23.003 [21].
sst Indicates the S-NSSAI consists of Slice/Service Type, see TS 23.003 [21].

– *SpeedStateScaleFactors*

The IE *SpeedStateScaleFactors* concerns factors, to be applied when the UE is in medium or high speed state, used for scaling a mobility control related parameter.

***SpeedStateScaleFactors* information element**

```
-- ASN1START
-- TAG-SPEEDSTATESCALEFACTORS-START

SpeedStateScaleFactors ::=          SEQUENCE {
    sf-Medium                           ENUMERATED {oDot25, oDot5, oDot75, lDot0},
    sf-High                             ENUMERATED {oDot25, oDot5, oDot75, lDot0}
}
-- TAG-SPEEDSTATESCALEFACTORS-STOP
-- ASN1STOP
```

***SpeedStateScaleFactors* field descriptions**
sf-High The concerned mobility control related parameter is multiplied with this factor if the UE is in High Mobility state as defined in TS 38.304 [20]. Value oDot25 corresponds to 0.25, oDot5 corresponds to 0.5, oDot75 corresponds to 0.75 and so on8
sf-Medium The concerned mobility control related parameter is multiplied with this factor if the UE is in Medium Mobility state as defined in TS 38.304 [20]. Value oDot25 corresponds to 0.25, oDot5 corresponds to 0.5, oDot75 corresponds to 0.75 and so on.

– *SS-RSSI-Measurement*

The IE *SS-RSSI-Measurement* is used to configure RSSI measurements based on synchronization reference signals.

***SS-RSSI-Measurement* information element**

```
-- ASN1START
-- TAG-SS-RSSI-MEASUREMENT-START

SS-RSSI-Measurement ::=             SEQUENCE {
    measurementSlots                    BIT STRING (SIZE (1..80)),
    endSymbol                           INTEGER(0..3)
}

-- TAG-SS-RSSI-MEASUREMENT-STOP
-- ASN1STOP
```

SS-RSSI-Measurement field descriptions
endSymbol Within a slot that is configured for RSSI measurements (see measurementSlots) the UE measures the RSSI from symbol 0 to symbol endSymbol. This field identifies the entry in Table 5.1.3-1 in TS 38.215 [9], which determines the actual end symbol.
measurementSlots Indicates the slots in which the UE can perform RSSI measurements. The length of the BIT STRING is equal to the number of slots in the configured SMTC window (determined by the duration and by the subcarrierSpacing). The first (left-most / most significant) bit in the bitmap corresponds to the first slot in the SMTC window, the second bit in the bitmap corresponds to the second slot in the SMTC window, and so on. The UE measures in slots for which the corresponding bit in the bitmap is set to 1.

– *SPS-Config*

The *SPS-Config* IE is used to configure downlink semi-persistent transmission. Downlink SPS may be configured on the SpCell as well as on SCells. But it shall not be configured for more than one serving cell of a cell group at once.

***SPS-Config* information element**

```
-- ASN1START
-- TAG-SPS-CONFIG-START

SPS-Config ::=                          SEQUENCE {
    periodicity                             ENUMERATED {ms10, ms20, ms32, ms40, ms64, ms80, ms128, ms160, ms320, ms640,
```

```
                                                        spare6, spare5, spare4, spare3, spare2, spare1},
    nrofHARQ-Processes                      INTEGER (1..8),
    n1PUCCH-AN                              PUCCH-ResourceId                                                    OPTIONAL,   -- Need M
    mcs-Table                               ENUMERATED {qam64LowSE}                                             OPTIONAL,   -- Need S
    ...
}

-- TAG-SPS-CONFIG-STOP
-- ASN1STOP
```

***SPS-Config* field descriptions**
mcs-Table Indicates the MCS table the UE shall use for DL SPS (see TS 38.214 [19],clause 5.1.3.1. If present, the UE shall use the MCS table of low-SE 64QAM table indicated in Table 5.1.3.1-3 of TS 38.214 [19]. If this field is absent and field mcs-table in PDSCH-Config is set to 'qam256' and the activating DCI is of format 1_1, the UE applies the 256QAM table indicated in Table 5.1.3.1-2 of TS 38.214 [19]. Otherwise, the UE applies the non-low-SE 64QAM table indicated in Table 5.1.3.1-1 of TS 38.214 [19].
n1PUCCH-AN HARQ resource for PUCCH for DL SPS. The network configures the resource either as format0 or format1. The actual PUCCH-Resource is configured in PUCCH-Config and referred to by its ID. See TS 38.213 [13], clause 9.2.3.
nrofHARQ-Processes Number of configured HARQ processes for SPS DL (see TS 38.321 [3], clause 5.8.1).
periodicity Periodicity for DL SPS (see TS 38.214 [19] and TS 38.321 [3], clause 5.8.1).

– *SRB-Identity*

The IE SRB-Identity is used to identify a Signalling Radio Bearer (SRB) used by a UE.

```
-- ASN1START
-- TAG-SRB-IDENTITY-START

SRB-Identity ::=                    INTEGER (1..3)

-- TAG-SRB-IDENTITY-STOP
-- ASN1STOP
```

– *SRS-CarrierSwitching*

The IE *SRS-CarrierSwitching* is used to configure for SRS carrier switching when PUSCH is not configured and independent SRS power control from that of PUSCH.

SRS-CarrierSwitching information element

```
-- ASN1START
-- TAG-SRS-CARRIERSWITCHING-START
```

```
SRS-CarrierSwitching ::=            SEQUENCE {
    srs-SwitchFromServCellIndex         INTEGER (0..31)                                                         OPTIONAL,   -- Need M
    srs-SwitchFromCarrier               ENUMERATED {sUL, nUL},
    srs-TPC-PDCCH-Group                 CHOICE {
        typeA                               SEQUENCE (SIZE (1..32)) OF SRS-TPC-PDCCH-Config,
        typeB                               SRS-TPC-PDCCH-Config
    }                                                                                                           OPTIONAL,   -- Need M
    monitoringCells                     SEQUENCE (SIZE (1..maxNrofServingCells)) OF ServCellIndex               OPTIONAL,   -- Need M
    ...
}

SRS-TPC-PDCCH-Config ::=            SEQUENCE {
    srs-CC-SetIndexlist                 SEQUENCE (SIZE(1..4)) OF SRS-CC-SetIndex                                OPTIONAL    -- Need M
}

SRS-CC-SetIndex ::=                 SEQUENCE {
    cc-SetIndex                         INTEGER (0..3)                                                          OPTIONAL,   -- Need M
    cc-IndexInOneCC-Set                 INTEGER (0..7)                                                          OPTIONAL    -- Need M
}

-- TAG-SRS-CARRIERSWITCHING-STOP
-- ASN1STOP
```

***SRS-CC-SetIndex* field descriptions**
cc-IndexInOneCC-Set Indicates the CC index in one CC set for Type A (see TS 38.212 [17], TS 38.213 [13], clause 7.3.1, 11.3).
cc-SetIndex Indicates the CC set index for Type A associated (see TS 38.212 [17], TS 38.213 [13], clause 7.3.1, 11.3).

***SRS-CarrierSwitching* field descriptions**
monitoringCells A set of serving cells for monitoring PDCCH conveying SRS DCI format with CRC scrambled by TPC-SRS-RNTI (see TS 38.212 [17], TS 38.213 [13], clause 7.3.1, 11.3).
srs-SwitchFromServCellIndex Indicates the serving cell whose UL transmission may be interrupted during SRS transmission on a PUSCH-less cell. During SRS transmission on a PUSCH-less cell, the UE may temporarily suspend the UL transmission on a serving cell with PUSCH in the same CG to allow the PUSCH-less cell to transmit SRS. (see TS 38.214 [19], clause 6.2.1.3).
srs-TPC-PDCCH-Group Network configures the UE with either typeA-SRS-TPC-PDCCH-Group or typeB-SRS-TPC-PDCCH-Group, if any.
typeA Type A trigger configuration for SRS transmission on a PUSCH-less SCell (see TS 38.213 [13], clause 11.4).
typeB Type B trigger configuration for SRS transmission on a PUSCH-less SCell (see TS 38.213 [13], clause 11.4).

SRS-TPC-PDCCH-Config field descriptions
srs-CC-SetIndexlist A list of pairs of [cc-SetIndex; cc-IndexInOneCC-Set] (see TS 38.212 [17], TS 38.213 [13], clause 7.3.1, 11.3).

– *SRS-Config*

The *SRS-Config* IE is used to configure sounding reference signal transmissions. The configuration defines a list of SRS-Resources and a list of SRS-ResourceSets. Each resource set defines a set of SRS-Resources. The network triggers the transmission of the set of SRS-Resources using a configured aperiodicSRS-ResourceTrigger (L1 DCI).

SRS-Config information element

```
-- ASN1START
-- TAG-SRS-CONFIG-START

SRS-Config ::=                          SEQUENCE {
    srs-ResourceSetToReleaseList            SEQUENCE (SIZE(1..maxNrofSRS-ResourceSets)) OF SRS-ResourceSetId    OPTIONAL,   -- Need N
    srs-ResourceSetToAddModList             SEQUENCE (SIZE(1..maxNrofSRS-ResourceSets)) OF SRS-ResourceSet      OPTIONAL,   -- Need N
    srs-ResourceToReleaseList               SEQUENCE (SIZE(1..maxNrofSRS-Resources)) OF SRS-ResourceId          OPTIONAL,   -- Need N
    srs-ResourceToAddModList                SEQUENCE (SIZE(1..maxNrofSRS-Resources)) OF SRS-Resource            OPTIONAL,   -- Need N
    tpc-Accumulation                        ENUMERATED {disabled}                                               OPTIONAL,   -- Need S
    ...
}

SRS-ResourceSet ::=                     SEQUENCE {
    srs-ResourceSetId                       SRS-ResourceSetId,
    srs-ResourceIdList                      SEQUENCE (SIZE(1..maxNrofSRS-ResourcesPerSet)) OF SRS-ResourceId    OPTIONAL,   -- Cond Setup

    resourceType                            CHOICE {
        aperiodic                               SEQUENCE {
            aperiodicSRS-ResourceTrigger            INTEGER (1..maxNrofSRS-TriggerStates-1),
            csi-RS                                  NZP-CSI-RS-ResourceId                                       OPTIONAL, -- Cond NonCodebook
            slotOffset                              INTEGER (1..32)                                             OPTIONAL, -- Need S
            ...,
            [[
            aperiodicSRS-ResourceTriggerList-v1530      SEQUENCE (SIZE(1..maxNrofSRS-TriggerStates-2))
                                                            OF INTEGER (1..maxNrofSRS-TriggerStates-1)          OPTIONAL  -- Need M
            ]]
        },
        semi-persistent                         SEQUENCE {
            associatedCSI-RS                        NZP-CSI-RS-ResourceId                                       OPTIONAL, -- Cond NonCodebook
            ...
        },
        periodic                                SEQUENCE {
            associatedCSI-RS                        NZP-CSI-RS-ResourceId                                       OPTIONAL, -- Cond NonCodebook
            ...
        }
    },
    usage                                   ENUMERATED {beamManagement, codebook, nonCodebook, antennaSwitching},
    alpha                                   Alpha                                                               OPTIONAL, -- Need S
    p0                                      INTEGER (-202..24)                                                  OPTIONAL, -- Cond Setup
    pathlossReferenceRS                     CHOICE {
```

```
        ssb-Index                               SSB-Index,
        csi-RS-Index                            NZP-CSI-RS-ResourceId
    }                                                                                                   OPTIONAL, -- Need M
    srs-PowerControlAdjustmentStates        ENUMERATED { sameAsFci2, separateClosedLoop}                OPTIONAL, -- Need S
    ...
}

SRS-ResourceSetId ::=                   INTEGER (0..maxNrofSRS-ResourceSets-1)

SRS-Resource ::=                        SEQUENCE {
    srs-ResourceId                          SRS-ResourceId,
    nrofSRS-Ports                           ENUMERATED {port1, ports2, ports4},
    ptrs-PortIndex                          ENUMERATED {n0, n1 }                                        OPTIONAL,   -- Need R
    transmissionComb                        CHOICE {
        n2                                      SEQUENCE {
            combOffset-n2                           INTEGER (0..1),
            cyclicShift-n2                          INTEGER (0..7)
        },
        n4                                      SEQUENCE {
            combOffset-n4                           INTEGER (0..3),
            cyclicShift-n4                          INTEGER (0..11)
        }
    },
    resourceMapping                         SEQUENCE {
        startPosition                           INTEGER (0..5),
        nrofSymbols                             ENUMERATED {n1, n2, n4},
        repetitionFactor                        ENUMERATED {n1, n2, n4}
    },
    freqDomainPosition                      INTEGER (0..67),
    freqDomainShift                         INTEGER (0..268),
    freqHopping                             SEQUENCE {
        c-SRS                                   INTEGER (0..63),
        b-SRS                                   INTEGER (0..3),
        b-hop                                   INTEGER (0..3)
    },
    groupOrSequenceHopping                  ENUMERATED { neither, groupHopping, sequenceHopping },
    resourceType                            CHOICE {
        aperiodic                               SEQUENCE {
            ...
        },
        semi-persistent                         SEQUENCE {
            periodicityAndOffset-sp                     SRS-PeriodicityAndOffset,
            ...
        },
        periodic                                SEQUENCE {
            periodicityAndOffset-p                      SRS-PeriodicityAndOffset,
            ...
        }
    },
    sequenceId                              INTEGER (0..1023),
    spatialRelationInfo                     SRS-SpatialRelationInfo                                 OPTIONAL,   -- Need R
    ...
}
```

```
SRS-SpatialRelationInfo ::=     SEQUENCE {
    servingCellId                   ServCellIndex                                                       OPTIONAL,   -- Need S
    referenceSignal                 CHOICE {
        ssb-Index                       SSB-Index,
        csi-RS-Index                    NZP-CSI-RS-ResourceId,
        srs                             SEQUENCE {
            resourceId                      SRS-ResourceId,
            uplinkBWP                       BWP-Id
        }
    }
}


SRS-ResourceId ::=                  INTEGER (0..maxNrofSRS-Resources-1)

SRS-PeriodicityAndOffset ::=        CHOICE {
    sl1                                 NULL,
    sl2                                 INTEGER(0..1),
    sl4                                 INTEGER(0..3),
    sl5                                 INTEGER(0..4),
    sl8                                 INTEGER(0..7),
    sl10                                INTEGER(0..9),
    sl16                                INTEGER(0..15),
    sl20                                INTEGER(0..19),
    sl32                                INTEGER(0..31),
    sl40                                INTEGER(0..39),
    sl64                                INTEGER(0..63),
    sl80                                INTEGER(0..79),
    sl160                               INTEGER(0..159),
    sl320                               INTEGER(0..319),
    sl640                               INTEGER(0..639),
    sl1280                              INTEGER(0..1279),
    sl2560                              INTEGER(0..2559)
}

-- TAG-SRS-CONFIG-STOP
-- ASN1STOP
```

SRS-Config field descriptions
tpc-Accumulation If the field is absent, UE applies TPC commands via accumulation. If disabled, UE applies the TPC command without accumulation (this applies to SRS when a separate closed loop is configured for SRS) (see TS 38.213 [13], clause 7.3)

***SRS-Resource* field descriptions**
cyclicShift-n2 Cyclic shift configuration (see TS 38.214 [19], clause 6.2.1).
cyclicShift-n4 Cyclic shift configuration (see TS 38.214 [19], clause 6.2.1).
freqHopping Includes parameters capturing SRS frequency hopping (see TS 38.214 [19], clause 6.2.1).
groupOrSequenceHopping Parameter(s) for configuring group or sequence hopping (see TS 38.211 [16], clause 6.4.1.4.2).
periodicityAndOffset-p Periodicity and slot offset for this SRS resource. All values in "number of slots" sl1 corresponds to a periodicity of 1 slot, value sl2 corresponds to a periodicity of 2 slots, and so on. For each periodicity the corresponding offset is given in number of slots. For periodicity sl1 the offset is 0 slots (see TS 38.214 [19], clause 6.2.1).
periodicityAndOffset-sp Periodicity and slot offset for this SRS resource. All values in "number of slots". sl1 corresponds to a periodicity of 1 slot, value sl2 corresponds to a periodicity of 2 slots, and so on. For each periodicity the corresponding offset is given in number of slots. For periodicity sl1 the offset is 0 slots (see TS 38.214 [19], clause 6.2.1).
ptrs-PortIndex The PTRS port index for this SRS resource for non-codebook based UL MIMO. This is only applicable when the corresponding PTRS-UplinkConfig is set to CP-OFDM. The ptrs-PortIndex configured here must be smaller than or equal to the maxNnrofPorts configured in the PTRS-UplinkConfig (see TS 38.214 [19], clause 6.2.3.1).
resourceMapping OFDM symbol location of the SRS resource within a slot including number of OFDM symbols (N = 1, 2 or 4 per SRS resource), startPosition (SRSSymbolStartPosition = 0..5; "0" refers to the last symbol, "1" refers to the second last symbol) and RepetitionFactor (r = 1, 2 or 4) (see TS 38.214 [19], clause 6.2.1 and TS 38.211 [16], clause 6.4.1.4). The configured SRS resource does not exceed the slot boundary.
resourceType Periodicity and offset for semi-persistent and periodic SRS resource (see TS 38.214 [19], clause 6.2.1).
sequenceId Sequence ID used to initialize pseudo random group and sequence hopping (see TS 38.214 [19], clause 6.2.1).
spatialRelationInfo Configuration of the spatial relation between a reference RS and the target SRS. Reference RS can be SSB/CSI-RS/SRS (see TS 38.214 [19], clause 6.2.1).
transmissionComb Comb value (2 or 4) and comb offset (0..combValue-1) (see TS 38.214 [19], clause 6.2.1).

SRS-ResourceSet field descriptions
alpha alpha value for SRS power control (see TS 38.213 [13], clause 7.3). When the field is absent the UE applies the value 1.
aperiodicSRS-ResourceTriggerList An additional list of DCI "code points" upon which the UE shall transmit SRS according to this SRS resource set configuration (see TS 38.214 [19], clause 6.1.1.2).
aperiodicSRS-ResourceTrigger The DCI "code point" upon which the UE shall transmit SRS according to this SRS resource set configuration (see TS 38.214 [19], clause 6.1.1.2).
associatedCSI-RS ID of CSI-RS resource associated with this SRS resource set in non-codebook based operation (see TS 38.214 [19], clause 6.1.1.2).
csi-RS ID of CSI-RS resource associated with this SRS resource set. (see TS 38.214 [19], clause 6.1.1.2).
p0 P0 value for SRS power control. The value is in dBm. Only even values (step size 2) are allowed (see TS 38.213 [13], clause 7.3).
pathlossReferenceRS A reference signal (e.g. a CSI-RS config or a SS block) to be used for SRS path loss estimation (see TS 38.213 [13], clause 7.3).
resourceType Time domain behavior of SRS resource configuration. Corresponds to L1 parameter 'SRS-ResourceConfigType' (see TS 38.214 [19], clause 6.2.1). The network configures SRS resources in the same resource set with the same time domain behavior on periodic, aperiodic and semi-persistent SRS.
slotOffset An offset in number of slots between the triggering DCI and the actual transmission of this SRS-ResourceSet. If the field is absent the UE applies no offset (value 0).
srs-PowerControlAdjustmentStates Indicates whether hsrs,c(i) = fc(i,1) or hsrs,c(i) = fc(i,2) (if twoPUSCH-PC-AdjustmentStates are configured) or serarate close loop is configured for SRS. This parameter is applicable only for Uls on which UE also transmits PUSCH. If absent or release, the UE applies the value sameAs-Fci1 (see TS 38.213 [13], clause 7.3).
srs-ResourceIdList The IDs of the SRS-Resources used in this SRS-ResourceSet. If this SRS-ResourceSet is configured with usage set to codebook, the srs-ResourceIdList contains at most 2 entries. If this SRS-ResourceSet is configured with usage set to nonCodebook, the srs-ResourceIdList contains at most 4 entries.
srs-ResourceSetId The ID of this resource set. It is unique in the context of the BWP in which the parent SRS-Config is defined.
usage Indicates if the SRS resource set is used for beam management, codebook based or non-codebook based transmission or antenna switching. See TS 38.214 [19], clause 6.2.1.

Conditional Presence	Explanation
Setup	This field is mandatory present upon configuration of SRS-ResourceSet or SRS-Resource and optional (Need M) otherwise.
NonCodebook	This field is optionally present, Need M, in case of non-codebook based transmission, otherwise the field is absent.

– *SRS-TPC-CommandConfig*

The IE SRS-TPC-CommandConfig is used to configure the UE for extracting TPC commands for SRS from a group-TPC messages on DCI

***SRS-TPC-CommandConfig* information element**

```
-- ASN1START
-- TAG-SRS-TPC-COMMANDCONFIG-START
```

```
SRS-TPC-CommandConfig ::=           SEQUENCE {
    startingBitOfFormat2-3              INTEGER (1..31)                                                         OPTIONAL,   -- Need R
    fieldTypeFormat2-3                  INTEGER (0..1)                                                          OPTIONAL,   -- Need R
    ...,
    [[
    startingBitOfFormat2-3SUL-v1530     INTEGER (1..31)                                                         OPTIONAL    -- Need R
    ]]
}

-- TAG-SRS-TPC-COMMANDCONFIG-STOP
-- ASN1STOP
```

***SRS-TPC-CommandConfig* field descriptions**
fieldTypeFormat2-3 The type of a field within the group DCI with SRS request fields (optional), which indicates how many bits in the field are for SRS request (0 or 2). Note that for Type A, there is a common SRS request field for all SCells in the set, but each SCell has its own TPC command bits. See TS 38.212 [17] clause 7.3.1 and , TS 38.213 [13], clause 11.3.
startingBitOfFormat2-3 The starting bit position of a block within the group DCI with SRS request fields (optional) and TPC commands. The value 1 of the field corresponds to the first/left most bit of format2-3. The value 2 of the field corresponds to the second bit format2-3, and so on (see TS 38.212 [17], clause 7.3.1 and TS 38.213 [13], clause 11.3).
startingBitOfFormat2-3SUL The starting bit position of a block within the group DCI with SRS request fields (optional) and TPC commands for SUL carrier (see TS 38.212 [17], clause 7.3.1 and TS 38.213 [13], clause 11.3).

– *SSB-Index*

The IE *SSB-Index* identifies an SS-Block within an SS-Burst. See FFS_Ref, section FFS_Section.

SSB-Index information element

```
-- ASN1START
-- TAG-SSB-INDEX-START

SSB-Index ::=                       INTEGER (0..maxNrofSSBs-1)

-- TAG-SSB-INDEX-STOP
-- ASN1STOP
```

– *SSB-MTC*

The IE *SSB-MTC* is used to configure measurement timing configurations, i.e., timing occasions at which the UE measures SSBs.

SSB-MTC information element

```
-- ASN1START
-- TAG-SSB-MTC-START
```

```
SSB-MTC ::=                         SEQUENCE {
    periodicityAndOffset                CHOICE {
        sf5                             INTEGER (0..4),
        sf10                                INTEGER (0..9),
        sf20                                INTEGER (0..19),
        sf40                                INTEGER (0..39),
        sf80                                INTEGER (0..79),
        sf160                           INTEGER (0..159)
    },
    duration                            ENUMERATED { sf1, sf2, sf3, sf4, sf5 }
}

SSB-MTC2 ::=                    SEQUENCE {
    pci-List                        SEQUENCE (SIZE (1..maxNrofPCIsPerSMTC)) OF PhysCellId                      OPTIONAL,   -- Need M
    periodicity                     ENUMERATED {sf5, sf10, sf20, sf40, sf80, spare3, spare2, spare1}
}

-- TAG-SSB-MTC-STOP
-- ASN1STOP
```

***SSB-MTC*field descriptions**
duration Duration of the measurement window in which to receive SS/PBCH blocks. It is given in number of subframes (see TS 38.213 [13], clause 4.1).
periodicityAndOffset Periodicity and offset of the measurement window in which to receive SS/PBCH blocks. Periodicity and offset are given in number of subframes. FFS_FIXME: This does not match the L1 parameter table! They seem to intend an index to a hidden table in L1 specs. (see TS 38.213 [13], clause REF): Periodicity for the given PCIs. Timing offset and Duration as provided in smtc1.

***SSB-MTC2* field descriptions**
pci-List PCIs that are known to follow this SMTC.

– *SSB-ToMeasure*

The IE *SSB-ToMeasure* is used to configure a pattern of SSBs.

SSB-ToMeasure information element

```
-- ASN1START
-- TAG-SSB-TOMEASURE-START

SSB-ToMeasure ::=               CHOICE {
    shortBitmap                     BIT STRING (SIZE (4)),
    mediumBitmap                    BIT STRING (SIZE (8)),
    longBitmap                      BIT STRING (SIZE (64))
}

-- TAG-SSB-TOMEASURE-STOP
```

```
-- ASN1STOP
```

SSB-ToMeasure field descriptions
longBitmap Bitmap when maximum number of SS/PBCH blocks per half frame equals to 64 as defined in TS 38.213 [13], clause 4.1.
mediumBitmap Bitmap when maximum number of SS/PBCH blocks per half frame equals to 8 as defined in TS 38.213 [13], clause 4.1.
shortBitmap Bitmap when maximum number of SS/PBCH blocks per half frame equals to 4 as defined in TS 38.213 [13], clause 4.1.

– *SubcarrierSpacing*

The IE *SubcarrierSpacing* determines the subcarrier spacing. Restrictions applicable for certain frequencies, channels or signals are clarified in the fields that use this IE.

SubcarrierSpacing information element

```
-- ASN1START
-- TAG-SUBCARRIER-SPACING-START

SubcarrierSpacing ::=               ENUMERATED {kHz15, kHz30, kHz60, kHz120, kHz240, spare3, spare2, spare1}

-- TAG-SUBCARRIER-SPACING-STOP
-- ASN1STOP
```

– *TAG-Config*

The IE *TAG-Config* is used to configure parameters for a time-alignment group.

TAG-Config **information element**

```
-- ASN1START
-- TAG-TAG-CONFIG-START

TAG-Config ::=                      SEQUENCE {
    tag-ToReleaseList                   SEQUENCE (SIZE (1..maxNrofTAGs)) OF TAG-Id                          OPTIONAL,   -- Need N
    tag-ToAddModList                    SEQUENCE (SIZE (1..maxNrofTAGs)) OF TAG                             OPTIONAL    -- Need N
}

TAG ::=                             SEQUENCE {
    tag-Id                              TAG-Id,
    timeAlignmentTimer                  TimeAlignmentTimer,
    ...
}

TAG-Id ::=                          INTEGER (0..maxNrofTAGs-1)

TimeAlignmentTimer ::=              ENUMERATED {ms500, ms750, ms1280, ms1920, ms2560, ms5120, ms10240, infinity}
```

```
-- TAG-TAG-CONFIG-STOP
-- ASN1STOP
```

TAG field descriptions
tag-Id Indicates the TAG of the SpCell or an SCell, see TS 38.321 [3]. Uniquely identifies the TAG within the scope of a Cell Group (i.e. MCG or SCG). If the field is not configured for an SCell, the SCell is part of the PTAG.
timeAlignmentTimer Value in ms of the timeAlignmentTimer for TAG with ID tag-Id, as specified in TS 38.321 [3].

– *TCI-State*

The IE *TCI-State* associates one or two DL reference signals with a corresponding quasi-colocation (QCL) type.

TCI-State information element

```
-- ASN1START
-- TAG-TCI-STATE-START

TCI-State ::=                       SEQUENCE {
    tci-StateId                         TCI-StateId,
    qcl-Type1                           QCL-Info,
    qcl-Type2                           QCL-Info                                                        OPTIONAL,   -- Need R
    ...
}

QCL-Info ::=                        SEQUENCE {
    cell                                ServCellIndex                                                   OPTIONAL,   -- Need R
    bwp-Id                              BWP-Id                                                          OPTIONAL, -- Cond CSI-RS-Indicated
    referenceSignal                     CHOICE {
        csi-rs                              NZP-CSI-RS-ResourceId,
        ssb                                 SSB-Index
    },
    qcl-Type                            ENUMERATED {typeA, typeB, typeC, typeD},
    ...
}

-- TAG-TCI-STATE-STOP
-- ASN1STOP
```

***QCL-Info* field descriptions**
bwp-Id The DL BWP which the RS is located in.
cell The UE's serving cell in which the referenceSignal is configured. If the field is absent, it applies to the serving cell in which the TCI-State is configured. The RS can be located on a serving cell other than the serving cell in which the TCI-State is configured only if the qcl-Type is configured as typeC or typeD. See TS 38.214 [19] clause 5.1.5.
referenceSignal Reference signal with which quasi-collocation information is provided as specified in TS 38.214 [19] subclause 5.1.5.
qcl-Type QCL type as specified in TS 38.214 [19] subclause 5.1.5.

Conditional Presence	Explanation
CSI-RS-Indicated	This field is mandatory present if *csi-rs* or *csi-RS-for-tracking* is included, absent otherwise

– *TCI-StateId*

The IE *TCI-StateId* is used to identify one *TCI-State* configuration.

***TCI-StateId* information element**

```
-- ASN1START
-- TAG-TCI-STATEID-START

TCI-StateId ::=                     INTEGER (0..maxNrofTCI-States-1)

-- TAG-TCI-STATEID-STOP
-- ASN1STOP
```

– *TDD-UL-DL-Config*

The *TDD-UL-DL-Config* IEs determines the Uplink/Downlink TDD configuration. There are both, UE- and cell specific IEs.

***TDD-UL-DL-Config* information element**

```
-- ASN1START
-- TAG-TDD-UL-DL-CONFIG-START

TDD-UL-DL-ConfigCommon ::=          SEQUENCE {
    referenceSubcarrierSpacing          SubcarrierSpacing,
    pattern1                            TDD-UL-DL-Pattern,
    pattern2                            TDD-UL-DL-Pattern                                                   OPTIONAL, -- Need R
    ...
}

TDD-UL-DL-Pattern ::=               SEQUENCE {
```

```
    dl-UL-TransmissionPeriodicity       ENUMERATED {ms0p5, ms0p625, ms1, ms1p25, ms2, ms2p5, ms5, ms10},
    nrofDownlinkSlots                   INTEGER (0..maxNrofSlots),
    nrofDownlinkSymbols                 INTEGER (0..maxNrofSymbols-1),
    nrofUplinkSlots                     INTEGER (0..maxNrofSlots),
    nrofUplinkSymbols                   INTEGER (0..maxNrofSymbols-1),
    ...,
    [[
    dl-UL-TransmissionPeriodicity-v1530     ENUMERATED {ms3, ms4}                                                   OPTIONAL -- Need R
    ]]
}

TDD-UL-DL-ConfigDedicated ::=       SEQUENCE {
    slotSpecificConfigurationsToAddModList      SEQUENCE (SIZE (1..maxNrofSlots)) OF TDD-UL-DL-SlotConfig           OPTIONAL, -- Need N
    slotSpecificConfigurationsToreleaseList     SEQUENCE (SIZE (1..maxNrofSlots)) OF TDD-UL-DL-SlotIndex            OPTIONAL, -- Need N
    ...
}

TDD-UL-DL-SlotConfig ::=            SEQUENCE {
    slotIndex                           TDD-UL-DL-SlotIndex,
    symbols                             CHOICE {
        allDownlink                         NULL,
        allUplink                           NULL,
        explicit                            SEQUENCE {
            nrofDownlinkSymbols                 INTEGER (1..maxNrofSymbols-1)                                       OPTIONAL, -- Need S
            nrofUplinkSymbols                   INTEGER (1..maxNrofSymbols-1)                                       OPTIONAL  -- Need S
        }
    }
}

TDD-UL-DL-SlotIndex ::=             INTEGER (0..maxNrofSlots-1)

-- TAG-TDD-UL-DL-CONFIG-STOP
-- ASN1STOP
```

***TDD-UL-DL-ConfigCommon* field descriptions**
referenceSubcarrierSpacing Reference SCS used to determine the time domain boundaries in the UL-DL pattern which must be common across all subcarrier specific carriers, i.e., independent of the actual subcarrier spacing using for data transmission. Only the values 15, 30 or 60 kHz (<6GHz) and 60 or 120 kHz (>6GHz) are applicable. The network configures a not larger than any SCS of configured BWPs for the serving cell. Corresponds to L1 parameter 'reference-SCS' (see TS 38.213 [13], clause 11.1).

TDD-UL-DL-Pattern field descriptions
dl-UL-TransmissionPeriodicity Periodicity of the DL-UL pattern, see TS 38.213 [13], clause 11.1. If the *dl-UL-TransmissionPeriodicity-v1530* is signalled, UE shall ignore the *dl-UL-TransmissionPeriodicity* (without suffix).
nrofDownlinkSlots Number of consecutive full DL slots at the beginning of each DL-UL pattern, see TS 38.213 [13], clause 11.1. In this release, the maximum value for this field is 80.
nrofDownlinkSymbols Number of consecutive DL symbols in the beginning of the slot following the last full DL slot (as derived from nrofDownlinkSlots). The value 0 indicates that there is no partial-downlink slot. (see TS 38.213 [13], clause 11.1).
nrofUplinkSlots Number of consecutive full UL slots at the end of each DL-UL pattern, see TS 38.213 [13], clause 11.1. In this release, the maximum value for this field is 80.
nrofUplinkSymbols Number of consecutive UL symbols in the end of the slot preceding the first full UL slot (as derived from nrofUplinkSlots). The value 0 indicates that there is no partial-uplink slot. (see TS 38.213 [13], clause 11.1).

TDD-UL-DL-ConfigDedicated field descriptions
slotSpecificConfigurationsToAddModList The slotSpecificConfiguration allows overriding UL/DL allocations provided in tdd-UL-DL-configurationCommon, see TS 38.213 [13], clause 11.1.

TDD-UL-DL-SlotConfig field descriptions
nrofDownlinkSymbols Number of consecutive DL symbols in the beginning of the slot identified by slotIndex. If the field is absent the UE assumes that there are no leading DL symbols. (see TS 38.213 [13], section FFS_Section).
nrofUplinkSymbols Number of consecutive UL symbols in the end of the slot identified by slotIndex. If the field is absent the UE assumes that there are no trailing UL symbols. (see TS 38.213 [13], section FFS_Section).
slotIndex Identifies a slot within a dl-UL-TransmissionPeriodicity (given in tdd-UL-DL-configurationCommon).
symbols The direction (downlink or uplink) for the symbols in this slot. "allDownlink" indicates that all symbols in this slot are used for downlink; "allUplink" indicates that all symbols in this slot are used for uplink; "explicit" indicates explicitly how many symbols in the beginning and end of this slot are allocated to downlink and uplink, respectively.

– *TrackingAreaCode*

The IE *TrackingAreaCode* is used to identify a tracking area within the scope of a PLMN, see TS 24.501 [23].

TrackingAreaCode information element

```
-- ASN1START
-- TAG-TRACKINGAREACODE-START

TrackingAreaCode ::= BIT STRING (SIZE (24))

-- TAG-TRACKINGAREACODE-STOP
```

```
-- ASN1STOP
```

– *T-Reselection*

Editor's Note: Text and value converted from 36.331.

The IE *T-Reselection* concerns the cell reselection timer Treselection$_{RAT}$ for NR and E-UTRA Value in seconds. For value 0, behaviour as specified in 7.1.2 applies.

***T-Reselection*information element**

```
-- ASN1START
-- TAG-TRESELECTION-START

T-Reselection ::=                   INTEGER (0..7)

-- TAG-TRESELECTION-STOP
-- ASN1STOP
```

– *TimeToTrigger*

The IE *TimeToTrigger* specifies the value range used for time to trigger parameter, which concerns the time during which specific criteria for the event needs to be met in order to trigger a measurement report. Value ms0 corresponds to 0 ms and behaviour as specified in 7.1.2 applies, ms40 corresponds to 40 ms, and so on.

***TimeToTrigger* information element**

```
-- ASN1START
-- TAG-TIMETOTRIGGER-START

TimeToTrigger ::=                   ENUMERATED {
                                        ms0, ms40, ms64, ms80, ms100, ms128, ms160, ms256,
                                        ms320, ms480, ms512, ms640, ms1024, ms1280, ms2560,
                                        ms5120}

-- TAG-TIMETOTRIGGER-STOP
-- ASN1STOP
```

Editor's Note:: Values should be checked.

– UAC-BarringInfoSetIndex

The IE *UAC-BarringInfoSetIndex* provides the index of the entry in *uac-BarringInfoSetList*.

***UAC-BarringInfoSetIndex* information element**

```
-- ASN1START
-- TAG-UAC-BARRING-INFO-SET-INDEX-START
```

```
UAC-BarringInfoSetIndex  ::=                INTEGER (1..maxBarringInfoSet)

-- TAG-UAC-BARRING-INFO-SET-INDEX-STOP
-- ASN1STOP
```

***UAC-BarringInfoSetIndex* field descriptions**
uac-barringInfoSetIndex Index of the entry in field *uac-BarringInfoSetList*. Value 1 corresponds to the first entry in *uac-BarringInfoSetList,* value 2 corresponds to the second entry in this list and so on. An index value referring to an entry not included in *uac-BarringInfoSetList* indicates no barring.

– UAC-BarringInfoSetList

The IE *UAC-BarringInfoSetList* provides a list of access control parameter sets. An access category can be configured with access parameters according to one of the sets.

UAC-BarringInfoSetList information element

```
-- ASN1START
-- TAG-UAC-BARRING-INFO-SET-LIST-START

UAC-BarringInfoSetList ::=          SEQUENCE (SIZE(1..maxBarringInfoSet)) OF UAC-BarringInfoSet

UAC-BarringInfoSet ::=              SEQUENCE {
    uac-BarringFactor                   ENUMERATED {p00, p05, p10, p15, p20, p25, p30, p40,
                                                    p50, p60, p70, p75, p80, p85, p90, p95},
    uac-BarringTime                     ENUMERATED {s4, s8, s16, s32, s64, s128, s256, s512},
    uac-BarringForAccessIdentity        BIT STRING (SIZE(7))
}

-- TAG-UAC-BARRING-INFO-SET-LIST-STOP
-- ASN1STOP
```

***UAC-BarringInfoSetList* field descriptions**
uac-BarringInfoSetList List of access control parameter sets. Each access category can be configured with access parameters corresponding to a particular set by *uac-barringInfoSetIndex*. Association of an access category with an index that has no corresponding entry in the *uac-BarringInfoSetList* is valid configuration and indicates no barring.
uac-BarringForAccessIdentity Indicates whether access attempt is allowed for each Access Identity. The leftmost bit, bit 0 in the bit string corresponds to Access Identity 1, bit 1 in the bit string corresponds to Access Identity 2, bit 2 in the bit string corresponds to Access Identity 11, bit 3 in the bit string corresponds to Access Identity 12, bit 4 in the bit string corresponds to Access Identity 13, bit 5 in the bit string corresponds to Access Identity 14, and bit 6 in the bit string corresponds to Access Identity 15. Value 0 means that access attempt is allowed for the corresponding access identity.
uac-BarringFactor Represents the probability that access attempt would be allowed during access barring check.
uac-BarringTime The minimum time before a new access attempt is to be performed after an access attempt was barred at access barring check for the same access category.

– UAC-BarringPerCatList

The IE *UAC-BarringPerCatList* provides access control parameters for a list of access categories.

UAC-BarringPerCatList information element

```
-- ASN1START
-- TAG-UAC-BARRING-PER-CAT-LIST-START

UAC-BarringPerCatList ::=           SEQUENCE (SIZE (1..maxAccessCat-1)) OF UAC-BarringPerCat

UAC-BarringPerCat ::=               SEQUENCE {
   accessCategory                       INTEGER (1..maxAccessCat-1),
   uac-barringInfoSetIndex              UAC-BarringInfoSetIndex
}

-- TAG-UAC-BARRING-PER-CAT-LIST-STOP
-- ASN1STOP
```

***UAC-BarringPerCatList* field descriptions**
accessCategory The Access Category according to TS 22.261 [25].

– UAC-BarringPerPLMN-List

The IE *UAC-BarringPerPLMN-List* provides access category specific access control parameters, which are configured per PLMN.

UAC-BarringPerPLMN-List information element

```
-- ASN1START
-- TAG-UAC-BARRING-PER-PLMN-LIST-START

UAC-BarringPerPLMN-List ::=         SEQUENCE (SIZE (1.. maxPLMN)) OF UAC-BarringPerPLMN

UAC-BarringPerPLMN ::=              SEQUENCE {
    plmn-IdentityIndex                  INTEGER (1..maxPLMN),
    uac-ACBarringListType               CHOICE{
        uac-ImplicitACBarringList           SEQUENCE (SIZE(maxAccessCat-1)) OF UAC-BarringInfoSetIndex,
        uac-ExplicitACBarringList           UAC-BarringPerCatList
    }                                                                            OPTIONAL     -- Need S
}

-- TAG-UAC-BARRING-PER-PLMN-LIST-STOP
-- ASN1STOP
```

***UAC-BarringPerPLMN-List* field descriptions**
uac-ACBarringListType Access control parameters for each access category valid only for a specific PLMN. UE behaviour upon absence of this field is specified in clause 5.3.14.2.
plmn-IdentityIndex Index of the PLMN across the *plmn-IdentityList* fields included in SIB1.

– *UE-TimersAndConstants*

The IE UE-TimersAndConstants contains timers and constants used by the UE in RRC_CONNECTED, RRC_INACTIVE and RRC_IDLE.

***UE-TimersAndConstants* information element**

```
-- ASN1START
-- TAG-UE-TIMERS-AND-CONSTANTS-START

UE-TimersAndConstants ::=           SEQUENCE {
    t300                                ENUMERATED {ms100, ms200, ms300, ms400, ms600, ms1000, ms1500, ms2000},
    t301                                ENUMERATED {ms100, ms200, ms300, ms400, ms600, ms1000, ms1500, ms2000},
    t310                                ENUMERATED {ms0, ms50, ms100, ms200, ms500, ms1000, ms2000},
    n310                                ENUMERATED {n1, n2, n3, n4, n6, n8, n10, n20},
    t311                                ENUMERATED {ms1000, ms3000, ms5000, ms10000, ms15000, ms20000, ms30000},
    n311                                ENUMERATED {n1, n2, n3, n4, n5, n6, n8, n10},
    t319                                ENUMERATED {ms100, ms200, ms300, ms400, ms600, ms1000, ms1500, ms2000},
    ...
}

-- TAG-UE-TIMERS-AND-CONSTANTS-STOP
-- ASN1STOP
```

– UplinkConfigCommon

The IE *UplinkConfigCommon*provides common uplink parameters of a cell.

***UplinkConfigCommon*information element**

```
-- ASN1START
-- TAG-UPLINK-CONFIG-COMMON-START

UplinkConfigCommon ::=              SEQUENCE {
    frequencyInfoUL                     FrequencyInfoUL                                     OPTIONAL,   -- Cond InterFreqHOAndServCellAdd
    initialUplinkBWP                    BWP-UplinkCommon                                    OPTIONAL,   -- Cond ServCellAdd
    dummy                               TimeAlignmentTimer
}

-- TAG-UPLINK-CONFIG-COMMON-STOP
-- ASN1STOP
```

***UplinkConfigCommon* field descriptions**
frequencyInfoUL Absolute uplink frequency configuration and subcarrier specific virtual carriers.
initialUplinkBWP The initial uplink BWP configuration for a SpCell (PCell of MCG or SCG) and SCell (see TS 38.213 [13], clause 12).

Conditional Presence	Explanation
InterFreqHOAndServCellAdd	This field is mandatory present for inter-frequency handover and upon serving cell (PSCell/SCell) addition. Otherwise, the field is optionally present, Need M.
ServCellAdd	This field is mandatory present upon serving cell addition (for PSCell and SCell). It is optionally present, Need M otherwise.

– *UplinkConfigCommonSIB*

The IE *UplinkConfigCommonSIB* provides common uplink parameters of a cell.

UplinkConfigCommonSIB information element

```
-- ASN1START
-- TAG-UPLINK-CONFIG-COMMON-START

UplinkConfigCommonSIB ::=               SEQUENCE {
    frequencyInfoUL                         FrequencyInfoUL-SIB,
    initialUplinkBWP                        BWP-UplinkCommon,
    timeAlignmentTimerCommon                TimeAlignmentTimer
}

-- TAG-UPLINK-CONFIG-COMMON-STOP
-- ASN1STOP
```

***UplinkConfigCommonSIB* field descriptions**
frequencyInfoUL Absolute uplink frequency configuration and subcarrier specific virtual carriers.
InitialUplinkBWP The initial uplink BWP configuration for a SpCell (PCell of MCG or SCG) (see TS 38.213 [13], clause 12).

– *UplinkTxDirectCurrentList*

The IE *UplinkTxDirectCurrentList* indicates the Tx Direct Current locations per serving cell for each configured UL BWP in the serving cell, based on the BWP numerology and the associated carrier bandwidth.

UplinkTxDirectCurrentList information element

```
-- ASN1START
-- TAG-UPLINKTXDIRECTCURRENTLIST-START
```

```
UplinkTxDirectCurrentList ::=           SEQUENCE (SIZE (1..maxNrofServingCells)) OF UplinkTxDirectCurrentCell

UplinkTxDirectCurrentCell ::=           SEQUENCE {
    servCellIndex                           ServCellIndex,
    uplinkDirectCurrentBWP                  SEQUENCE (SIZE (1..maxNrofBWPs)) OF UplinkTxDirectCurrentBWP,
    ...
}

UplinkTxDirectCurrentBWP ::=            SEQUENCE {
    bwp-Id                                  BWP-Id,
    shift7dot5kHz                           BOOLEAN,
    txDirectCurrentLocation                 INTEGER (0..3301)
}

-- TAG-UPLINKTXDIRECTCURRENTLIST-STOP
-- ASN1STOP
```

***UplinkTxDirectCurrentBWP* field descriptions**
bwp-Id The BWP-Id of the corresponding uplink BWP.
shift7dot5kHz Indicates whether there is 7.5 kHz shift or not. 7.5 kHz shift is applied if the field is set to TRUE. Otherwise 7.5 kHz shift is not applied.
txDirectCurrentLocation The uplink Tx Direct Current location for the carrier. Only values in the value range of this field between 0 and 3299, which indicate the subcarrier index within the carrier corresponding to the numerology of the corresponding uplink BWP and value 3300, which indicates "Outside the carrier" and value 3301, which indicates "Undetermined position within the carrier" are used in this version of the specification.

***UplinkTxDirectCurrentCell* field descriptions**
servCellIndex The serving cell ID of the serving cell corresponding to the uplinkDCLocationsPerBWP.
uplinkDirectCurrentBWP The Tx Direct Current locations for all the uplink BWPs configured at the corresponding serving cell.

– *ZP-CSI-RS-Resource*

The IE *ZP-CSI-RS-Resource* is used to configure a Zero-Power (ZP) CSI-RS resource (see TS 38.214 [19], clause 5.1.4.2).

ZP-CSI-RS-Resource information element

```
-- ASN1START
-- TAG-ZP-CSI-RS-RESOURCE-START

ZP-CSI-RS-Resource ::=              SEQUENCE {
    zp-CSI-RS-ResourceId                ZP-CSI-RS-ResourceId,
    resourceMapping                     CSI-RS-ResourceMapping,
    periodicityAndOffset                CSI-ResourcePeriodicityAndOffset                        OPTIONAL, --Cond PeriodicOrSemiPersistent
```

```
    ...
}

ZP-CSI-RS-ResourceId ::=            INTEGER (0..maxNrofZP-CSI-RS-Resources-1)

-- TAG-ZP-CSI-RS-RESOURCE-STOP
-- ASN1STOP
```

ZP-CSI-RS-Resource field descriptions
periodicityAndOffset Periodicity and slot offset for periodic/semi-persistent ZP-CSI-RS (see TS 38.214 [19], clause 5.1.4.2).
resourceMapping OFDM symbol and subcarrier occupancy of the ZP-CSI-RS resource within a slot.
zp-CSI-RS-ResourceId ZP CSI-RS resource configuration ID (see TS 38.214 [19], clause 5.1.4.2).

– *ZP-CSI-RS-ResourceSet*

The IE *ZP-CSI-RS-ResourceSet* refers to a set of *ZP-CSI-RS-Resources* using their *ZP-CSI-RS-ResourceId*s. It corresponds to the L1 parameter '*ZP-CSI-RS-ResourceSetConfigList*'.

ZP-CSI-RS-ResourceSet information element

```
-- ASN1START
-- TAG-ZP-CSI-RS-RESOURCESET-START

ZP-CSI-RS-ResourceSet ::=           SEQUENCE {
    zp-CSI-RS-ResourceSetId             ZP-CSI-RS-ResourceSetId,
    zp-CSI-RS-ResourceIdList            SEQUENCE (SIZE(1..maxNrofZP-CSI-RS-ResourcesPerSet)) OF ZP-CSI-RS-ResourceId,
    ...
}

-- TAG-ZP-CSI-RS-RESOURCESET-STOP
-- ASN1STOP
```

ZP-CSI-RS-ResourceSet field descriptions
zp-CSI-RS-ResourceIdList The list of ZP-CSI-RS-ResourceId identifying the ZP-CSI-RS-Resource elements belonging to this set.

– *ZP-CSI-RS-ResourceSetId*

The IE *ZP-CSI-RS-ResourceSetId* identifies a *ZP-CSI-RS-ResourceSet*.

ZP-CSI-RS-ResourceSetId information element

```
-- ASN1START
-- TAG-ZP-CSI-RS-RESOURCESETID-START

ZP-CSI-RS-ResourceSetId ::=                     INTEGER (0..maxNrofZP-CSI-RS-ResourceSets-1)

-- TAG-ZP-CSI-RS-RESOURCESETID-STOP
-- ASN1STOP
```

6.3.3 UE capability information elements

– *AccessStratumRelease*

The IE *AccessStratumRelease* indicates the release supported by the UE.

AccessStratumRelease information element

```
-- ASN1START
-- TAG-ACCESSSTRATUMRELEASE-START

AccessStratumRelease ::= ENUMERATED {
                            rel15, spare7, spare6, spare5, spare4, spare3, spare2, spare1, ... }

-- TAG-ACCESSSTRATUMRELEASE-STOP
-- ASN1STOP
```

– *BandCombinationList*

The IE *BandCombinationList* contains a list of NR CA and/or MR-DC band combinations (also including DL only or UL only band).

BandCombinationList information element

```
-- ASN1START
-- TAG-BANDCOMBINATIONLIST-START

BandCombinationList ::=             SEQUENCE (SIZE (1..maxBandComb)) OF BandCombination

BandCombinationList-v1540 ::=       SEQUENCE (SIZE (1..maxBandComb)) OF BandCombination-v1540

BandCombination ::=                 SEQUENCE {
    bandList                            SEQUENCE (SIZE (1..maxSimultaneousBands)) OF BandParameters,
    featureSetCombination               FeatureSetCombinationId,

    ca-ParametersEUTRA                  CA-ParametersEUTRA                      OPTIONAL,
    ca-ParametersNR                     CA-ParametersNR                         OPTIONAL,
    mrdc-Parameters                     MRDC-Parameters                         OPTIONAL,
    supportedBandwidthCombinationSet    BIT STRING (SIZE (1..32))               OPTIONAL,
    powerClass-v1530                    ENUMERATED {pc2}                        OPTIONAL
```

```
}

BandCombination-v1540::=            SEQUENCE {
    bandList-v1540                      SEQUENCE (SIZE (1..maxSimultaneousBands)) OF BandParameters-v1540,
    ca-ParametersNR-v1540               CA-ParametersNR-v1540                   OPTIONAL
}

BandParameters ::=                      CHOICE {
    eutra                               SEQUENCE {
        bandEUTRA                           FreqBandIndicatorEUTRA,
        ca-BandwidthClassDL-EUTRA           CA-BandwidthClassEUTRA              OPTIONAL,
        ca-BandwidthClassUL-EUTRA           CA-BandwidthClassEUTRA              OPTIONAL
    },
    nr                                  SEQUENCE {
        bandNR                              FreqBandIndicatorNR,
        ca-BandwidthClassDL-NR              CA-BandwidthClassNR                 OPTIONAL,
        ca-BandwidthClassUL-NR              CA-BandwidthClassNR                 OPTIONAL
    }
}

BandParameters-v1540 ::=            SEQUENCE {
    srs-CarrierSwitch                   CHOICE {
        nr                                  SEQUENCE {
            srs-SwitchingTimesListNR            SEQUENCE (SIZE (1..maxSimultaneousBands)) OF SRS-SwitchingTimeNR
        },
        eutra                               SEQUENCE {
            srs-SwitchingTimesListEUTRA         SEQUENCE (SIZE (1..maxSimultaneousBands)) OF SRS-SwitchingTimeEUTRA
        }
    }                                                                           OPTIONAL,
    srs-TxSwitch-v1540                  SEQUENCE {
        supportedSRS-TxPortSwitch       ENUMERATED {t1r2, t1r4, t2r4, t1r4-t2r4, t1r1, t2r2, t4r4, notSupported},
        txSwitchImpactToRx              INTEGER (1..32)                         OPTIONAL,
        txSwitchWithAnotherBand         INTEGER (1..32)                         OPTIONAL
    }                                                                           OPTIONAL
}

-- TAG-BANDCOMBINATIONLIST-STOP
-- ASN1STOP
```

BandCombination field descriptions
BandCombinationList-v1540 The UE shall include the same number of entries, and listed in the same order, as in *BandCombinationList* (without suffix).
powerClass Power class that the UE supports when operating according to this band combination. If the field is absent, the UE supports the default power class. If this power class is higher than the power class that the UE supports on the individual bands of this band combination (ue-PowerClass in BandNR), the latter determines maximum TX power available in each band. The UE sets the new power class parameter only in band combinations with two FR1 uplink serving cells.
supportedBandwidthCombinationSet For NR SA and for inter-band EN-DC, the field defines the bandwidth combinations for the NR part of the band combination. For intra-band EN-DC, the field indicates the supported bandwidth combination set applicable to the NR and LTE band combinations. The first (left-most) bit in the bitmap corresponds to the BWCS#0 and so on. If the bit is set to 1, the UE supports the corresponding BWCS.
srs-SwitchingTimesListNR Indicates, for a particular pair of NR bands, the RF retuning time when switching between a NR carrier corresponding to this band entry and another (PUSCH-less) NR carrier corresponding to the band entry in the order indicated below: - For the first NR band, the UE shall include the same number of entries for NR bands as in bandList i.e. first entry corresponds to first NR band in *bandList* and so on, - For the second NR band, the UE shall include one entry less i.e. first entry corresponds to the second NR band in bandList and so on - And so on
srs-SwitchingTimesListEUTRA Indicates, for a particular pair of E-UTRA bands, the RF retuning time when switching between an E-UTRA carrier corresponding to this band entry and another (PUSCH-less) E-UTRA carrier corresponding to the band entry in the order indicated below: - For the first E-UTRA band, the UE shall include the same number of entries for E-UTRA bands as in *bandList* i.e. first entry corresponds to first E-UTRA band in *bandList* and so on, - For the second E-UTRA band, the UE shall include one entry less i.e. first entry corresponds to the second E-UTRA band in *bandList* and so on - And so on

– *CA-BandwidthClassEUTRA*

```
-- ASN1START
-- TAG-CA-BANDWIDTHCLASSEUTRA-START

CA-BandwidthClassEUTRA ::=          ENUMERATED {a, b, c, d, e, f, ...}

-- TAG-CA-BANDWIDTHCLASSEUTRA-STOP
-- ASN1STOP
```

– *CA-BandwidthClassNR*

```
-- ASN1START
-- TAG-CA-BANDWIDTHCLASSNR-START

CA-BandwidthClassNR ::=             ENUMERATED {a, b, c, d, e, f, g, h, i, j, k, l, m, n, o, p, q, ...}

-- TAG-CA-BANDWIDTHCLASSNR-STOP
-- ASN1STOP
```

– *CA-ParametersEUTRA*

The IE *CA-ParameterEUTRA* contains the E-UTRA part of band combination parameters for a given MR-DC band combination.

NOTE: If an additional E-UTRA band combination parameters are defined in TS 36.331 [10], which are supported for MR-DC, they will be defined here as well.

```
-- ASN1START
-- TAG-CA-PARAMETERSEUTRA-START

CA-ParametersEUTRA ::=                          SEQUENCE {
    multipleTimingAdvance                           ENUMERATED {supported}                          OPTIONAL,
    simultaneousRx-Tx                               ENUMERATED {supported}                          OPTIONAL,
    supportedNAICS-2CRS-AP                          BIT STRING (SIZE (1..8))                        OPTIONAL,
    additionalRx-Tx-PerformanceReq                  ENUMERATED {supported}                          OPTIONAL,
    ue-CA-PowerClass-N                              ENUMERATED {class2}                             OPTIONAL,
    supportedBandwidthCombinationSetEUTRA-v1530     BIT STRING (SIZE (1..32))                       OPTIONAL,
    ...
}

-- TAG-CA-PARAMETERSEUTRA-STOP
-- ASN1STOP
```

CA-ParametersEUTRA field descriptions
supportedBandwidthCombinationSetEUTRA Indicates the set of supported bandwidth combinations for the LTE part for inter-band EN-DC. The first (left-most) bit in the bitmap corresponds to the BWCS#0 and so on. If the bit is set to 1, the UE supports the corresponding BWCS.

– *CA-ParametersNR*

The IE *CA-ParametersNR* contains carrier aggregation related capabilities that are defined per band combination.

CA-ParametersNR information element

```
-- ASN1START
-- TAG-CA-PARAMETERSNR-START

CA-ParametersNR ::=                 SEQUENCE {
    multipleTimingAdvances              ENUMERATED {supported}      OPTIONAL,
    parallelTxSRS-PUCCH-PUSCH           ENUMERATED {supported}      OPTIONAL,
    parallelTxPRACH-SRS-PUCCH-PUSCH     ENUMERATED {supported}      OPTIONAL,
    simultaneousRxTxInterBandCA         ENUMERATED {supported}      OPTIONAL,
    simultaneousRxTxSUL                 ENUMERATED {supported}      OPTIONAL,
    diffNumerologyAcrossPUCCH-Group     ENUMERATED {supported}      OPTIONAL,
    diffNumerologyWithinPUCCH-Group     ENUMERATED {supported}      OPTIONAL,
    supportedNumberTAG                  ENUMERATED {n2, n3, n4}     OPTIONAL,
    ...
}

CA-ParametersNR-v1540 ::=           SEQUENCE {
```

```
    simultaneousSRS-AssocCSI-RS-AllCC                         INTEGER (5..32)         OPTIONAL,
    csi-RS-IM-ReceptionForFeedbackPerBandComb                 SEQUENCE {
        maxNumberSimultaneousNZP-CSI-RS-ActBWP-AllCC              INTEGER (1..64)     OPTIONAL,
        totalNumberPortsSimultaneousNZP-CSI-RS-ActBWP-AllCC      INTEGER (2..256)    OPTIONAL
    }                                                                                    OPTIONAL,
    simultaneousCSI-ReportsAllCC                              INTEGER (5..32)         OPTIONAL,
    dualPA-Architecture                                       ENUMERATED {supported}  OPTIONAL
}

-- TAG-CA-PARAMETERSNR-STOP
-- ASN1STOP
```

CA-ParametersNR field description
maxNumberSimultaneousNZP-CSI-RS-ActBWP-AllCC Limits the total number of NZP-CSI-RS resources that the NW may configure across all CCs (irrespective of the associated codebook type). The network applies this limit in addition to the limits signalled in *MIMO-ParametersPerBand-> maxNumberSimultaneousNZP-CSI-RS-PerCC* and in *Phy-ParametersFRX-Diff-> maxNumberSimultaneousNZP-CSI-RS-PerCC*.
simultaneousCSI-ReportsAllCC This parameter may further limit *simultaneousCSI-ReportsPerCC* in *MIMO-ParametersPerBand* and *Phy-ParametersFRX-Diff* for each band in a given band combination.
simultaneousSRS-AssocCSI-RS-AllCC This parameter may further limit *simultaneousSRS-AssocCSI-RS-PerCC* in *MIMO-ParametersPerBand* and *Phy-ParametersFRX-Diff* for each band in a given band combination.
totalNumberPortsSimultaneousNZP-CSI-RS-ActBWP-AllCC Limits the total number of ports that the NW may configure across all NZP-CSI-RS resources across all CCs (irrespective of the associated codebook type). The network applies this limit in addition to the limits signalled in *MIMO-ParametersPerBand-> totalNumberPortsSimultaneousNZP-CSI-RS-PerCC* and in *Phy-ParametersFRX-Diff-> totalNumberPortsSimultaneousNZP-CSI-RS-PerCC*.

– *CodebookParameters*

The IE *CodebookParameters* is used to convey codebook related parameters.

***CodebookParameters* information element**

```
-- ASN1START
-- TAG-CODEBOOKPARAMETERS-START

CodebookParameters ::=             SEQUENCE {
    type1                                SEQUENCE {
        singlePanel                          SEQUENCE {
            supportedCSI-RS-ResourceList       SEQUENCE (SIZE (1.. maxNrofCSI-RS-Resources)) OF SupportedCSI-RS-Resource,
            modes                                 ENUMERATED {mode1, mode1andMode2},
            maxNumberCSI-RS-PerResourceSet     INTEGER (1..8)
        },
        multiPanel                           SEQUENCE {
            supportedCSI-RS-ResourceList      SEQUENCE (SIZE (1.. maxNrofCSI-RS-Resources)) OF SupportedCSI-RS-Resource,
            modes                                 ENUMERATED {mode1, mode2, both},
            nrofPanels                           ENUMERATED {n2, n4},
            maxNumberCSI-RS-PerResourceSet     INTEGER (1..8)
```

```
        }                                                                                          OPTIONAL
    },
    type2                                   SEQUENCE {
        supportedCSI-RS-ResourceList         SEQUENCE (SIZE (1.. maxNrofCSI-RS-Resources)) OF SupportedCSI-RS-Resource,
        parameterLx                            INTEGER (2..4),
        amplitudeScalingType                  ENUMERATED {wideband, widebandAndSubband},
        amplitudeSubsetRestriction           ENUMERATED {supported}              OPTIONAL
    }                                                                                              OPTIONAL,
    type2-PortSelection                     SEQUENCE {
        supportedCSI-RS-ResourceList           SEQUENCE (SIZE (1.. maxNrofCSI-RS-Resources)) OF SupportedCSI-RS-Resource,
        parameterLx                              INTEGER (2..4),
        amplitudeScalingType                    ENUMERATED {wideband, widebandAndSubband}
    }                                                                                              OPTIONAL
}

SupportedCSI-RS-Resource ::=     SEQUENCE {
    maxNumberTxPortsPerResource      ENUMERATED {p2, p4, p8, p12, p16, p24, p32},
    maxNumberResourcesPerBand        INTEGER (1..64),
    totalNumberTxPortsPerBand        INTEGER (2..256)
}

-- TAG-CODEBOOKPARAMETERS-STOP
-- ASN1STOP
```

– *FeatureSetCombination*

The IE FeatureSetCombination is a two-dimensional matrix of FeatureSet entries.

Each FeatureSetsPerBand contains a list of feature sets applicable to the carrier(s) of one band entry of the associated band combination. Across the associated bands, the UE shall support the combination of FeatureSets at the same position in the FeatureSetsPerBand. All FeatureSetsPerBand in one FeatureSetCombination must have the same number of entries.

The number of FeatureSetsPerBand in the FeatureSetCombination must be equal to the number of band entries in an associated band combination. The first FeatureSetPerBand applies to the first band entry of the band combination, and so on.

Each FeatureSet contains either a pair of NR- or E-UTRA feature set IDs for UL and DL.

In case of NR, the actual feature sets for UL and DL are defined in the FeatureSets IE and referred to from here by their ID, i.e., their position in the featureSetsUplink / featureSetsDownlink list in the FeatureSet IE.

In case of E-UTRA, the feature sets referred to from this list are defined in TS 36.331 [10] and conveyed as part of the UE-EUTRA-Capability container. The FeatureSetUL-Id-r15 and FeatureSetDL-Id-r15 in the E-UTRA feature sets correspond to the FeatureSetEUTRA-DownlinkId and FeatureSetEUTRA-UplinkId, respectively.

The FeatureSetUplink and FeatureSetDownlink referred to from the FeatureSet comprise, among other information, a set of FeatureSetUplinkPerCC-Id:s and FeatureSetDownlinkPerCC-Id:s. The number of these per-CC IDs determines the number of carriers that the UE is able to aggregate contiguously in frequency domain in the corresponding band. The number of carriers supported by the UE is also restricted by the BWC indicated in the associated BandCombination, if present.

In feature set combinations the UE shall exclude entries for fallback combinations with same capabilities since the network may anyway assume that the UE supports those.

NOTE: The UE may advertise fallback band-combinations in which it supports additional functionality explicitly in two ways: Either by setting FeatureSet IDs to zero (inter-band and intra-band non-contiguous fallback) and by reducing the number of FeatureSet-PerCC Ids in a Feature Set (intra-band contiguous fallback). Or by separate BandCombination entries with associated FeatureSetCombinations.

NOTE: The UE may advertise a FeatureSetCombinations containing only fallback band combinations. That means, in a FeatureSetCombination each group of FeatureSets across the bands may contain at least one pair of FeatureSetUplinkId and FeatureSetDownlinkId which is set to 0/0.

FeatureSetCombination information element

```
-- ASN1START
-- TAG-FEATURESETCOMBINATION-START

FeatureSetCombination ::=       SEQUENCE (SIZE (1..maxSimultaneousBands)) OF FeatureSetsPerBand

FeatureSetsPerBand ::=          SEQUENCE (SIZE (1..maxFeatureSetsPerBand)) OF FeatureSet

FeatureSet ::=                  CHOICE {
    eutra                           SEQUENCE {
        downlinkSetEUTRA                FeatureSetEUTRA-DownlinkId,
        uplinkSetEUTRA                  FeatureSetEUTRA-UplinkId
    },
    nr                              SEQUENCE {
        downlinkSetNR                   FeatureSetDownlinkId,
        uplinkSetNR                     FeatureSetUplinkId
    }
}

-- TAG-FEATURESETCOMBINATION-STOP
-- ASN1STOP
```

– *FeatureSetCombinationId*

The IE *FeatureSetCombinationId* identifies a FeatureSetCombination. The *FeatureSetCombinationId* of a *FeatureSetCombination* is the position of the *FeatureSetCombination* in the featureSetCombinations list (in *UE-NR-Capability* or *UE-MRDC-Capability*).

NOTE: The *FeatureSetCombinationId* = 1024 is not used due to the maximum entry number of *featureSetCombinations*.

FeatureSetCombinationId information element

```
-- ASN1START
-- TAG-FEATURESET-COMBINATION-ID-START

FeatureSetCombinationId ::=         INTEGER (0.. maxFeatureSetCombinations)

-- TAG-FEATURESET-COMBINATION-ID-STOP
-- ASN1STOP
```

– *FeatureSetDownlink*

The IE *FeatureSetDownlink* indicates a set of features that the UE supports on the carriers corresponding to one band entry in a band combination.

FeatureSetDownlink information element

```
-- ASN1START
-- TAG-FEATURESETDOWNLINK-START

FeatureSetDownlink ::=                  SEQUENCE {
    featureSetListPerDownlinkCC             SEQUENCE (SIZE (1..maxNrofServingCells)) OF FeatureSetDownlinkPerCC-Id,

    intraBandFreqSeparationDL               FreqSeparationClass                                                 OPTIONAL,
    scalingFactor                           ENUMERATED {f0p4, f0p75, f0p8}                                      OPTIONAL,
    crossCarrierScheduling-OtherSCS         ENUMERATED {supported}                                              OPTIONAL,
    scellWithoutSSB                         ENUMERATED {supported}                                              OPTIONAL,
    csi-RS-MeasSCellWithoutSSB              ENUMERATED {supported}                                              OPTIONAL,
    dummy1                                  ENUMERATED {supported}                                              OPTIONAL,
    type1-3-CSS                             ENUMERATED {supported}                                              OPTIONAL,
    pdcch-MonitoringAnyOccasions            ENUMERATED {withoutDCI-Gap, withDCI-Gap}                            OPTIONAL,
    dummy2                                  ENUMERATED {supported}                                              OPTIONAL,
    ue-SpecificUL-DL-Assignment             ENUMERATED {supported}                                              OPTIONAL,
    searchSpaceSharingCA-DL                 ENUMERATED {supported}                                              OPTIONAL,
    timeDurationForQCL                      SEQUENCE {
        scs-60kHz                           ENUMERATED {s7, s14, s28}                                           OPTIONAL,
        scs-120kHz                          ENUMERATED {s14, s28}                                               OPTIONAL
    }                                                                                                           OPTIONAL,
    pdsch-ProcessingType1-DifferentTB-PerSlot SEQUENCE {
        scs-15kHz                               ENUMERATED {upto2, upto4, upto7}                                OPTIONAL,
        scs-30kHz                               ENUMERATED {upto2, upto4, upto7}                                OPTIONAL,
        scs-60kHz                               ENUMERATED {upto2, upto4, upto7}                                OPTIONAL,
        scs-120kHz                              ENUMERATED {upto2, upto4, upto7}                                OPTIONAL
    }                                                                                                           OPTIONAL,
    dummy3                                  DummyA                                                              OPTIONAL,
    dummy4                                  SEQUENCE (SIZE (1.. maxNrofCodebooks)) OF DummyB                    OPTIONAL,
    dummy5                                  SEQUENCE (SIZE (1.. maxNrofCodebooks)) OF DummyC                    OPTIONAL,
    dummy6                                  SEQUENCE (SIZE (1.. maxNrofCodebooks)) OF DummyD                    OPTIONAL,
    dummy7                                  SEQUENCE (SIZE (1.. maxNrofCodebooks)) OF DummyE                    OPTIONAL
}

FeatureSetDownlink-v1540 ::= SEQUENCE {
    oneFL-DMRS-TwoAdditionalDMRS-DL         ENUMERATED {supported}                      OPTIONAL,
    additionalDMRS-DL-Alt                   ENUMERATED {supported}                      OPTIONAL,
    twoFL-DMRS-TwoAdditionalDMRS-DL         ENUMERATED {supported}                      OPTIONAL,
    oneFL-DMRS-ThreeAdditionalDMRS-DL       ENUMERATED {supported}                      OPTIONAL,
    pdcch-MonitoringAnyOccasionsWithSpanGap SEQUENCE {
        scs-15kHz                               ENUMERATED {set1, set2, set3}           OPTIONAL,
        scs-30kHz                               ENUMERATED {set1, set2, set3}           OPTIONAL,
        scs-60kHz                               ENUMERATED {set1, set2, set3}           OPTIONAL,
        scs-120kHz                              ENUMERATED {set1, set2, set3}           OPTIONAL
    } OPTIONAL,
    pdsch-SeparationWithGap                 ENUMERATED {supported}                      OPTIONAL,
    pdsch-ProcessingType2                   SEQUENCE {
```

```
        scs-15kHz                               ProcessingParameters                     OPTIONAL,
        scs-30kHz                               ProcessingParameters                     OPTIONAL,
        scs-60kHz                               ProcessingParameters                     OPTIONAL
    } OPTIONAL,
    pdsch-ProcessingType2-Limited           SEQUENCE {
        differentTB-PerSlot-SCS-30kHz           ENUMERATED {upto1, upto2, upto4, upto7}
    } OPTIONAL,
    dl-MCS-TableAlt-DynamicIndication       ENUMERATED {supported}                       OPTIONAL
}

DummyA ::=      SEQUENCE {
    maxNumberNZP-CSI-RS-PerCC                   INTEGER (1..32),
    maxNumberPortsAcrossNZP-CSI-RS-PerCC        ENUMERATED {p2, p4, p8, p12, p16, p24, p32, p40, p48, p56, p64, p72, p80,
                                                            p88, p96, p104, p112, p120, p128, p136, p144, p152, p160, p168,
                                                            p176, p184, p192, p200, p208, p216, p224, p232, p240, p248, p256},
    maxNumberCS-IM-PerCC                        ENUMERATED {n1, n2, n4, n8, n16, n32},
    maxNumberSimultaneousCSI-RS-ActBWP-AllCC    ENUMERATED {n5, n6, n7, n8, n9, n10, n12, n14, n16, n18, n20, n22, n24, n26,
                                                                n28, n30, n32, n34, n36, n38, n40, n42, n44, n46, n48, n50, n52,
                                                                n54, n56, n58, n60, n62, n64},
    totalNumberPortsSimultaneousCSI-RS-ActBWP-AllCC ENUMERATED {p8, p12, p16, p24, p32, p40, p48, p56, p64, p72, p80,
                                                                p88, p96, p104, p112, p120, p128, p136, p144, p152, p160, p168,
                                                                p176, p184, p192, p200, p208, p216, p224, p232, p240, p248, p256}
}

DummyB ::=       SEQUENCE {
    maxNumberTxPortsPerResource         ENUMERATED {p2, p4, p8, p12, p16, p24, p32},
    maxNumberResources                  INTEGER (1..64),
    totalNumberTxPorts                  INTEGER (2..256),
    supportedCodebookMode               ENUMERATED {mode1, mode1AndMode2},
    maxNumberCSI-RS-PerResourceSet      INTEGER (1..8)
}

DummyC ::=        SEQUENCE {
    maxNumberTxPortsPerResource         ENUMERATED {p8, p16, p32},
    maxNumberResources                  INTEGER (1..64),
    totalNumberTxPorts                  INTEGER (2..256),
    supportedCodebookMode               ENUMERATED {mode1, mode2, both},
    supportedNumberPanels               ENUMERATED {n2, n4},
    maxNumberCSI-RS-PerResourceSet      INTEGER (1..8)
}

DummyD ::=                 SEQUENCE {
    maxNumberTxPortsPerResource         ENUMERATED {p4, p8, p12, p16, p24, p32},
    maxNumberResources                  INTEGER (1..64),
    totalNumberTxPorts                  INTEGER (2..256),
    parameterLx                         INTEGER (2..4),
    amplitudeScalingType                ENUMERATED {wideband, widebandAndSubband},
    amplitudeSubsetRestriction          ENUMERATED {supported}                          OPTIONAL,
    maxNumberCSI-RS-PerResourceSet      INTEGER (1..8)
}

DummyE ::=    SEQUENCE {
    maxNumberTxPortsPerResource         ENUMERATED {p4, p8, p12, p16, p24, p32},
    maxNumberResources                  INTEGER (1..64),
```

```
    totalNumberTxPorts                  INTEGER (2..256),
    parameterLx                         INTEGER (2..4),
    amplitudeScalingType                ENUMERATED {wideband, widebandAndSubband},
    maxNumberCSI-RS-PerResourceSet      INTEGER (1..8)
}

-- TAG-FEATURESETDOWNLINK-STOP
-- ASN1STOP
```

FeatureSetDownlink field descriptions
crossCarrierScheduling-OtherSCS The UE shall set this field to the same value as *crossCarrierScheduling-OtherSCS* in the associated FeatureSetUplink (if present).
featureSetListPerDownlinkCC Indicates which features the UE supports on the individual carriers of the feature set (and hence of a band entry that refer to the feature set). The UE shall hence include as many FeatureSetDownlinkPerCC-Id in this list as the number of carriers it supports according to the ca-bandwidthClassDL. The order of the elements in this list is not relevant, i.e., the network may configure any of the carriers in accordance with any of the FeatureSetDownlinkPerCC-Id in this list.

– *FeatureSetDownlinkId*

The IE *FeatureSetDownlinkId* identifies a downlink feature set. The *FeatureSetDownlinkId* of a *FeatureSetDownlink* is the index position of the *FeatureSetDownlink* in the *featureSetsDownlink* list in the *FeatureSets* IE. The first element in that list is referred to by *FeatureSetDownlinkId* = 1. The *FeatureSetDownlinkId=0* is not used by an actual *FeatureSetDownlink* but means that the UE does not support a carrier in this band of a band combination.

FeatureSetDownlinkId information element

```
-- ASN1START
-- TAG-FEATURESET-DOWNLINK-ID-START

FeatureSetDownlinkId ::=            INTEGER (0..maxDownlinkFeatureSets)

-- TAG-FEATURESET-DOWNLINK-ID-STOP
-- ASN1STOP
```

– *FeatureSetDownlinkPerCC*

The IE *FeatureSetDownlinkPerCC* indicates a set of features that the UE supports on the corresponding carrier of one band entry of a band combination.

FeatureSetDownlinkPerCC information element

```
-- ASN1START
-- TAG-FEATURESETDOWNLINKPERCC-START

FeatureSetDownlinkPerCC ::=         SEQUENCE {
    supportedSubcarrierSpacingDL        SubcarrierSpacing,
    supportedBandwidthDL                SupportedBandwidth,
    channelBW-90mhz                     ENUMERATED {supported}                                      OPTIONAL,
    maxNumberMIMO-LayersPDSCH           MIMO-LayersDL                                               OPTIONAL,
```

```
    supportedModulationOrderDL          ModulationOrder                                                         OPTIONAL
}

-- TAG-FEATURESETDOWNLINKPERCC-STOP
-- ASN1STOP
```

– *FeatureSetDownlinkPerCC-Id*

The IE *FeatureSetDownlinkPerCC-Id* identifies a set of features applicable to one carrier of a feature set. The *FeatureSetDownlinkPerCC-Id* of a *FeatureSetDownlinkPerCC* is the index position of the *FeatureSetDownlinkPerCC* in the *featureSetsDownlinkPerCC*. The first element in the list is referred to by *FeatureSetDownlinkPerCC-Id* = 1, and so on.

FeatureSetDownlinkPerCC-Id information element

```
-- ASN1START
-- TAG-FEATURESET-DOWNLINK-PER-CC-ID-START

FeatureSetDownlinkPerCC-Id ::=      INTEGER (1..maxPerCC-FeatureSets)

-- TAG-FEATURESET-DOWNLINK-PER-CC-ID-STOP
-- ASN1STOP
```

– *FeatureSetEUTRA-DownlinkId*

The IE *FeatureSetEUTRA-DownlinkId* identifies a downlink feature set in E-UTRA. The *FeatureSetEUTRA-DownlinkId=0* is used when the UE does not support a carrier in this band of a band combination.

FeatureSetEUTRA-DownlinkId information element

```
-- ASN1START
-- TAG-FEATURESET-EUTRA-DOWNLINK-ID-START

FeatureSetEUTRA-DownlinkId ::=      INTEGER (0..maxEUTRA-DL-FeatureSets)

-- TAG-FEATURESET-EUTRA-DOWNLINK-ID-STOP
-- ASN1STOP
```

– *FeatureSetEUTRA-UplinkId*

The IE *FeatureSetEUTRA-UplinkId* identifies an uplink feature set. The *FeatureSetEUTRA-UplinkId =0* is used when the UE does not support a carrier in this band of a band combination.

FeatureSetEUTRA-UplinkId information element

```
-- ASN1START
-- TAG-FEATURESET-EUTRA-UPLINK-ID-START
```

```
FeatureSetEUTRA-UplinkId ::=                    INTEGER (0..maxEUTRA-UL-FeatureSets)

-- TAG-FEATURESET-EUTRA-UPLINK-ID-STOP
-- ASN1STOP
```

– *FeatureSets*

The IE *FeatureSets* is used to provide pools of downlink and uplink features sets. A *FeatureSetCombination* refers to the IDs of the feature set(s) that the UE supports in that *FeatureSetCombination*. The *BandCombination* entries in the *BandCombinationList* then indicate the ID of the *FeatureSetCombination* that the UE supports fot that band combination.

The entries in the lists in this IE are identified by their index position. For example, the *FeatureSetUplinkPerCC-Id* = 4 identifies the 4th element in the *featureSetsUplinkPerCC* list.

NOTE: When feature sets (per CC) IEs require extension in future versions of the specification, new versions of the FeatureSetDownlink, FeatureSetUplink, FeatureSets, FeatureSetDownlinkPerCC and/or FeatureSetUplinkPerCC will be created and instantiated in corresponding new lists in the FeatureSets IE. For example, if new capability bits are to be added to the FeatureSetDownlink, they will instead be defined in a new FeatureSetDownlink-rxy which will be instantiated in a new featureSetDownlinkList-rxy list. If a UE indicates in a FeatureSetCombination that it supports the FeatureSetDownlink with ID #5, it implies that it supports both the features in FeatureSetDownlink #5 and FeatureSetDownlink-rxy #5 (if present). The number of entries in the new list(s) shall be the same as in the original list(s).

***FeatureSets* information element**

```
-- ASN1START
-- TAG-FEATURESETS-START

FeatureSets ::= SEQUENCE {
    featureSetsDownlink                 SEQUENCE (SIZE (1..maxDownlinkFeatureSets)) OF FeatureSetDownlink               OPTIONAL,
    featureSetsDownlinkPerCC            SEQUENCE (SIZE (1..maxPerCC-FeatureSets)) OF FeatureSetDownlinkPerCC            OPTIONAL,
    featureSetsUplink                   SEQUENCE (SIZE (1..maxUplinkFeatureSets)) OF FeatureSetUplink                   OPTIONAL,
    featureSetsUplinkPerCC              SEQUENCE (SIZE (1..maxPerCC-FeatureSets)) OF FeatureSetUplinkPerCC              OPTIONAL,
    ...,
    [[
    featureSetsDownlink-v1540           SEQUENCE (SIZE (1..maxDownlinkFeatureSets)) OF FeatureSetDownlink-v1540         OPTIONAL,
    featureSetsUplink-v1540             SEQUENCE (SIZE (1..maxUplinkFeatureSets)) OF FeatureSetUplink-v1540             OPTIONAL,
    featureSetsUplinkPerCC-v1540        SEQUENCE (SIZE (1..maxPerCC-FeatureSets)) OF FeatureSetUplinkPerCC-v1540        OPTIONAL
    ]]
}

-- TAG-FEATURESETS-STOP
-- ASN1STOP
```

– *FeatureSetUplink*

The IE *FeatureSetUplink* is used to indicate the features that the UE supports on the carriers corresponding to one band entry in a band combination.

FeatureSetUplink information element

```
-- ASN1START
-- TAG-FEATURESETUPLINK-START

FeatureSetUplink ::=                SEQUENCE {
    featureSetListPerUplinkCC           SEQUENCE (SIZE (1.. maxNrofServingCells)) OF FeatureSetUplinkPerCC-Id,
    scalingFactor                       ENUMERATED {f0p4, f0p75, f0p8}              OPTIONAL,
    crossCarrierScheduling-OtherSCS     ENUMERATED {supported}                      OPTIONAL,
    intraBandFreqSeparationUL           FreqSeparationClass                         OPTIONAL,
    searchSpaceSharingCA-UL             ENUMERATED {supported}                      OPTIONAL,
    dummy1                  DummyI                      OPTIONAL,
    supportedSRS-Resources              SRS-Resources                               OPTIONAL,
    twoPUCCH-Group                      ENUMERATED {supported}                      OPTIONAL,
    dynamicSwitchSUL                    ENUMERATED {supported}                      OPTIONAL,
    simultaneousTxSUL-NonSUL            ENUMERATED {supported}                      OPTIONAL,
    pusch-ProcessingType1-DifferentTB-PerSlot SEQUENCE {
        scs-15kHz                               ENUMERATED {upto2, upto4, upto7}  OPTIONAL,
        scs-30kHz                               ENUMERATED {upto2, upto4, upto7}  OPTIONAL,
        scs-60kHz                               ENUMERATED {upto2, upto4, upto7}  OPTIONAL,
        scs-120kHz                              ENUMERATED {upto2, upto4, upto7}  OPTIONAL
    }                                                                               OPTIONAL,
    dummy2                               DummyF                                     OPTIONAL
}

FeatureSetUplink-v1540 ::=           SEQUENCE {
    zeroSlotOffsetAperiodicSRS           ENUMERATED {supported}                  OPTIONAL,
    pa-PhaseDiscontinuityImpacts         ENUMERATED {supported}                  OPTIONAL,
    pusch-SeparationWithGap              ENUMERATED {supported}                  OPTIONAL,
    pusch-ProcessingType2                SEQUENCE {
        scs-15kHz                            ProcessingParameters                OPTIONAL,
        scs-30kHz                            ProcessingParameters                OPTIONAL,
        scs-60kHz                            ProcessingParameters                OPTIONAL
    } OPTIONAL,
    ul-MCS-TableAlt-DynamicIndication    ENUMERATED {supported}                  OPTIONAL
}

DummyF ::=                               SEQUENCE {
    maxNumberPeriodicCSI-ReportPerBWP          INTEGER (1..4),
    maxNumberAperiodicCSI-ReportPerBWP         INTEGER (1..4),
    maxNumberSemiPersistentCSI-ReportPerBWP    INTEGER (0..4),
    simultaneousCSI-ReportsAllCC               INTEGER (5..32)
}

-- TAG- FEATURESETUPLINK-STOP
-- ASN1STOP
```

FeatureSetUplink field descriptions
crossCarrierScheduling-OtherSCS The UE shall set this field to the same value as *crossCarrierScheduling-OtherSCS* in the associated FeatureSetDownlink (if present).
featureSetsPerUplinkCC Indicates which features the UE supports on the individual carriers of the feature set (and hence of a band entry that refers to the feature set). The UE shall hence include as many FeatureSetUplinkPerCC-Id in this list as the number of carriers it supports according to the ca-BandwidthClassUL. The order of the elements in this list is not relevant, i.e., the network may configure any of the carriers in accordance with any of the FeatureSetUplinkPerCC-Id in this list.

– *FeatureSetUplinkId*

The IE *FeatureSetUplinkId* identifies an uplink feature set. The *FeatureSetUplinkId* of a *FeatureSetUplink* is the index position of the *FeatureSetUplink* in the *featureSetsUplink* list in the *FeatureSets* IE. The first element in the list is referred to by *FeatureSetUplinkId* = 1, and so on. The *FeatureSetUplinkId =0* is not used by an actual *FeatureSetUplink* but means that the UE does not support a carrier in this band of a band combination.

FeatureSetUplinkId information element

```
-- ASN1START
-- TAG-FEATURESET-UPLINK-ID-START

FeatureSetUplinkId ::=                  INTEGER (0..maxUplinkFeatureSets)

-- TAG-FEATURESET-UPLINK-ID-STOP
-- ASN1STOP
```

– *FeatureSetUplinkPerCC*

The IE *FeatureSetDownlinkPerCC* indicates a set of features that the UE supports on the corresponding carrier of one band entry of a band combination.

FeatureSetUplinkPerCC information element

```
-- ASN1START
-- TAG-FEATURESETUPLINKPERCC-START

FeatureSetUplinkPerCC ::=               SEQUENCE {
    supportedSubcarrierSpacingUL            SubcarrierSpacing,
    supportedBandwidthUL                    SupportedBandwidth,
    channelBW-90mhz                         ENUMERATED {supported}                  OPTIONAL,
    mimo-CB-PUSCH                           SEQUENCE {
        maxNumberMIMO-LayersCB-PUSCH            MIMO-LayersUL                       OPTIONAL,
        maxNumberSRS-ResourcePerSet             INTEGER (1..2)
    }                                                                               OPTIONAL,
    maxNumberMIMO-LayersNonCB-PUSCH         MIMO-LayersUL                           OPTIONAL,
    supportedModulationOrderUL              ModulationOrder                         OPTIONAL
}
FeatureSetUplinkPerCC-v1540 ::=       SEQUENCE {
    mimo-NonCB-PUSCH                      SEQUENCE {
        maxNumberSRS-ResourcePerSet           INTEGER (1..4),
        maxNumberSimultaneousSRS-ResourceTx   INTEGER (1..4)
```

```
    } OPTIONAL
}

-- TAG-FEATURESETUPLINKPERCC-STOP
-- ASN1STOP
```

– *FeatureSetUplinkPerCC-Id*

The IE *FeatureSetUplinkPerCC-Id* identifies a set of features applicable to one carrier of a feature set. The *FeatureSetUplinkPerCC-Id* of a *FeatureSetUplinkPerCC* is the index position of the *FeatureSetUplinkPerCC* in the *featureSetsUplinkPerCC*. The first element in the list is referred to by *FeatureSetUplinkPerCC-Id* = 1, and so on.

FeatureSetUplinkPerCC-Id information element

```
-- ASN1START
-- TAG-FEATURESET-UPLINK-PER-CC-ID-START

FeatureSetUplinkPerCC-Id ::=            INTEGER (1..maxPerCC-FeatureSets)

-- TAG-FEATURESET-UPLINK-PER-CC-ID-STOP
-- ASN1STOP
```

– *FreqBandIndicatorEUTRA*

```
-- ASN1START
-- TAG-FREQ-BAND-INDICATOR-EUTRA-START

FreqBandIndicatorEUTRA ::=  INTEGER (1..maxBandsEUTRA)

-- TAG-FREQ-BAND-INDICATOR-EUTRA-STOP
-- ASN1STOP
```

– *FreqBandList*

The IE *FreqBandList* is used by the network to request NR CA and/or MR-DC band combinations for specific NR and/or E-UTRA frequency bands and/or up to a specific number of carriers and/or up to specific aggregated bandwidth. This is also used to request feature sets (for NR) and feature set combinations (for NR and MR-DC).

FreqBandList information element

```
-- ASN1START
-- TAG-FREQBANDLIST-START

FreqBandList ::=                SEQUENCE (SIZE (1..maxBandsMRDC)) OF FreqBandInformation

FreqBandInformation ::=         CHOICE {
    bandInformationEUTRA            FreqBandInformationEUTRA,
    bandInformationNR               FreqBandInformationNR
}
```

```
FreqBandInformationEUTRA ::=    SEQUENCE {
    bandEUTRA                       FreqBandIndicatorEUTRA,
    ca-BandwidthClassDL-EUTRA       CA-BandwidthClassEUTRA                  OPTIONAL,   -- Need N
    ca-BandwidthClassUL-EUTRA       CA-BandwidthClassEUTRA                  OPTIONAL    -- Need N
}

FreqBandInformationNR ::=       SEQUENCE {
    bandNR                          FreqBandIndicatorNR,
    maxBandwidthRequestedDL         AggregatedBandwidth                     OPTIONAL,   -- Need N
    maxBandwidthRequestedUL         AggregatedBandwidth                     OPTIONAL,   -- Need N
    maxCarriersRequestedDL          INTEGER (1..maxNrofServingCells)        OPTIONAL,   -- Need N
    maxCarriersRequestedUL          INTEGER (1..maxNrofServingCells)        OPTIONAL    -- Need N
}

AggregatedBandwidth ::=         ENUMERATED {mhz50, mhz100, mhz150, mhz200, mhz250, mhz300, mhz350,
                                            mhz400, mhz450, mhz500, mhz550, mhz600, mhz650, mhz700, mhz750, mhz800}

-- TAG-FREQBANDLIST-STOP
-- ASN1STOP
```

– *FreqSeparationClass*

The IE *FreqSeparationClass* is used for an intra-band non-contiguous CA band combination to indicate frequency separation between lower edge of lowest CC and upper edge of highest CC in a frequency band.

FreqSeparationClass information element

```
-- ASN1START
-- TAG-FREQSEPARATIONCLASS-START

FreqSeparationClass ::= ENUMERATED {c1, c2, c3, ...}

-- TAG-FREQSEPARATIONCLASS-STOP
-- ASN1STOP
```

– *IMS-Parameters*

The IE *IMS-Parameters* is used to convery capabilities related to IMS.

IMS-Parameters information element

```
-- ASN1START
-- TAG-IMS-PARAMETERS-START

IMS-Parameters ::=          SEQUENCE {
    ims-ParametersCommon        IMS-ParametersCommon                    OPTIONAL,
    ims-ParametersFRX-Diff      IMS-ParametersFRX-Diff                  OPTIONAL,
    ...
```

```
}

IMS-ParametersCommon ::=   SEQUENCE {
    voiceOverEUTRA-5GC          ENUMERATED {supported}                  OPTIONAL,
    ...
}

IMS-ParametersFRX-Diff ::= SEQUENCE {
    voiceOverNR                 ENUMERATED {supported}                  OPTIONAL,
    ...
}

-- TAG-IMS-PARAMETERS-STOP
-- ASN1STOP
```

– *InterRAT-Parameters*

The IE *InterRAT-Parameters* is used convey UE capabilities related to the other RATs.

InterRAT-Parameters **information element**

```
-- ASN1START
-- TAG-INTERRAT-PARAMETERS-START

InterRAT-Parameters ::=             SEQUENCE {
    eutra                               EUTRA-Parameters                OPTIONAL,
    ...
}

EUTRA-Parameters ::=                SEQUENCE {
    supportedBandListEUTRA          SEQUENCE (SIZE (1..maxBandsEUTRA)) OF FreqBandIndicatorEUTRA,
    eutra-ParametersCommon          EUTRA-ParametersCommon                                      OPTIONAL,
    eutra-ParametersXDD-Diff            EUTRA-ParametersXDD-Diff                                OPTIONAL,
    ...
}

EUTRA-ParametersCommon ::=      SEQUENCE {
    mfbi-EUTRA                          ENUMERATED {supported}          OPTIONAL,
    modifiedMPR-BehaviorEUTRA           BIT STRING (SIZE (32))          OPTIONAL,
    multiNS-Pmax-EUTRA                  ENUMERATED {supported}          OPTIONAL,
    rs-SINR-MeasEUTRA                   ENUMERATED {supported}          OPTIONAL,
    ...
}

EUTRA-ParametersXDD-Diff ::=        SEQUENCE {
    rsrqMeasWidebandEUTRA               ENUMERATED {supported}          OPTIONAL,
    ...
}

-- TAG-INTERRAT-PARAMETERS-STOP
-- ASN1STOP
```

– *MAC-Parameters*

The IE *MAC-Parameters* is used to convey capabilities related to MAC.

***MAC-Parameters* information element**

```
-- ASN1START
-- TAG-MAC-PARAMETERS-START

MAC-Parameters ::= SEQUENCE {
    mac-ParametersCommon            MAC-ParametersCommon        OPTIONAL,
    mac-ParametersXDD-Diff          MAC-ParametersXDD-Diff      OPTIONAL
}

MAC-ParametersCommon ::=    SEQUENCE {
    lcp-Restriction                 ENUMERATED {supported}      OPTIONAL,
    dummy                           ENUMERATED {supported}      OPTIONAL,
    lch-ToSCellRestriction          ENUMERATED {supported}      OPTIONAL,
    ...,
    [[
    recommendedBitRate              ENUMERATED {supported}      OPTIONAL,
    recommendedBitRateQuery     ENUMERATED {supported}          OPTIONAL
    ]]
}

MAC-ParametersXDD-Diff ::=  SEQUENCE {
    skipUplinkTxDynamic             ENUMERATED {supported}     OPTIONAL,
    logicalChannelSR-DelayTimer     ENUMERATED {supported}     OPTIONAL,
    longDRX-Cycle                   ENUMERATED {supported}     OPTIONAL,
    shortDRX-Cycle                  ENUMERATED {supported}     OPTIONAL,
    multipleSR-Configurations       ENUMERATED {supported}     OPTIONAL,
    multipleConfiguredGrants    ENUMERATED {supported}         OPTIONAL,
    ...
}

-- TAG-MAC-PARAMETERS-STOP
-- ASN1STOP
```

– *MeasAndMobParameters*

The IE *MeasAndMobParameters* is used to convey UE capabilities related to measurements for radio resource management (RRM), radio link monitoring (RLM) and mobility (e.g. handover).

***MeasAndMobParameters* information element**

```
-- ASN1START
-- TAG-MEASANDMOBPARAMETERS-START

MeasAndMobParameters ::=                SEQUENCE {
    measAndMobParametersCommon          MeasAndMobParametersCommon          OPTIONAL,
    measAndMobParametersXDD-Diff            MeasAndMobParametersXDD-Diff        OPTIONAL,
```

```
    measAndMobParametersFRX-Diff                MeasAndMobParametersFRX-Diff        OPTIONAL
}

MeasAndMobParametersCommon ::=          SEQUENCE {
    supportedGapPattern                 BIT STRING (SIZE (22))          OPTIONAL,
    ssb-RLM                             ENUMERATED {supported}          OPTIONAL,
    ssb-AndCSI-RS-RLM                   ENUMERATED {supported}          OPTIONAL,
    ...,
    [[
    eventB-MeasAndReport        ENUMERATED {supported}      OPTIONAL,
    handoverFDD-TDD             ENUMERATED {supported}      OPTIONAL,
    eutra-CGI-Reporting         ENUMERATED {supported}      OPTIONAL,
    nr-CGI-Reporting            ENUMERATED {supported}      OPTIONAL
    ]],
    [[
    independentGapConfig        ENUMERATED {supported}                  OPTIONAL,
    periodicEUTRA-MeasAndReport ENUMERATED {supported}                  OPTIONAL,
    handoverFR1-FR2             ENUMERATED {supported}                  OPTIONAL,
    maxNumberCSI-RS-RRM-RS-SINR ENUMERATED {n4, n8, n16, n32, n64, n96} OPTIONAL
    ]]
}

MeasAndMobParametersXDD-Diff ::=            SEQUENCE {
    intraAndInterF-MeasAndReport        ENUMERATED {supported}  OPTIONAL,
    eventA-MeasAndReport                ENUMERATED {supported}  OPTIONAL,
    ...,
    [[
    handoverInterF              ENUMERATED {supported}  OPTIONAL,
    handoverLTE             ENUMERATED {supported}  OPTIONAL,
    handover-eLTE               ENUMERATED {supported}  OPTIONAL
    ]]
}

MeasAndMobParametersFRX-Diff ::=            SEQUENCE {
    ss-SINR-Meas                        ENUMERATED {supported}      OPTIONAL,
    csi-RSRP-AndRSRQ-MeasWithSSB        ENUMERATED {supported}      OPTIONAL,
    csi-RSRP-AndRSRQ-MeasWithoutSSB     ENUMERATED {supported}      OPTIONAL,
    csi-SINR-Meas                       ENUMERATED {supported}      OPTIONAL,
    csi-RS-RLM                          ENUMERATED {supported}      OPTIONAL,
    ...,
    [[
    handoverInterF              ENUMERATED {supported}  OPTIONAL,
    handoverLTE                 ENUMERATED {supported}  OPTIONAL,
    handover-eLTE               ENUMERATED {supported}  OPTIONAL
    ]],
    [[
    maxNumberResource-CSI-RS-RLM    ENUMERATED {n2, n4, n6, n8}     OPTIONAL
    ]]
}

-- TAG-MEASANDMOBPARAMETERS-STOP
-- ASN1STOP
```

– *MeasAndMobParametersMRDC*

The IE *MeasAndMobParametersMRDC* is used to convey capability parameters related to RRM measurements and RRC mobility.

MeasAndMobParametersMRDC information element

```
-- ASN1START
-- TAG-MEASANDMOBPARAMETERSMRDC-START

MeasAndMobParametersMRDC ::=            SEQUENCE {
    measAndMobParametersMRDC-Common         MeasAndMobParametersMRDC-Common                 OPTIONAL,
    measAndMobParametersMRDC-XDD-Diff       MeasAndMobParametersMRDC-XDD-Diff               OPTIONAL,
    measAndMobParametersMRDC-FRX-Diff       MeasAndMobParametersMRDC-FRX-Diff               OPTIONAL
}

MeasAndMobParametersMRDC-Common ::=     SEQUENCE {
    independentGapConfig                    ENUMERATED {supported}              OPTIONAL
}

MeasAndMobParametersMRDC-XDD-Diff ::=   SEQUENCE {
    sftd-MeasPSCell                         ENUMERATED {supported}              OPTIONAL,
    sftd-MeasNR-Cell                        ENUMERATED {supported}              OPTIONAL
}

MeasAndMobParametersMRDC-FRX-Diff ::=   SEQUENCE {
    simultaneousRxDataSSB-DiffNumerology    ENUMERATED {supported}              OPTIONAL
}

-- TAG-MEASANDMOBPARAMETERSMRDC-STOP
-- ASN1STOP
```

– *MIMO-Layers*

```
-- ASN1START
-- TAG-MIMO-LAYERS-START

MIMO-LayersDL ::=   ENUMERATED {twoLayers, fourLayers, eightLayers}

MIMO-LayersUL ::=   ENUMERATED {oneLayer, twoLayers, fourLayers}

-- TAG-MIMO-LAYERS-STOP
-- ASN1STOP
```

– *MIMO-ParametersPerBand*

The IE *MIMO-ParametersPerBand* is used to convey MIMO related parameters specific for a certain band (not per feature set or band combination).

MIMO-ParametersPerBand information element

```
-- ASN1START
-- TAG-MIMO-PARAMETERSPERBAND-START

MIMO-ParametersPerBand ::=          SEQUENCE {
    tci-StatePDSCH                      SEQUENCE {
        maxNumberConfiguredTCIstatesPerCC   ENUMERATED {n4, n8, n16, n32, n64, n128}                            OPTIONAL,
        maxNumberActiveTCI-PerBWP           ENUMERATED {n1, n2, n4, n8}                                         OPTIONAL
    }                                                                                                           OPTIONAL,
    additionalActiveTCI-StatePDCCH      ENUMERATED {supported}                                                  OPTIONAL,
    pusch-TransCoherence                ENUMERATED {nonCoherent, partialCoherent, fullCoherent}                 OPTIONAL,
    beamCorrespondence                  ENUMERATED {supported}                                                  OPTIONAL,
    periodicBeamReport                  ENUMERATED {supported}                                                  OPTIONAL,
    aperiodicBeamReport                 ENUMERATED {supported}                                                  OPTIONAL,
    sp-BeamReportPUCCH                  ENUMERATED {supported}                                                  OPTIONAL,
    sp-BeamReportPUSCH                  ENUMERATED {supported}                                                  OPTIONAL,
    dummy1                              DummyG                                                                  OPTIONAL,
    maxNumberRxBeam                     INTEGER (2..8)                                                          OPTIONAL,
    maxNumberRxTxBeamSwitchDL           SEQUENCE {
        scs-15kHz                           ENUMERATED {n4, n7, n14}                                            OPTIONAL,
        scs-30kHz                           ENUMERATED {n4, n7, n14}                                            OPTIONAL,
        scs-60kHz                           ENUMERATED {n4, n7, n14}                                            OPTIONAL,
        scs-120kHz                          ENUMERATED {n4, n7, n14}                                            OPTIONAL,
        scs-240kHz                          ENUMERATED {n4, n7, n14}                                            OPTIONAL
    }                                                                                                           OPTIONAL,
    maxNumberNonGroupBeamReporting      ENUMERATED {n1, n2, n4}                                                 OPTIONAL,
    groupBeamReporting                  ENUMERATED {supported}                                                  OPTIONAL,
    uplinkBeamManagement                SEQUENCE {
        maxNumberSRS-ResourcePerSet-BM      ENUMERATED {n2, n4, n8, n16},
        maxNumberSRS-ResourceSet            INTEGER (1..8)
    }                                                                                                           OPTIONAL,
    maxNumberCSI-RS-BFD                 INTEGER (1..64)                                                         OPTIONAL,
    maxNumberSSB-BFD                    INTEGER (1..64)                                                         OPTIONAL,
    maxNumberCSI-RS-SSB-CBD             INTEGER (1..256)                                                        OPTIONAL,
    dummy2                              ENUMERATED {supported}                                                  OPTIONAL,
    twoPortsPTRS-UL                     ENUMERATED {supported}                                                  OPTIONAL,
    supportedSRS-Resources              SRS-Resources                                                           OPTIONAL,
    dummy3                              INTEGER (1..4)                                                          OPTIONAL,
    beamReportTiming                    SEQUENCE {
        scs-15kHz                           ENUMERATED {sym2, sym4, sym8}                                       OPTIONAL,
        scs-30kHz                           ENUMERATED {sym4, sym8, sym14, sym28}                               OPTIONAL,
        scs-60kHz                           ENUMERATED {sym8, sym14, sym28}                                     OPTIONAL,
        scs-120kHz                          ENUMERATED {sym14, sym28, sym56}                                    OPTIONAL
    }                                                                                                           OPTIONAL,
    ptrs-DensityRecommendationSetDL     SEQUENCE {
        scs-15kHz                           PTRS-DensityRecommendationDL                                        OPTIONAL,
        scs-30kHz                           PTRS-DensityRecommendationDL                                        OPTIONAL,
        scs-60kHz                           PTRS-DensityRecommendationDL                                        OPTIONAL,
        scs-120kHz                          PTRS-DensityRecommendationDL                                        OPTIONAL
    }                                                                                                           OPTIONAL,
    ptrs-DensityRecommendationSetUL     SEQUENCE {
        scs-15kHz                           PTRS-DensityRecommendationUL                                        OPTIONAL,
        scs-30kHz                           PTRS-DensityRecommendationUL                                        OPTIONAL,
```

```
        scs-60kHz                           PTRS-DensityRecommendationUL                                        OPTIONAL,
        scs-120kHz                          PTRS-DensityRecommendationUL                                        OPTIONAL
    }                                                                                                           OPTIONAL,
    dummy4                              DummyH                                                                  OPTIONAL,
    aperiodicTRS                        ENUMERATED {supported}                                                  OPTIONAL,
    ...,
    [[
    beamCorrespondenceCA                ENUMERATED {true}                                                       OPTIONAL,
    beamManagementSSB-CSI-RS            BeamManagementSSB-CSI-RS                                                OPTIONAL,
    beamSwitchTiming                    SEQUENCE {
        scs-60kHz                           ENUMERATED {sym14, sym28, sym48, sym224, sym336}                    OPTIONAL,
        scs-120kHz                          ENUMERATED {sym14, sym28, sym48, sym224, sym336}                    OPTIONAL
    }                                                                                                           OPTIONAL,
    codebookParameters                  CodebookParameters                                                      OPTIONAL,
    csi-RS-IM-ReceptionForFeedback      CSI-RS-IM-ReceptionForFeedback                                          OPTIONAL,
    csi-RS-ProcFrameworkForSRS          CSI-RS-ProcFrameworkForSRS                                              OPTIONAL,
    csi-ReportFramework                 CSI-ReportFramework                                                     OPTIONAL,
    csi-RS-ForTracking                  CSI-RS-ForTracking                                                      OPTIONAL,
    srs-AssocCSI-RS                     SEQUENCE (SIZE (1.. maxNrofCSI-RS-Resources)) OF SupportedCSI-RS-Resource  OPTIONAL,
    spatialRelations                    SpatialRelations                                                        OPTIONAL
    ]]
}

DummyG ::=                          SEQUENCE {
    maxNumberSSB-CSI-RS-ResourceOneTx   ENUMERATED {n8, n16, n32, n64},
    maxNumberSSB-CSI-RS-ResourceTwoTx   ENUMERATED {n0, n4, n8, n16, n32, n64},
    supportedCSI-RS-Density             ENUMERATED {one, three, oneAndThree}
}

BeamManagementSSB-CSI-RS ::=        SEQUENCE {
    maxNumberSSB-CSI-RS-ResourceOneTx   ENUMERATED {n0, n8, n16, n32, n64},
    maxNumberCSI-RS-Resource            ENUMERATED {n0, n4, n8, n16, n32, n64},
    maxNumberCSI-RS-ResourceTwoTx       ENUMERATED {n0, n4, n8, n16, n32, n64},
    supportedCSI-RS-Density             ENUMERATED {one, three, oneAndThree}                                    OPTIONAL,
    maxNumberAperiodicCSI-RS-Resource   ENUMERATED {n0, n1, n4, n8, n16, n32, n64}
}

DummyH ::=                          SEQUENCE {
    burstLength                         INTEGER (1..2),
    maxSimultaneousResourceSetsPerCC    INTEGER (1..8),
    maxConfiguredResourceSetsPerCC      INTEGER (1..64),
    maxConfiguredResourceSetsAllCC      INTEGER (1..128)
}

CSI-RS-ForTracking ::=              SEQUENCE {
    maxBurstLength                      INTEGER (1..2),
    maxSimultaneousResourceSetsPerCC    INTEGER (1..8),
    maxConfiguredResourceSetsPerCC      INTEGER (1..64),
    maxConfiguredResourceSetsAllCC      INTEGER (1..256)
}

CSI-RS-IM-ReceptionForFeedback ::=              SEQUENCE {
    maxConfigNumberNZP-CSI-RS-PerCC                 INTEGER (1..64),
    maxConfigNumberPortsAcrossNZP-CSI-RS-PerCC      INTEGER (2..256),
```

```
    maxConfigNumberCSI-IM-PerCC                     ENUMERATED {n1, n2, n4, n8, n16, n32},
    maxNumberSimultaneousNZP-CSI-RS-PerCC           INTEGER (1..64),
    totalNumberPortsSimultaneousNZP-CSI-RS-PerCC    INTEGER (2..256)
}

CSI-RS-ProcFrameworkForSRS ::=                  SEQUENCE {
    maxNumberPeriodicSRS-AssocCSI-RS-PerBWP         INTEGER (1..4),
    maxNumberAperiodicSRS-AssocCSI-RS-PerBWP        INTEGER (1..4),
    maxNumberSP-SRS-AssocCSI-RS-PerBWP              INTEGER (0..4),
    simultaneousSRS-AssocCSI-RS-PerCC               INTEGER (1..8)
}

CSI-ReportFramework ::=                         SEQUENCE {
    maxNumberPeriodicCSI-PerBWP-ForCSI-Report       INTEGER (1..4),
    maxNumberAperiodicCSI-PerBWP-ForCSI-Report      INTEGER (1..4),
    maxNumberSemiPersistentCSI-PerBWP-ForCSI-Report INTEGER (0..4),
    maxNumberPeriodicCSI-PerBWP-ForBeamReport       INTEGER (1..4),
    maxNumberAperiodicCSI-PerBWP-ForBeamReport      INTEGER (1..4),
    maxNumberAperidicCSI-triggeringStatePerCC       ENUMERATED {n3, n7, n15, n31, n63, n128},
    maxNumberSemiPersistentCSI-PerBWP-ForBeamReport INTEGER (0..4),
    simultaneousCSI-ReportsPerCC                    INTEGER (1..8)
}

PTRS-DensityRecommendationDL ::=    SEQUENCE {
    frequencyDensity1                   INTEGER (1..276),
    frequencyDensity2                   INTEGER (1..276),
    timeDensity1                        INTEGER (0..29),
    timeDensity2                        INTEGER (0..29),
    timeDensity3                        INTEGER (0..29)
}

PTRS-DensityRecommendationUL ::=    SEQUENCE {
    frequencyDensity1                   INTEGER (1..276),
    frequencyDensity2                   INTEGER (1..276),
    timeDensity1                        INTEGER (0..29),
    timeDensity2                        INTEGER (0..29),
    timeDensity3                        INTEGER (0..29),
    sampleDensity1                      INTEGER (1..276),
    sampleDensity2                      INTEGER (1..276),
    sampleDensity3                      INTEGER (1..276),
    sampleDensity4                      INTEGER (1..276),
    sampleDensity5                      INTEGER (1..276)
}

SpatialRelations ::=                    SEQUENCE {
    maxNumberConfiguredSpatialRelations     ENUMERATED {n4, n8, n16, n32, n64, n96},
    maxNumberActiveSpatialRelations         ENUMERATED {n1, n2, n4, n8, n14},
    additionalActiveSpatialRelationPUCCH    ENUMERATED {supported}                             OPTIONAL,
    maxNumberDL-RS-QCL-TypeD                ENUMERATED {n1, n2, n4, n8, n14}
}

SRS-Resources ::=                   SEQUENCE {
    maxNumberAperiodicSRS-PerBWP            ENUMERATED {n1, n2, n4, n8, n16},
    maxNumberAperiodicSRS-PerBWP-PerSlot    INTEGER (1..6),
```

```
    maxNumberPeriodicSRS-PerBWP             ENUMERATED {n1, n2, n4, n8, n16},
    maxNumberPeriodicSRS-PerBWP-PerSlot     INTEGER (1..6),
    maxNumberSemiPersitentSRS-PerBWP        ENUMERATED {n1, n2, n4, n8, n16},
    maxNumberSP-SRS-PerBWP-PerSlot          INTEGER (1..6),
    maxNumberSRS-Ports-PerResource          ENUMERATED {n1, n2, n4}
}

DummyI ::=               SEQUENCE {
    supportedSRS-TxPortSwitch           ENUMERATED {t1r2, t1r4, t2r4, t1r4-t2r4, tr-equal},
    txSwitchImpactToRx                  ENUMERATED {true}                                      OPTIONAL
}

-- TAG-MIMO-PARAMETERSPERBAND-STOP
-- ASN1STOP
```

***MIMO-ParametersPerBand* field description**
csi-RS-IM-ReceptionForFeedback/ csi-RS-ProcFrameworkForSRS/ csi-ReportFramework CSI related capabilities which the UE supports on each of the carriers operated on this band. For mixed FR1-FR2 band combinations these values may be further limited by the corresponding fields in *Phy-ParametersFRX-Diff*.

– *ModulationOrder*

```
-- ASN1START
-- TAG-MODULATION-ORDER-START

ModulationOrder ::= ENUMERATED {bpsk-halfpi, bpsk, qpsk, qam16, qam64, qam256}

-- TAG-MODULATION-ORDER-STOP
-- ASN1STOP
```

– *MRDC-Parameters*

The IE *MRDC-Parameters* contains the band combination parameters specific to MR-DC for a given MR-DC band combination.

MRDC-Parameters information element

```
-- ASN1START
-- TAG-MRDC-PARAMETERS-START

MRDC-Parameters ::= SEQUENCE {
    singleUL-Transmission               ENUMERATED {supported}              OPTIONAL,
    dynamicPowerSharing                 ENUMERATED {supported}              OPTIONAL,
    tdm-Pattern                         ENUMERATED {supported}              OPTIONAL,
    ul-SharingEUTRA-NR                  ENUMERATED {tdm, fdm, both}         OPTIONAL,
    ul-SwitchingTimeEUTRA-NR            ENUMERATED {type1, type2}           OPTIONAL,
    simultaneousRxTxInterBandENDC       ENUMERATED {supported}              OPTIONAL,
    asyncIntraBandENDC                  ENUMERATED {supported}              OPTIONAL,
    ...,
```

```
    [[
    dualPA-Architecture                   ENUMERATED {supported}              OPTIONAL,
    intraBandENDC-Support-v1540           ENUMERATED {non-contiguous, both}   OPTIONAL,
    ul-TimingAlignmentEUTRA-NR            ENUMERATED {required}               OPTIONAL
    ]]
}

-- TAG-MRDC-PARAMETERS-STOP
-- ASN1STOP
```

– PDCP-Parameters

The IE *PDCP-Parameters* is used to convey capabilities related to PDCP.

PDCP-Parameters information element

```
-- ASN1START
-- TAG-PDCP-PARAMETERS-START

PDCP-Parameters ::=         SEQUENCE {
    supportedROHC-Profiles      SEQUENCE {
        profile0x0000               BOOLEAN,
        profile0x0001               BOOLEAN,
        profile0x0002               BOOLEAN,
        profile0x0003               BOOLEAN,
        profile0x0004               BOOLEAN,
        profile0x0006               BOOLEAN,
        profile0x0101               BOOLEAN,
        profile0x0102               BOOLEAN,
        profile0x0103               BOOLEAN,
        profile0x0104               BOOLEAN
    },
    maxNumberROHC-ContextSessions         ENUMERATED {cs2, cs4, cs8, cs12, cs16, cs24, cs32, cs48, cs64,
                                                  cs128, cs256, cs512, cs1024, cs16384, spare2, spare1},
    uplinkOnlyROHC-Profiles               ENUMERATED {supported}      OPTIONAL,
    continueROHC-Context                  ENUMERATED {supported}      OPTIONAL,
    outOfOrderDelivery                    ENUMERATED {supported}      OPTIONAL,
    shortSN                               ENUMERATED {supported}      OPTIONAL,
    pdcp-DuplicationSRB                   ENUMERATED {supported}      OPTIONAL,
    pdcp-DuplicationMCG-OrSCG-DRB         ENUMERATED {supported}      OPTIONAL,
    ...
}

-- TAG-PDCP-PARAMETERS-STOP
-- ASN1STOP
```

– PDCP-ParametersMRDC

The IE *PDCP-ParametersMRDC* is used to convey PDCP related capabilities for MR-DC.

PDCP-ParametersMRDC information element

```
-- ASN1START
-- TAG-PDCP-PARAMETERSMRDC-START

PDCP-ParametersMRDC ::=                 SEQUENCE {
    pdcp-DuplicationSplitSRB                ENUMERATED {supported}      OPTIONAL,
    pdcp-DuplicationSplitDRB                ENUMERATED {supported}      OPTIONAL
}

-- TAG-PDCP-PARAMETERSMRDC-STOP
-- ASN1STOP
```

– *Phy-Parameters*

The IE *Phy-Parameters* is used to convey the physical layer capabilities.

Phy-Parameters information element

```
-- ASN1START
-- TAG-PHY-PARAMETERS-START

Phy-Parameters ::=                  SEQUENCE {
    phy-ParametersCommon                Phy-ParametersCommon                        OPTIONAL,
    phy-ParametersXDD-Diff              Phy-ParametersXDD-Diff                      OPTIONAL,
    phy-ParametersFRX-Diff              Phy-ParametersFRX-Diff                      OPTIONAL,
    phy-ParametersFR1                   Phy-ParametersFR1                           OPTIONAL,
    phy-ParametersFR2                   Phy-ParametersFR2                           OPTIONAL
}

Phy-ParametersCommon ::=            SEQUENCE {
    csi-RS-CFRA-ForHO                   ENUMERATED {supported}                      OPTIONAL,
    dynamicPRB-BundlingDL               ENUMERATED {supported}                      OPTIONAL,
    sp-CSI-ReportPUCCH                  ENUMERATED {supported}                      OPTIONAL,
    sp-CSI-ReportPUSCH                  ENUMERATED {supported}                      OPTIONAL,
    nzp-CSI-RS-IntefMgmt                ENUMERATED {supported}                      OPTIONAL,
    type2-SP-CSI-Feedback-LongPUCCH     ENUMERATED {supported}                      OPTIONAL,
    precoderGranularityCORESET          ENUMERATED {supported}                      OPTIONAL,
    dynamicHARQ-ACK-Codebook            ENUMERATED {supported}                      OPTIONAL,
    semiStaticHARQ-ACK-Codebook         ENUMERATED {supported}                      OPTIONAL,
    spatialBundlingHARQ-ACK             ENUMERATED {supported}                      OPTIONAL,
    dynamicBetaOffsetInd-HARQ-ACK-CSI   ENUMERATED {supported}                      OPTIONAL,
    pucch-Repetition-F1-3-4             ENUMERATED {supported}                      OPTIONAL,
    ra-Type0-PUSCH                      ENUMERATED {supported}                      OPTIONAL,
    dynamicSwitchRA-Type0-1-PDSCH       ENUMERATED {supported}                      OPTIONAL,
    dynamicSwitchRA-Type0-1-PUSCH       ENUMERATED {supported}                      OPTIONAL,
    pdsch-MappingTypeA                  ENUMERATED {supported}                      OPTIONAL,
    pdsch-MappingTypeB                  ENUMERATED {supported}                      OPTIONAL,
    interleavingVRB-ToPRB-PDSCH         ENUMERATED {supported}                      OPTIONAL,
    interSlotFreqHopping-PUSCH          ENUMERATED {supported}                      OPTIONAL,
    type1-PUSCH-RepetitionMultiSlots    ENUMERATED {supported}                      OPTIONAL,
    type2-PUSCH-RepetitionMultiSlots    ENUMERATED {supported}                      OPTIONAL,
```

```
    pusch-RepetitionMultiSlots          ENUMERATED {supported}                      OPTIONAL,
    pdsch-RepetitionMultiSlots          ENUMERATED {supported}                      OPTIONAL,
    downlinkSPS                         ENUMERATED {supported}                      OPTIONAL,
    configuredUL-GrantType1             ENUMERATED {supported}                      OPTIONAL,
    configuredUL-GrantType2             ENUMERATED {supported}                      OPTIONAL,
    pre-EmptIndication-DL               ENUMERATED {supported}                      OPTIONAL,
    cbg-TransIndication-DL              ENUMERATED {supported}                      OPTIONAL,
    cbg-TransIndication-UL              ENUMERATED {supported}                      OPTIONAL,
    cbg-FlushIndication-DL              ENUMERATED {supported}                      OPTIONAL,
    dynamicHARQ-ACK-CodeB-CBG-Retx-DL   ENUMERATED {supported}                      OPTIONAL,
    rateMatchingResrcSetSemi-Static     ENUMERATED {supported}                      OPTIONAL,
    rateMatchingResrcSetDynamic         ENUMERATED {supported}                      OPTIONAL,
    bwp-SwitchingDelay                  ENUMERATED {type1, type2}                   OPTIONAL,
    ...,
    [[
    dummy                               ENUMERATED {supported}                      OPTIONAL
    ]],
    [[
    maxNumberSearchSpaces               ENUMERATED {n10}                            OPTIONAL,
    rateMatchingCtrlResrsSetDynamic     ENUMERATED {supported}                      OPTIONAL,
    maxLayersMIMO-Indication            ENUMERATED {supported}                      OPTIONAL
    ]]
}

Phy-ParametersXDD-Diff ::=          SEQUENCE {
    dynamicSFI                          ENUMERATED {supported}                      OPTIONAL,
    twoPUCCH-F0-2-ConsecSymbols         ENUMERATED {supported}                      OPTIONAL,
    twoDifferentTPC-Loop-PUSCH          ENUMERATED {supported}                      OPTIONAL,
    twoDifferentTPC-Loop-PUCCH          ENUMERATED {supported}                      OPTIONAL,
    ...,
    [[
    dl-SchedulingOffset-PDSCH-TypeA     ENUMERATED {supported}                      OPTIONAL,
    dl-SchedulingOffset-PDSCH-TypeB     ENUMERATED {supported}                      OPTIONAL,
    ul-SchedulingOffset                 ENUMERATED {supported}                      OPTIONAL
    ]]
}

Phy-ParametersFRX-Diff ::=          SEQUENCE {
    dynamicSFI                          ENUMERATED {supported}                      OPTIONAL,
    dummy1                              BIT STRING (SIZE (2))                       OPTIONAL,
    twoFL-DMRS                          BIT STRING (SIZE (2))                       OPTIONAL,
    dummy2                              BIT STRING (SIZE (2))                       OPTIONAL,
    dummy3                              BIT STRING (SIZE (2))                       OPTIONAL,
    supportedDMRS-TypeDL                ENUMERATED {type1, type1And2}               OPTIONAL,
    supportedDMRS-TypeUL                ENUMERATED {type1, type1And2}               OPTIONAL,
    semiOpenLoopCSI                     ENUMERATED {supported}                      OPTIONAL,
    csi-ReportWithoutPMI                ENUMERATED {supported}                      OPTIONAL,
    csi-ReportWithoutCQI                ENUMERATED {supported}                      OPTIONAL,
    onePortsPTRS                        BIT STRING (SIZE (2))                       OPTIONAL,
    twoPUCCH-F0-2-ConsecSymbols         ENUMERATED {supported}                      OPTIONAL,
    pucch-F2-WithFH                     ENUMERATED {supported}                      OPTIONAL,
    pucch-F3-WithFH                     ENUMERATED {supported}                      OPTIONAL,
    pucch-F4-WithFH                     ENUMERATED {supported}                      OPTIONAL,
    freqHoppingPUCCH-F0-2               ENUMERATED {notSupported}                   OPTIONAL,
```

```
    freqHoppingPUCCH-F1-3-4             ENUMERATED {notSupported}                     OPTIONAL,
    mux-SR-HARQ-ACK-CSI-PUCCH-MultiPerSlot ENUMERATED {supported}                     OPTIONAL,
    uci-CodeBlockSegmentation           ENUMERATED {supported}                        OPTIONAL,
    onePUCCH-LongAndShortFormat         ENUMERATED {supported}                        OPTIONAL,
    twoPUCCH-AnyOthersInSlot            ENUMERATED {supported}                        OPTIONAL,
    intraSlotFreqHopping-PUSCH          ENUMERATED {supported}                        OPTIONAL,
    pusch-LBRM                          ENUMERATED {supported}                        OPTIONAL,
    pdcch-BlindDetectionCA              INTEGER (4..16)                               OPTIONAL,
    tpc-PUSCH-RNTI                      ENUMERATED {supported}                        OPTIONAL,
    tpc-PUCCH-RNTI                      ENUMERATED {supported}                        OPTIONAL,
    tpc-SRS-RNTI                        ENUMERATED {supported}                        OPTIONAL,
    absoluteTPC-Command                 ENUMERATED {supported}                        OPTIONAL,
    twoDifferentTPC-Loop-PUSCH          ENUMERATED {supported}                        OPTIONAL,
    twoDifferentTPC-Loop-PUCCH          ENUMERATED {supported}                        OPTIONAL,
    pusch-HalfPi-BPSK                   ENUMERATED {supported}                        OPTIONAL,
    pucch-F3-4-HalfPi-BPSK              ENUMERATED {supported}                        OPTIONAL,
    almostContiguousCP-OFDM-UL          ENUMERATED {supported}                        OPTIONAL,
    sp-CSI-RS                           ENUMERATED {supported}                        OPTIONAL,
    sp-CSI-IM                           ENUMERATED {supported}                        OPTIONAL,
    tdd-MultiDL-UL-SwitchPerSlot        ENUMERATED {supported}                        OPTIONAL,
    multipleCORESET                     ENUMERATED {supported}                        OPTIONAL,
    ...,
    [[
    csi-RS-IM-ReceptionForFeedback      CSI-RS-IM-ReceptionForFeedback                OPTIONAL,
    csi-RS-ProcFrameworkForSRS          CSI-RS-ProcFrameworkForSRS                    OPTIONAL,
    csi-ReportFramework                 CSI-ReportFramework                           OPTIONAL,
    mux-SR-HARQ-ACK-CSI-PUCCH-OncePerSlot SEQUENCE {
        sameSymbol                          ENUMERATED {supported}                    OPTIONAL,
        diffSymbol                          ENUMERATED {supported}                    OPTIONAL
    } OPTIONAL,
    mux-SR-HARQ-ACK-PUCCH               ENUMERATED {supported}                        OPTIONAL,
    mux-MultipleGroupCtrlCH-Overlap     ENUMERATED {supported}                        OPTIONAL,
    dl-SchedulingOffset-PDSCH-TypeA     ENUMERATED {supported}                        OPTIONAL,
    dl-SchedulingOffset-PDSCH-TypeB     ENUMERATED {supported}                        OPTIONAL,
    ul-SchedulingOffset                 ENUMERATED {supported}                        OPTIONAL,
    dl-64QAM-MCS-TableAlt               ENUMERATED {supported}                        OPTIONAL,
    ul-64QAM-MCS-TableAlt               ENUMERATED {supported}                        OPTIONAL,
    cqi-TableAlt                        ENUMERATED {supported}                        OPTIONAL,
    oneFL-DMRS-TwoAdditionalDMRS-UL     ENUMERATED {supported}                        OPTIONAL,
    twoFL-DMRS-TwoAdditionalDMRS-UL     ENUMERATED {supported}                        OPTIONAL,
    oneFL-DMRS-ThreeAdditionalDMRS-UL   ENUMERATED {supported}                        OPTIONAL
    ]]
}

Phy-ParametersFR1 ::=               SEQUENCE {
    pdcchMonitoringSingleOccasion       ENUMERATED {supported}                        OPTIONAL,
    scs-60kHz                           ENUMERATED {supported}                        OPTIONAL,
    pdsch-256QAM-FR1                    ENUMERATED {supported}                        OPTIONAL,
    pdsch-RE-MappingFR1-PerSymbol       ENUMERATED {n10, n20}                         OPTIONAL,
    ...,
    [[
    pdsch-RE-MappingFR1-PerSlot     ENUMERATED {n16, n32, n48, n64, n80, n96, n112, n128,
                                    n144, n160, n176, n192, n208, n224, n240, n256} OPTIONAL
    ]]
```

```
}

Phy-ParametersFR2 ::=                SEQUENCE {
    dummy                                ENUMERATED {supported}                        OPTIONAL,
    pdsch-RE-MappingFR2-PerSymbol    ENUMERATED {n6, n20}                              OPTIONAL,
    ...,
    [[
    pCell-FR2                        ENUMERATED {supported}                            OPTIONAL,
    pdsch-RE-MappingFR2-PerSlot      ENUMERATED {n16, n32, n48, n64, n80, n96, n112, n128,
                                     n144, n160, n176, n192, n208, n224, n240, n256} OPTIONAL
    ]]
}

-- TAG-PHY-PARAMETERS-STOP
-- ASN1STOP
```

Phy-ParametersFRX-Diff field description
csi-RS-IM-ReceptionForFeedback/ csi-RS-ProcFrameworkForSRS/ csi-ReportFramework These fields are optionally present in *fr1-fr2-Add-UE-NR-Capabilities* in *UE-NR-Capability*. For a band combination comprised of FR1 and FR2 bands, these parameters, if present, limit the corresponding parameters in *MIMO-ParametersPerBand*.

– *Phy-ParametersMRDC*

The IE *Phy-ParametersMRDC* is used to convey physical layer capabilities for MR-DC.

Phy-ParametersMRDC information element

```
-- ASN1START
-- TAG-PHY-PARAMETERSMRDC-START

Phy-ParametersMRDC ::=               SEQUENCE {
    naics-Capability-List                SEQUENCE (SIZE (1..maxNrofNAICS-Entries)) OF NAICS-Capability-Entry         OPTIONAL,
    ...
}

NAICS-Capability-Entry ::=           SEQUENCE {
    numberOfNAICS-CapableCC              INTEGER(1..5),
    numberOfAggregatedPRB                ENUMERATED {n50, n75, n100, n125, n150, n175, n200, n225,
                                                     n250, n275, n300, n350, n400, n450, n500, spare},
    ...
}

-- TAG-PHY-PARAMETERSMRDC-STOP
-- ASN1STOP
```

***PHY-ParametersMRDC* field descriptions**
naics-Capability-List Indicates that UE in MR-DC supports NAICS as defined in defined in TS 36.331 [10].

– *ProcessingParameters*

The IE *ProcessingParameters* is used to indicate PDSCH/PUSCH processing capabilities supported by the UE.

ProcessingParameters information element

```
-- ASN1START
-- TAG-PROCESSINGPARAMETERS-START

ProcessingParameters ::=        SEQUENCE {
    fallback                        ENUMERATED {sc, cap1-only},
    differentTB-PerSlot             SEQUENCE {
        upto1                           NumberOfCarriers                    OPTIONAL,
        upto2                           NumberOfCarriers                    OPTIONAL,
        upto4                           NumberOfCarriers                    OPTIONAL,
        upto7                           NumberOfCarriers                    OPTIONAL
    } OPTIONAL
}

NumberOfCarriers ::=    INTEGER (1..16)

-- TAG-PROCESSINGPARAMETERS-STOP
-- ASN1STOP
```

– *RAT-Type*

The IE *RAT-Type* is used to indicate the radio access technology (RAT), including NR, of the requested/transferred UE capabilities.

RAT-Type information element

```
-- ASN1START
-- TAG-RAT-TYPE-START

RAT-Type ::= ENUMERATED {nr, eutra-nr, eutra, spare1, ...}

-- TAG-RAT-TYPE-STOP
-- ASN1STOP
```

– *RF-Parameters*

The IE *RF-Parameters* is used to convey RF-related capabilities for NR operation.

RF-Parameters information element

```
-- ASN1START
-- TAG-RF-PARAMETERS-START

RF-Parameters ::=                   SEQUENCE {
    supportedBandListNR                 SEQUENCE (SIZE (1..maxBands)) OF BandNR,
    supportedBandCombinationList        BandCombinationList                         OPTIONAL,
    appliedFreqBandListFilter           FreqBandList                                OPTIONAL,
    ...,
    [[
    supportedBandCombinationList-v1540  BandCombinationList-v1540                   OPTIONAL,
    srs-SwitchingTimeRequested          ENUMERATED {true}                           OPTIONAL
    ]]
}

BandNR ::=                          SEQUENCE {
    bandNR                              FreqBandIndicatorNR,
    modifiedMPR-Behaviour               BIT STRING (SIZE (8))                       OPTIONAL,
    mimo-ParametersPerBand              MIMO-ParametersPerBand                      OPTIONAL,
    extendedCP                          ENUMERATED {supported}                      OPTIONAL,
    multipleTCI                         ENUMERATED {supported}                      OPTIONAL,
    bwp-WithoutRestriction              ENUMERATED {supported}                      OPTIONAL,
    bwp-SameNumerology                  ENUMERATED {upto2, upto4}                   OPTIONAL,
    bwp-DiffNumerology                  ENUMERATED {upto4}                          OPTIONAL,
    crossCarrierScheduling-SameSCS      ENUMERATED {supported}                      OPTIONAL,
    pdsch-256QAM-FR2                    ENUMERATED {supported}                      OPTIONAL,
    pusch-256QAM                        ENUMERATED {supported}                      OPTIONAL,
    ue-PowerClass                       ENUMERATED {pc1, pc2, pc3, pc4}             OPTIONAL,
    rateMatchingLTE-CRS                 ENUMERATED {supported}                      OPTIONAL,
    channelBWs-DL-v1530                 CHOICE {
        fr1                                 SEQUENCE {
            scs-15kHz                           BIT STRING (SIZE (10))              OPTIONAL,
            scs-30kHz                           BIT STRING (SIZE (10))              OPTIONAL,
            scs-60kHz                           BIT STRING (SIZE (10))              OPTIONAL
        },
        fr2                                 SEQUENCE {
            scs-60kHz                           BIT STRING (SIZE (3))               OPTIONAL,
            scs-120kHz                          BIT STRING (SIZE (3))               OPTIONAL
        }
    }                                                                               OPTIONAL,
    channelBWs-UL-v1530                 CHOICE {
        fr1                                 SEQUENCE {
            scs-15kHz                           BIT STRING (SIZE (10))              OPTIONAL,
            scs-30kHz                           BIT STRING (SIZE (10))              OPTIONAL,
            scs-60kHz                           BIT STRING (SIZE (10))              OPTIONAL
        },
        fr2                                 SEQUENCE {
            scs-60kHz                           BIT STRING (SIZE (3))               OPTIONAL,
            scs-120kHz                          BIT STRING (SIZE (3))               OPTIONAL
        }
    }                                                                               OPTIONAL,
    ...,
    [[
```

```
    maxUplinkDutyCycle-PC2-FR1                  ENUMERATED {n60, n70, n80, n90, n100}           OPTIONAL
    ]],
    [[
    pucch-SpatialRelInfoMAC-CE          ENUMERATED {supported}                      OPTIONAL,
    powerBoosting-pi2BPSK               ENUMERATED {supported}                      OPTIONAL
    ]]
}

-- TAG-RF-PARAMETERS-STOP
-- ASN1STOP
```

RF-Parameters field descriptions
appliedFreqBandListFilter In this field the UE mirrors the FreqBandList that the NW provided in the capability enquiry, if any. The UE filtered the band combinations in the supportedBandCombinationList in accordance with this appliedFreqBandListFilter. The UE does not include this field if the UE capability is requested by E-UTRAN and the network request includes the field *eutra-nr-only* [10].
supportedBandCombinationList A list of band combinations that the UE supports for NR (without MR-DC). The *FeatureSetCombinationId*:s in this list refer to the *FeatureSetCombination* entries in the *featureSetCombinations* list in the *UE-NR-Capability* IE. The UE does not include this field if the UE capability is requested by E-UTRAN and the network request includes the field *eutra-nr-only* [10].

– *RF-ParametersMRDC*

The IE *RF-ParametersMRDC* is used to convey RF related capabilities for MR-DC.

RF-ParametersMRDC information element

```
-- ASN1START
-- TAG-RF-PARAMETERSMRDC-START

RF-ParametersMRDC ::=               SEQUENCE {
    supportedBandCombinationList        BandCombinationList                 OPTIONAL,
    appliedFreqBandListFilter           FreqBandList                        OPTIONAL,
    ...,
    [[
    srs-SwitchingTimeRequested          ENUMERATED {true}                   OPTIONAL,
    supportedBandCombinationList-v1540  BandCombinationList-v1540           OPTIONAL
    ]]
}

-- TAG-RF-PARAMETERSMRDC-STOP
-- ASN1STOP
```

***RF-ParametersMRDC* field descriptions**
appliedFreqBandListFilter In this field the UE mirrors the FreqBandList that the NW provided in the capability enquiry, if any. The UE filtered the band combinations in the supportedBandCombinationList in accordance with this appliedFreqBandListFilter.
supportedBandCombinationList A list of band combinations that the UE supports for MR-DC. The *FeatureSetCombinationId*:s in this list refer to the *FeatureSetCombination* entries in the *featureSetCombinations* list in the *UE-MRDC-Capability* IE.

– *RLC-Parameters*

The IE *RLC-Parameters* is used to convey capabilities related to RLC.

***RLC-Parameters* information element**

```
-- ASN1START
-- TAG-RLC-PARAMETERS-START

RLC-Parameters ::= SEQUENCE {
    am-WithShortSN                  ENUMERATED {supported}  OPTIONAL,
    um-WithShortSN                  ENUMERATED {supported}  OPTIONAL,
    um-WithLongSN                   ENUMERATED {supported}  OPTIONAL,
    ...
}

-- TAG-RLC-PARAMETERS-STOP
-- ASN1STOP
```

– *SDAP-Parameters*

The IE *SDAP-Parameters* is used to convey capabilities related to SDAP.

***SDAP-Parameters* information element**

```
-- ASN1START
-- TAG-SDAP-PARAMETERS-START

SDAP-Parameters ::= SEQUENCE {
    as-ReflectiveQoS                ENUMERATED {true}       OPTIONAL,
    ...
}

-- TAG-SDAP-PARAMETERS-STOP
-- ASN1STOP
```

– *SRS-SwitchingTimeNR*

The IE *SRS-SwitchingTimeNR* is used to indicate the SRS carrier switching time supported by the UE for one NR band pair.

SRS-SwitchingTimeNR information element

```
-- ASN1START
-- TAG-SRS-SWITCHINGTIMENR-START

SRS-SwitchingTimeNR ::= SEQUENCE {
    switchingTimeDL         ENUMERATED {n0us, n30us, n100us, n140us, n200us, n300us, n500us, n900us}  OPTIONAL,
    switchingTimeUL         ENUMERATED {n0us, n30us, n100us, n140us, n200us, n300us, n500us, n900us}  OPTIONAL
}

-- TAG-SRS-SWITCHINGTIMENR-STOP
-- ASN1STOP
```

– *SRS-SwitchingTimeEUTRA*

The IE *SRS-SwitchingTimeEUTRA* is used to indicate the SRS carrier switching time supported by the UE for one E-UTRA band pair.

SRS-SwitchingTimeEUTRA information element

```
-- ASN1START
-- TAG-SRS-SWITCHINGTIMEEUTRA-START

SRS-SwitchingTimeEUTRA ::= SEQUENCE {
    switchingTimeDL            ENUMERATED {n0, n0dot5, n1, n1dot5, n2, n2dot5, n3, n3dot5, n4, n4dot5, n5, n5dot5, n6, n6dot5, n7} OPTIONAL,
    switchingTimeUL            ENUMERATED {n0, n0dot5, n1, n1dot5, n2, n2dot5, n3, n3dot5, n4, n4dot5, n5, n5dot5, n6, n6dot5, n7} OPTIONAL
}
-- TAG-SRS-SWITCHINGTIMEEUTRA-STOP
-- ASN1STOP
```

– *SupportedBandwidth*

The IE *SupportedBandwidth* is used to indicate the maximum channel bandwidth supported by the UE on one carrier of a band of a band combination.

***SupportedBandwidth* information element**

```
-- ASN1START
-- TAG-SUPPORTEDBANDWIDTH-START

SupportedBandwidth ::=      CHOICE {
    fr1                         ENUMERATED {mhz5, mhz10, mhz15, mhz20, mhz25, mhz30, mhz40, mhz50, mhz60, mhz80, mhz100},
    fr2                         ENUMERATED {mhz50, mhz100, mhz200, mhz400}
}

-- TAG-SUPPORTEDBANDWIDTH-STOP
-- ASN1STOP
```

– *UE-CapabilityRAT-ContainerList*

The IE *UE-CapabilityRAT-ContainerList* contains a list of radio access technology specific capability containers.

***UE-CapabilityRAT-ContainerList* information element**

```
-- ASN1START
-- TAG-UE-CAPABILITY-RAT-CONTAINER-LIST-START

UE-CapabilityRAT-ContainerList ::=SEQUENCE (SIZE (0..maxRAT-CapabilityContainers)) OF UE-CapabilityRAT-Container

UE-CapabilityRAT-Container ::= SEQUENCE {
    rat-Type                            RAT-Type,
    ue-CapabilityRAT-Container          OCTET STRING
}

-- TAG-UE-CAPABILITY-RAT-CONTAINER-LIST-STOP
-- ASN1STOP
```

***UE-CapabilityRAT-ContainerList* field descriptions**
ue-CapabilityRAT-Container Container for the UE capabilities of the indicated RAT. The encoding is defined in the specification of each RAT: For *rat-Type* set to *nr*: the encoding of UE capabilities is defined in *UE-NR-Capability*. For *rat-Type* set to *eutra-nr*: the encoding of UE capabilities is defined in *UE-MRDC-Capability*. For *rat-Type* set to *eutra*: the encoding of UE capabilities is defined in *UE-EUTRA-Capability* specified in TS 36.331 [10].

– *UE-CapabilityRAT-RequestList*

The IE *UE-CapabilityRAT-RequestList* is used to request UE capabilities for one or more RATs from the UE.

***UE-CapabilityRAT-RequestList* information element**

```
-- ASN1START
-- TAG-UE-CAPABILITYRAT-REQUESTLIST-START

UE-CapabilityRAT-RequestList ::=        SEQUENCE (SIZE (1..maxRAT-CapabilityContainers)) OF UE-CapabilityRAT-Request

UE-CapabilityRAT-Request ::=            SEQUENCE {
    rat-Type                                RAT-Type,
    capabilityRequestFilter                 OCTET STRING                    OPTIONAL,   -- Need N
    ...
}

-- TAG-UE-CAPABILITYRAT-REQUESTLIST-STOP
-- ASN1STOP
```

***UE-CapabilityRAT-Request* field descriptions**
capabilityRequestFilter Information by which the network requests the UE to filter the UE capabilities. For ratType set to nr: the encoding of the capabilityRequestFilter is defined in UE-CapabilityRequestFilterNR.
rat-Type The RAT type for which the NW requests UE capabilities.

– *UE-CapabilityRequestFilterNR*

The IE *UE-CapabilityRequestFilterNR* is used to request filtered UE capabilities.

UE-CapabilityRequestFilterNR information element

```
-- ASN1START
-- TAG-UE-CAPABILITYREQUESTFILTERNR-START

UE-CapabilityRequestFilterNR ::=            SEQUENCE {
    frequencyBandList                           FreqBandList                            OPTIONAL,   -- Need N
    nonCriticalExtension                        UE-CapabilityRequestFilterNR-v1540      OPTIONAL
}

UE-CapabilityRequestFilterNR-v1540 ::=      SEQUENCE {
    srs-SwitchingTimeRequest                    ENUMERATED {true}                       OPTIONAL,  -- Need N
    nonCriticalExtension                        SEQUENCE {}                             OPTIONAL
}

-- TAG-UE-CAPABILITYREQUESTFILTERNR-STOP
-- ASN1STOP
```

– *UE-MRDC-Capability*

The IE *UE-MRDC-Capability* is used to convey the UE Radio Access Capability Parameters for MR-DC, see TS 38.306 [26].

UE-MRDC-Capability information element

```
-- ASN1START
-- TAG-UE-MRDC-CAPABILITY-START

UE-MRDC-Capability ::=              SEQUENCE {
    measAndMobParametersMRDC            MeasAndMobParametersMRDC                    OPTIONAL,
    phy-ParametersMRDC-v1530            Phy-ParametersMRDC                          OPTIONAL,
    rf-ParametersMRDC                   RF-ParametersMRDC,
    generalParametersMRDC               GeneralParametersMRDC-XDD-Diff              OPTIONAL,
    fdd-Add-UE-MRDC-Capabilities        UE-MRDC-CapabilityAddXDD-Mode               OPTIONAL,
    tdd-Add-UE-MRDC-Capabilities        UE-MRDC-CapabilityAddXDD-Mode               OPTIONAL,
    fr1-Add-UE-MRDC-Capabilities        UE-MRDC-CapabilityAddFRX-Mode               OPTIONAL,
    fr2-Add-UE-MRDC-Capabilities        UE-MRDC-CapabilityAddFRX-Mode               OPTIONAL,
    featureSetCombinations              SEQUENCE (SIZE (1..maxFeatureSetCombinations)) OF FeatureSetCombination         OPTIONAL,
    pdcp-ParametersMRDC-v1530           PDCP-ParametersMRDC                         OPTIONAL,
```

```
    lateNonCriticalExtension            OCTET STRING                            OPTIONAL,
    nonCriticalExtension                SEQUENCE {}                             OPTIONAL
}

UE-MRDC-CapabilityAddXDD-Mode ::=   SEQUENCE {
    measAndMobParametersMRDC-XDD-Diff       MeasAndMobParametersMRDC-XDD-Diff       OPTIONAL,
    generalParametersMRDC-XDD-Diff          GeneralParametersMRDC-XDD-Diff          OPTIONAL
}

UE-MRDC-CapabilityAddFRX-Mode ::=   SEQUENCE {
    measAndMobParametersMRDC-FRX-Diff       MeasAndMobParametersMRDC-FRX-Diff
}


GeneralParametersMRDC-XDD-Diff ::= SEQUENCE {
    splitSRB-WithOneUL-Path             ENUMERATED {supported}              OPTIONAL,
    splitDRB-withUL-Both-MCG-SCG        ENUMERATED {supported}              OPTIONAL,
    srb3                                ENUMERATED {supported}              OPTIONAL,
    v2x-EUTRA-v1530                     ENUMERATED {supported}              OPTIONAL,
    ...
}

-- TAG-UE-MRDC-CAPABILITY-STOP
-- ASN1STOP
```

UE-MRDC-Capability field descriptions
featureSetCombinations A list of FeatureSetCombination:s for MR-DC. The FeatureSetDownlink:s and FeatureSetUplink:s referred to from these FeatureSetCombination:s are defined in the featureSets list in UE-NR-Capability.

– *UE-NR-Capability*

The IE *UE-NR-Capability* is used to convey the NR UE Radio Access Capability Parameters, see TS 38.306 [26].

***UE-NR-Capability* information element**

```
-- ASN1START
-- TAG-UE-NR-CAPABILITY-START

UE-NR-Capability ::=                SEQUENCE {
    accessStratumRelease                AccessStratumRelease,
    pdcp-Parameters                     PDCP-Parameters,
    rlc-Parameters                      RLC-Parameters                      OPTIONAL,
    mac-Parameters                      MAC-Parameters                      OPTIONAL,
    phy-Parameters                      Phy-Parameters,
    rf-Parameters                       RF-Parameters,
    measAndMobParameters                MeasAndMobParameters                OPTIONAL,
    fdd-Add-UE-NR-Capabilities          UE-NR-CapabilityAddXDD-Mode         OPTIONAL,
    tdd-Add-UE-NR-Capabilities          UE-NR-CapabilityAddXDD-Mode         OPTIONAL,
    fr1-Add-UE-NR-Capabilities          UE-NR-CapabilityAddFRX-Mode         OPTIONAL,
```

```
    fr2-Add-UE-NR-Capabilities      UE-NR-CapabilityAddFRX-Mode         OPTIONAL,
    featureSets                     FeatureSets                         OPTIONAL,
    featureSetCombinations          SEQUENCE (SIZE (1..maxFeatureSetCombinations)) OF FeatureSetCombination         OPTIONAL,

    lateNonCriticalExtension        OCTET STRING                        OPTIONAL,
    nonCriticalExtension            UE-NR-Capability-v1530              OPTIONAL
}

UE-NR-Capability-v1530 ::=              SEQUENCE {
    fdd-Add-UE-NR-Capabilities-v1530        UE-NR-CapabilityAddXDD-Mode-v1530       OPTIONAL,
    tdd-Add-UE-NR-Capabilities-v1530        UE-NR-CapabilityAddXDD-Mode-v1530       OPTIONAL,
    dummy                                   ENUMERATED {supported}                  OPTIONAL,
    interRAT-Parameters                     InterRAT-Parameters                     OPTIONAL,
    inactiveState                           ENUMERATED {supported}                  OPTIONAL,
    delayBudgetReporting                    ENUMERATED {supported}                  OPTIONAL,
    nonCriticalExtension                    UE-NR-Capability-1540                   OPTIONAL
}

UE-NR-Capability-1540 ::=               SEQUENCE {
    sdap-Parameters                         SDAP-Parameters                         OPTIONAL,
    overheatingInd                          ENUMERATED {supported}                  OPTIONAL,
    ims-Parameters                          IMS-Parameters                          OPTIONAL,
    fr1-Add-UE-NR-Capabilities-v1540        UE-NR-CapabilityAddFRX-Mode-v1540       OPTIONAL,
    fr2-Add-UE-NR-Capabilities-v1540        UE-NR-CapabilityAddFRX-Mode-v1540       OPTIONAL,
    fr1-fr2-Add-UE-NR-Capabilities          UE-NR-CapabilityAddFRX-Mode             OPTIONAL,
    nonCriticalExtension                    SEQUENCE {}                             OPTIONAL
}

UE-NR-CapabilityAddXDD-Mode ::=         SEQUENCE {
    phy-ParametersXDD-Diff                  Phy-ParametersXDD-Diff                  OPTIONAL,
    mac-ParametersXDD-Diff                  MAC-ParametersXDD-Diff                  OPTIONAL,
    measAndMobParametersXDD-Diff            MeasAndMobParametersXDD-Diff            OPTIONAL
}

UE-NR-CapabilityAddXDD-Mode-v1530 ::=   SEQUENCE {
    eutra-ParametersXDD-Diff                EUTRA-ParametersXDD-Diff
}

UE-NR-CapabilityAddFRX-Mode ::= SEQUENCE {
    phy-ParametersFRX-Diff              Phy-ParametersFRX-Diff                      OPTIONAL,
    measAndMobParametersFRX-Diff        MeasAndMobParametersFRX-Diff                OPTIONAL
}

UE-NR-CapabilityAddFRX-Mode-v1540 ::=   SEQUENCE {
    ims-ParametersFRX-Diff                  IMS-ParametersFRX-Diff                  OPTIONAL
}

-- TAG-UE-NR-CAPABILITY-STOP
-- ASN1STOP
```

UE-NR-Capability field descriptions
featureSetCombinations A list of FeatureSetCombination:s for NR (not for MR-DC). The FeatureSetDownlink:s and FeatureSetUplink:s referred to from these FeatureSetCombination:s are defined in the featureSets list in UE-NR-Capability.

6.3.4 Other information elements

– *EUTRA-AllowedMeasBandwidth*

The IE *EUTRA-AllowedMeasBandwidth* is used to indicate the maximum allowed measurement bandwidth on a carrier frequency as defined by the parameter Transmission Bandwidth Configuration "N_{RB}" in TS 36.104 [33]. The values *mbw6*, *mbw15*, *mbw25*, *mbw50*, *mbw75*, *mbw100* indicate 6, 15, 25, 50, 75 and 100 resource blocks, respectively.

***EUTRA-AllowedMeasBandwidth* information element**

```
-- ASN1START
-- TAG-EUTRA-ALLOWED-MEAS-BANDWIDTH-START

EUTRA-AllowedMeasBandwidth ::=              ENUMERATED {mbw6, mbw15, mbw25, mbw50, mbw75, mbw100}

-- TAG-EUTRA-ALLOWED-MEAS-BANDWIDTH-STOP
-- ASN1STOP
```

– *EUTRA-MBSFN-SubframeConfigList*

The IE *EUTRA-MBSFN-SubframeConfigList* is used to define an E-UTRA MBSFN subframe pattern (for the purpose of NR rate matching).

***EUTRA-MBSFN-SubframeConfigList* information element**

```
-- ASN1START
-- TAG-EUTRA-MBSFN-SUBFRAMECONFIGLIST-START

EUTRA-MBSFN-SubframeConfigList ::=  SEQUENCE (SIZE (1..maxMBSFN-Allocations)) OF EUTRA-MBSFN-SubframeConfig

EUTRA-MBSFN-SubframeConfig ::=      SEQUENCE {
    radioframeAllocationPeriod          ENUMERATED {n1, n2, n4, n8, n16, n32},
    radioframeAllocationOffset          INTEGER (0..7),
    subframeAllocation1                 CHOICE {
        oneFrame                            BIT STRING (SIZE(6)),
        fourFrames                          BIT STRING (SIZE(24))
    },
    subframeAllocation2                 CHOICE {
        oneFrame                            BIT STRING (SIZE(2)),
        fourFrames                          BIT STRING (SIZE(8))
    }                                                                                                       OPTIONAL,   -- Need R
    ...
}
```

```
-- TAG-EUTRA-MBSFN-SUBFRAMECONFIGLIST-STOP
-- ASN1STOP
```

***EUTRA-MBSFN-SubframeConfig* field descriptions**
radioframeAllocationOffset Field as defined in MBSFN-SubframeConfig in TS 36.331 [10]
radioframeAllocationPeriod Field as defined in MBSFN-SubframeConfig in TS 36.331 [10]
subframeAllocation1 Field as defined in MBSFN-SubframeConfig in TS 36.331 [10]
subframeAllocation2 Field as defined in MBSFN-SubframeConfig-v1430 in TS 36.331 [10]

– *EUTRA-MultiBandInfoList*

The IE *EUTRA-MultiBandInfoList* indicates the list of frequency bands in addition to the band represented by CarrierFreq for which cell reselection parameters are common, and a list of additionalPmax and additionalSpectrumEmission.

EUTRA-MultiBandInfoList information element

```
-- ASN1START
-- TAG-EUTRA-MULTI-BAND-INFO-LIST-START

EUTRA-MultiBandInfoList ::=     SEQUENCE (SIZE (1..maxMultiBands)) OF EUTRA-MultiBandInfo

EUTRA-MultiBandInfo ::=         SEQUENCE {
    eutra-FreqBandIndicator         FreqBandIndicatorEUTRA,
    eutra-NS-PmaxList               EUTRA-NS-PmaxList                           OPTIONAL    -- Need R
}

-- TAG-EUTRA-MULTI-BAND-INFO-LIST-STOP
-- ASN1STOP
```

– *EUTRA-NS-PmaxList*

The IE *EUTRA-NS-PmaxList* concerns a list of *additionalPmax* and *additionalSpectrumEmission*, as defined in TS 36.101 [22], table 6.2.4-1 for UEs neither in CE nor BL UEs and TS 36.101 [22], table 6.2.4E-1 for UEs in CE or BL UEs, for a given frequency band.

EUTRA-NS-PmaxList information element

```
-- ASN1START
-- TAG-EUTRA-NS-PMAX-LIST-START

EUTRA-NS-PmaxList ::=               SEQUENCE (SIZE (1..maxEUTRA-NS-Pmax)) OF EUTRA-NS-PmaxValue

EUTRA-NS-PmaxValue ::=              SEQUENCE {
```

```
    additionalPmax                      INTEGER (-30..33)                       OPTIONAL,   -- Need R
    additionalSpectrumEmission          INTEGER (1..288)                        OPTIONAL    -- Need R
}

-- TAG-EUTRA-NS-PMAX-LIST-STOP
-- ASN1STOP
```

– EUTRA-PhysCellId

The IE *EUTRA-PhysCellId* is used to indicate the physical layer identity of the cell, as defined in TS 36.211 [31].

EUTRA-PhysCellId information element

```
-- ASN1START
-- TAG-EUTRA-PHYS-CELL-ID-START

EUTRA-PhysCellId ::=                    INTEGER (0..503)

-- TAG-EUTRA-PHYS-CELL-ID-STOP
-- ASN1STOP
```

– EUTRA-PhysCellIdRange

The IE *EUTRA-PhysCellIdRange* is used to encode either a single or a range of physical cell identities. The range is encoded by using a *start* value and by indicating the number of consecutive physical cell identities (including *start*) in the range. For fields comprising multiple occurrences of *EUTRA-PhysCellIdRange*, NW may configure overlapping ranges of physical cell identities.

EUTRA-PhysCellIdRange information element

```
-- ASN1START
-- TAG-EUTRA-PHYS-CELL-ID-RANGE-START

EUTRA-PhysCellIdRange ::=       SEQUENCE {
    start                           EUTRA-PhysCellId,
    range                           ENUMERATED {n4, n8, n12, n16, n24, n32, n48, n64, n84, n96,
                                                n128, n168, n252, n504, spare2, spare1}                 OPTIONAL    -- Need N
}

-- TAG-EUTRA-PHYS-CELL-ID-RANGE-STOP
-- ASN1STOP
```

– EUTRA-PresenceAntennaPort1

The IE *EUTRA-PresenceAntennaPort1* is used to indicate whether all the neighbouring cells use Antenna Port 1. When set to *TRUE*, the UE may assume that at least two cell-specific antenna ports are used in all neighbouring cells.

***EUTRA-PresenceAntennaPort1* information element**

```
-- ASN1START
-- TAG-EUTRA-PRESENCE-ANTENNA-PORT1-START

EUTRA-PresenceAntennaPort1 ::=             BOOLEAN

-- TAG-EUTRA-PRESENCE-ANTENNA-PORT1-STOP
-- ASN1STOP
```

– *EUTRA-Q-OffsetRange*

The IE *EUTRA-Q-OffsetRange* is used to indicate a cell, or frequency specific offset to be applied when evaluating candidates for cell re-selection or when evaluating triggering conditions for measurement reporting. The value in dB. Value dB-24 corresponds to -24 dB, dB-22 corresponds to -22 dB and so on.

***EUTRA-Q-OffsetRange* information element**

```
-- ASN1START

EUTRA-Q-OffsetRange ::=                    ENUMERATED {
                                               dB-24, dB-22, dB-20, dB-18, dB-16, dB-14,
                                               dB-12, dB-10, dB-8, dB-6, dB-5, dB-4, dB-3,
                                               dB-2, dB-1, dB0, dB1, dB2, dB3, dB4, dB5,
                                               dB6, dB8, dB10, dB12, dB14, dB16, dB18,
                                               dB20, dB22, dB24}

-- ASN1STOP
```

– *MultiFrequencyBandListNR-SIB*

The IE *MultiFrequencyBandListNR-SIB* indicates the list of frequency bands in addition to the band represented by *dl-CarrierFreq* for which cell reselection parameters are common, and a list of additionalPmax and *additionalSpectrumEmission*

***MultiFrequencyBandListNR-SIB* information element**

```
-- ASN1START
-- TAG-MULTIFREQUENCYBANDLISTNR-SIB-START

MultiFrequencyBandListNR-SIB ::=           SEQUENCE (SIZE (1.. maxNrofMultiBands)) OF NR-MultiBandInfo

NR-MultiBandInfo ::=                       SEQUENCE {
            freqBandIndicatorNR                FreqBandIndicatorNR           OPTIONAL,    -- Cond OptULNotSIB2
            nr-NS-PmaxList                     NR-NS-PmaxList                OPTIONAL     -- Need S
}

-- TAG-MULTIFREQUENCYBANDLISTNR-SIB-STOP
-- ASN1STOP
```

***NR-MultiBandInfo* field descriptions**
freqBandIndicatorNR Provides an NR frequency band number as defined in TS 38.101 [15], table 5.2-1.
nr-NS-PmaxList Provides a list of additionalPmax and additionalSpectrumEmission values as defined in TS 38.101 [15], table 6.2.3-1. If the field is absent the UE uses value 0 for the *additionalSpectrumEmission* (see Table 6.2.3-1A in TS 38.101 [15]).

Conditional Presence	Explanation
OptULNotSIB2	The field is not present for SIB2 and is mandatory present in *frequencyInfoDL-SIB*. Otherwise, if the field is not present in *frequencyInfoUL-SIB* in *UplinkConfigCommonSIB*, the UE will use the frequency band indicated in *frequencyInfoDL-SIB* in *DownlinkConfigCommonSIB*.

– *NR-NS-PmaxList*

The IE *NR-NS-PmaxList* is used to configure a list of *additionalPmax* and *additionalSpectrumEmission*, as defined in TS 38.101 [15], table 6.2.3-1 for a given frequency band.

NR-NS-PmaxList information element

```
-- ASN1START
-- TAG-NR-NS-PMAXLIST-START

NR-NS-PmaxList ::=                          SEQUENCE (SIZE (1..maxNR-NS-Pmax)) OF NR-NS-PmaxValue

NR-NS-PmaxValue ::=                     SEQUENCE {
    additionalPmax                          P-Max                               OPTIONAL,   -- Need N
    additionalSpectrumEmission              AdditionalSpectrumEmission
}

-- TAG-NR-NS-PMAXLIST-STOP
-- ASN1STOP
```

– *OtherConfig*

The IE *OtherConfig* contains configuration related to other configuration

OtherConfig information element

```
-- ASN1START
-- TAG-OTHERCONFIG-START

OtherConfig ::=                 SEQUENCE {
    delayBudgetReportingConfig  CHOICE{
            release                 NULL,
            setup                   SEQUENCE{
                delayBudgetReportingProhibitTimer   ENUMERATED {s0, s0dot4, s0dot8, s1dot6, s3, s6, s12, s30}
            }
    }                                                                                                           OPTIONAL        -- Need M
}
```

```
OtherConfig-v1540 ::=           SEQUENCE {
    overheatingAssistanceConfig     SetupRelease {OverheatingAssistanceConfig}                            OPTIONAL, -- Need M
    ...
}

OverheatingAssistanceConfig ::= SEQUENCE {
    overheatingIndicationProhibitTimer    ENUMERATED {s0, s0dot5, s1, s2, s5, s10, s20, s30,
                                          s60, s90, s120, s300, s600, spare3, spare2, spare1}
}

-- TAG-OTHERCONFIG-STOP
-- ASN1STOP
```

***OtherConfig* field descriptions**
delayBudgetReportingProhibitTimer Prohibit timer for delay budget reporting. Value in seconds. Value s0 means prohibit timer is set to 0 second, value s0dot4 means prohibit timer is set to 0.4 second, and so on.
overheatingAssistanceConfig Configuration for the UE to report assistance information to inform the gNB about UE detected internal overheating.
overheatingIndicationProhibitTimer Prohibit timer for overheating assistance information reporting. Value in seconds. Value s0 means prohibit timer is set to 0 seconds, value s0dot5 means prohibit timer is set to 0.5 second, value s1 means prohibit timer is set to 1 second and so on.

– *RRC-TransactionIdentifier*

The IE *RRC-TransactionIdentifier* is used, together with the message type, for the identification of an RRC procedure (transaction).

***RRC-TransactionIdentifier* information element**

```
-- ASN1START
-- TAG-RRC-TRANSACTIONIDENTIFIER-START

RRC-TransactionIdentifier ::=       INTEGER (0..3)

-- TAG-RRC-TRANSACTIONIDENTIFIER-STOP
-- ASN1STOP
```

6.4 RRC multiplicity and type constraint values

– Multiplicity and type constraint definitions

```
-- ASN1START
-- TAG-MULTIPLICITY-AND-TYPE-CONSTRAINT-DEFINITIONS-START

maxBandComb                             INTEGER ::= 65536   -- Maximum number of DL band combinations
maxCellBlack                            INTEGER ::= 16      -- Maximum number of NR blacklisted cell ranges in SIB3, SIB4
```

```
maxCellInter                            INTEGER ::= 16      -- Maximum number of inter-Freq cells listed in SIB4
maxCellIntra                            INTEGER ::= 16      -- Maximum number of intra-Freq cells listed in SIB3
maxCellMeasEUTRA                        INTEGER ::= 32      -- Maximum number of cells in E-UTRAN
maxEARFCN                               INTEGER ::= 262143  -- Maximum value of E-UTRA carrier frequency
maxEUTRA-CellBlack                      INTEGER ::= 16      -- Maximum number of E-UTRA-blacklisted physical cell identity ranges in SIB5
maxEUTRA-NS-Pmax                        INTEGER ::= 8       -- Maximum number of NS and P-Max values per band
maxMultiBands                           INTEGER ::= 8       -- Maximum number of additional frequency bands that a cell belongs to
maxNARFCN                               INTEGER ::= 3279165 -- Maximum value of NR carrier frequency
maxNR-NS-Pmax                           INTEGER ::= 8       -- Maximum number of NS and P-Max values per band
maxNrofServingCells                     INTEGER ::= 32      -- Max number of serving cells (SpCells + SCells)
maxNrofServingCells-1                   INTEGER ::= 31      -- Max number of serving cells (SpCell + SCells) per cell group
maxNrofAggregatedCellsPerCellGroup      INTEGER ::= 16
maxNrofSCells                           INTEGER ::= 31      -- Max number of secondary serving cells per cell group
maxNrofCellMeas                         INTEGER ::= 32      -- Maximum number of entries in each of the cell lists in a measurement object
maxNrofSS-BlocksToAverage               INTEGER ::= 16      -- Max number for the (max) number of SS blocks to average to determine cell
                                                            -- measurement
maxNrofCSI-RS-ResourcesToAverage        INTEGER ::= 16      -- Max number for the (max) number of CSI-RS to average to determine cell
                                                            -- measurement
maxNrofDL-Allocations                   INTEGER ::= 16      -- Maximum number of PDSCH time domain resource allocations

maxNrofSR-ConfigPerCellGroup            INTEGER ::= 8       -- Maximum number of SR configurations per cell group

maxLCG-ID                               INTEGER ::= 7       -- Maximum value of LCG ID
maxLC-ID                                INTEGER ::= 32      -- Maximum value of Logical Channel ID
maxNrofTAGs                             INTEGER ::= 4       -- Maximum number of Timing Advance Groups
maxNrofTAGs-1                           INTEGER ::= 3       -- Maximum number of Timing Advance Groups minus 1

maxNrofBWPs                             INTEGER ::= 4       -- Maximum number of BWPs per serving cell
maxNrofCombIDC                          INTEGER ::= 128     -- Maximum number of reported MR-DC combinations for IDC
maxNrofSymbols-1                        INTEGER ::= 13      -- Maximum index identifying a symbol within a slot (14 symbols, indexed from 0..13)
maxNrofSlots                            INTEGER ::= 320     -- Maximum number of slots in a 10 ms period
maxNrofSlots-1                          INTEGER ::= 319     -- Maximum number of slots in a 10 ms period minus 1

maxNrofPhysicalResourceBlocks           INTEGER ::= 275     -- Maximum number of PRBs
maxNrofPhysicalResourceBlocks-1         INTEGER ::= 274     -- Maximum number of PRBs minus 1
maxNrofPhysicalResourceBlocksPlus1      INTEGER ::= 276     -- Maximum number of PRBs plus 1
maxNrofControlResourceSets-1            INTEGER ::= 11      -- Max number of CoReSets configurable on a serving cell minus 1
maxCoReSetDuration                      INTEGER ::= 3       -- Max number of OFDM symbols in a control resource set
maxNrofSearchSpaces-1                   INTEGER ::= 39      -- Max number of Search Spaces minus 1
maxSFI-DCI-PayloadSize                  INTEGER ::= 128     -- Max number payload of a DCI scrambled with SFI-RNTI
maxSFI-DCI-PayloadSize-1                INTEGER ::= 127     -- Max number payload of a DCI scrambled with SFI-RNTI minus 1
maxINT-DCI-PayloadSize                  INTEGER ::= 126     -- Max number payload of a DCI scrambled with INT-RNTI
maxINT-DCI-PayloadSize-1                INTEGER ::= 125     -- Max number payload of a DCI scrambled with INT-RNTI minus 1
maxNrofRateMatchPatterns                INTEGER ::= 4       -- Max number of rate matching patterns that may be configured
maxNrofRateMatchPatterns-1              INTEGER ::= 3       -- Max number of rate matching patterns that may be configured minus 1
maxNrofRateMatchPatternsPerGroup        INTEGER ::= 8       -- Max number of rate matching patterns that may be configured in one group

maxNrofCSI-ReportConfigurations         INTEGER ::= 48      -- Maximum number of report configurations
maxNrofCSI-ReportConfigurations-1       INTEGER ::= 47      -- Maximum number of report configurations minus 1

maxNrofCSI-ResourceConfigurations       INTEGER ::= 112     -- Maximum number of resource configurations
maxNrofCSI-ResourceConfigurations-1     INTEGER ::= 111     -- Maximum number of resource configurations minus 1

maxNrofAP-CSI-RS-ResourcesPerSet        INTEGER ::= 16
```

```
maxNrOfCSI-AperiodicTriggers            INTEGER ::= 128     -- Maximum number of triggers for aperiodic CSI reporting
maxNrofReportConfigPerAperiodicTrigger  INTEGER ::= 16      -- Maximum number of report configurations per trigger state for aperiodic reporting

maxNrofNZP-CSI-RS-Resources             INTEGER ::= 192     -- Maximum number of Non-Zero-Power (NZP) CSI-RS resources
maxNrofNZP-CSI-RS-Resources-1           INTEGER ::= 191     -- Maximum number of Non-Zero-Power (NZP) CSI-RS resources minus 1
maxNrofNZP-CSI-RS-ResourcesPerSet       INTEGER ::= 64      -- Maximum number of NZP CSI-RS resources per resource set
maxNrofNZP-CSI-RS-ResourceSets          INTEGER ::= 64      -- Maximum number of NZP CSI-RS resources per cell
maxNrofNZP-CSI-RS-ResourceSets-1        INTEGER ::= 63      -- Maximum number of NZP CSI-RS resources per cell minus 1
maxNrofNZP-CSI-RS-ResourceSetsPerConfig INTEGER ::= 16      -- Maximum number of resource sets per resource configuration
maxNrofNZP-CSI-RS-ResourcesPerConfig    INTEGER ::= 128     -- Maximum number of resources per resource configuration

maxNrofZP-CSI-RS-Resources              INTEGER ::= 32      -- Maximum number of Zero-Power (NZP) CSI-RS resources
maxNrofZP-CSI-RS-Resources-1            INTEGER ::= 31      -- Maximum number of Zero-Power (NZP) CSI-RS resources minus 1
maxNrofZP-CSI-RS-ResourceSets-1         INTEGER ::= 15
maxNrofZP-CSI-RS-ResourcesPerSet        INTEGER ::= 16
maxNrofZP-CSI-RS-ResourceSets           INTEGER ::= 16

maxNrofCSI-IM-Resources                 INTEGER ::= 32      -- Maximum number of CSI-IM resources. See CSI-IM-ResourceMax in 38.214.
maxNrofCSI-IM-Resources-1               INTEGER ::= 31      -- Maximum number of CSI-IM resources minus 1. See CSI-IM-ResourceMax in 38.214.
maxNrofCSI-IM-ResourcesPerSet           INTEGER ::= 8       -- Maximum number of CSI-IM resources per set. See CSI-IM-ResourcePerSetMax in 38.214
maxNrofCSI-IM-ResourceSets              INTEGER ::= 64      -- Maximum number of NZP CSI-IM resources per cell
maxNrofCSI-IM-ResourceSets-1            INTEGER ::= 63      -- Maximum number of NZP CSI-IM resources per cell minus 1
maxNrofCSI-IM-ResourceSetsPerConfig     INTEGER ::= 16      -- Maximum number of CSI IM resource sets per resource configuration

maxNrofCSI-SSB-ResourcePerSet           INTEGER ::= 64      -- Maximum number of SSB resources in a resource set
maxNrofCSI-SSB-ResourceSets             INTEGER ::= 64      -- Maximum number of CSI SSB resource sets per cell
maxNrofCSI-SSB-ResourceSets-1           INTEGER ::= 63      -- Maximum number of CSI SSB resource sets per cell minus 1
maxNrofCSI-SSB-ResourceSetsPerConfig    INTEGER ::= 1       -- Maximum number of CSI SSB resource sets per resource configuration

maxNrofFailureDetectionResources        INTEGER ::= 10      -- Maximum number of failure detection resources
maxNrofFailureDetectionResources-1      INTEGER ::= 9       -- Maximum number of failure detection resources minus 1

maxNrofObjectId                         INTEGER ::= 64      -- Maximum number of measurement objects
maxNrofPageRec                          INTEGER ::= 32      -- Maximum number of page records
maxNrofPCI-Ranges                       INTEGER ::= 8       -- Maximum number of PCI ranges
maxPLMN                                 INTEGER ::= 12      -- Maximum number of PLMNs broadcast and reported by UE at establisghment
maxNrofCSI-RS-ResourcesRRM              INTEGER ::= 96      -- Maximum number of CSI-RS resources for an RRM measurement object
maxNrofCSI-RS-ResourcesRRM-1            INTEGER ::= 95      -- Maximum number of CSI-RS resources for an RRM measurement object minus 1
maxNrofMeasId                           INTEGER ::= 64      -- Maximum number of configured measurements
maxNrofQuantityConfig                   INTEGER ::= 2       -- Maximum number of quantity configurations
maxNrofCSI-RS-CellsRRM                  INTEGER ::= 96      -- Maximum number of FFS

maxNrofSRS-ResourceSets                 INTEGER ::= 16      -- Maximum number of SRS resource sets in a BWP.
maxNrofSRS-ResourceSets-1               INTEGER ::= 15      -- Maximum number of SRS resource sets in a BWP minus 1.
maxNrofSRS-Resources                    INTEGER ::= 64      -- Maximum number of SRS resources.
maxNrofSRS-Resources-1                  INTEGER ::= 63      -- Maximum number of SRS resources in an SRS resource set minus 1.
maxNrofSRS-ResourcesPerSet              INTEGER ::= 16      -- Maximum number of SRS resources in an SRS resource set
maxNrofSRS-TriggerStates-1              INTEGER ::= 3       -- Maximum number of SRS trigger states minus 1, i.e., the largest code point.
maxNrofSRS-TriggerStates-2              INTEGER ::= 2       -- Maximum number of SRS trigger states minus 2.
maxRAT-CapabilityContainers             INTEGER ::= 8       -- Maximum number of interworking RAT containers (incl NR and MRDC)
maxSimultaneousBands                    INTEGER ::= 32      -- Maximum number of simultaneously aggregated bands


maxNrofSlotFormatCombinationsPerSet     INTEGER ::= 512     -- Maximum number of Slot Format Combinations in a SF-Set.
```

```
maxNrofSlotFormatCombinationsPerSet-1   INTEGER ::= 511     -- Maximum number of Slot Format Combinations in a SF-Set minus 1.
maxNrofPUCCH-Resources                  INTEGER ::= 128
maxNrofPUCCH-Resources-1                INTEGER ::= 127
maxNrofPUCCH-ResourceSets               INTEGER ::= 4       -- Maximum number of PUCCH Resource Sets
maxNrofPUCCH-ResourceSets-1             INTEGER ::= 3       -- Maximum number of PUCCH Resource Sets minus 1.
maxNrofPUCCH-ResourcesPerSet            INTEGER ::= 32      -- Maximum number of PUCCH Resources per PUCCH-Resour©ceSet
maxNrofPUCCH-P0-PerSet                  INTEGER ::= 8       -- Maximum number of P0-pucch present in a p0-pucch set
maxNrofPUCCH-PathlossReferenceRSs       INTEGER ::= 4       -- Maximum number of RSs used as pathloss reference for PUCCH power control.
maxNrofPUCCH-PathlossReferenceRSs-1     INTEGER ::= 3       -- Maximum number of RSs used as pathloss reference for PUCCH power control minus 1.

maxNrofP0-PUSCH-AlphaSets               INTEGER ::= 30      -- Maximum number of P0-pusch-alpha-sets (see 38,213, clause 7.1)
maxNrofP0-PUSCH-AlphaSets-1             INTEGER ::= 29      -- Maximum number of P0-pusch-alpha-sets minus 1 (see 38,213, clause 7.1)
maxNrofPUSCH-PathlossReferenceRSs       INTEGER ::= 4       -- Maximum number of RSs used as pathloss reference for PUSCH power control.
maxNrofPUSCH-PathlossReferenceRSs-1     INTEGER ::= 3       -- Maximum number of RSs used as pathloss reference for PUSCH power control minus 1.
maxNrofNAICS-Entries                    INTEGER ::= 8       -- Maximum number of supported NAICS capability set
maxBands                                INTEGER ::= 1024    -- Maximum number of supported bands in UE capability.
maxBandsMRDC                            INTEGER ::= 1280
maxBandsEUTRA                           INTEGER ::= 256
maxCellReport                           INTEGER ::= 8
maxDRB                                  INTEGER ::= 29      -- Maximum number of DRBs (that can be added in DRB-ToAddModLIst).
maxFreq                                 INTEGER ::= 8       -- Max number of frequencies.
maxFreqIDC-MRDC                         INTEGER ::= 32      -- Maximum number of candidate NR frequencies for MR-DC IDC indication
maxNrofCSI-RS                           INTEGER ::= 64
maxNrofCandidateBeams                   INTEGER ::= 16      -- Max number of PRACH-ResourceDedicatedBFR that in BFR config.
maxNrofPCIsPerSMTC                      INTEGER ::= 64      -- Maximun number of PCIs per SMTC.
maxNrofQFIs                             INTEGER ::= 64
maxNrOfSemiPersistentPUSCH-Triggers     INTEGER ::= 64      -- Maximum number of triggers for semi persistent reporting on PUSCH
maxNrofSR-Resources                     INTEGER ::= 8       -- Maximum number of SR resources per BWP in a cell.
maxNrofSlotFormatsPerCombination        INTEGER ::= 256
maxNrofSpatialRelationInfos             INTEGER ::= 8
maxNrofIndexesToReport                  INTEGER ::= 32
maxNrofIndexesToReport2                 INTEGER ::= 64
maxNrofSSBs                             INTEGER ::= 64      -- Maximum number of SSB resources in a resource set.
maxNrofSSBs-1                           INTEGER ::= 63      -- Maximum number of SSB resources in a resource set minus 1.
maxNrofS-NSSAI                          INTEGER ::= 8       -- Maximum number of S-NSSAI.
maxNrofTCI-StatesPDCCH                  INTEGER ::= 64
maxNrofTCI-States                       INTEGER ::= 128     -- Maximum number of TCI states.
maxNrofTCI-States-1                     INTEGER ::= 127     -- Maximum number of TCI states minus 1.
maxNrofUL-Allocations                   INTEGER ::= 16      -- Maximum number of PUSCH time domain resource allocations.
maxQFI                                  INTEGER ::= 63
maxRA-CSIRS-Resources                   INTEGER ::= 96
maxRA-OccasionsPerCSIRS                 INTEGER ::= 64      -- Maximum number of RA occasions for one CSI-RS
maxRA-Occasions-1                       INTEGER ::= 511     -- Maximum number of RA occasions in the system
maxRA-SSB-Resources                     INTEGER ::= 64
maxSCSs                                 INTEGER ::= 5
maxSecondaryCellGroups                  INTEGER ::= 3
maxNrofServingCellsEUTRA                INTEGER ::= 32
maxMBSFN-Allocations                    INTEGER ::= 8
maxNrofMultiBands                       INTEGER ::= 8
maxCellSFTD                             INTEGER ::= 3       -- Maximum number of cells for SFTD reporting
maxReportConfigId                       INTEGER ::= 64
maxNrofCodebooks                        INTEGER ::= 16      -- Maximum number of codebooks suppoted by the UE
maxNrofCSI-RS-Resources                 INTEGER ::= 7       -- Maximum number of codebook resources supported by the UE
```

```
maxNrofSRI-PUSCH-Mappings               INTEGER ::= 16
maxNrofSRI-PUSCH-Mappings-1             INTEGER ::= 15
maxSIB                                  INTEGER::= 32       -- Maximum number of SIBs
maxSIB-1                                INTEGER::= 31
maxSI-Message                           INTEGER::= 32       -- Maximum number of SI messages

maxPO-perPF                             INTEGER ::= 4       -- Maximum number of paging occasion per paging frame

maxAccessCat-1                          INTEGER ::= 63      -- Maximum number of Acccess Categories minus 1
maxBarringInfoSet                       INTEGER ::= 8       -- Maximum number of Acccess Categories
maxCellEUTRA                            INTEGER ::= 8       -- Maximum number of E-UTRA cells in SIB list
maxEUTRA-Carrier                        INTEGER ::= 8       -- Maximum number of E-UTRA carriers in SIB list
maxPLMNIdentities                       INTEGER ::= 8       -- Maximum number of PLMN identites in RAN area configurations

maxDownlinkFeatureSets                  INTEGER ::= 1024    -- (for NR DL) Total number of FeatureSets (size of the pool)
maxUplinkFeatureSets                    INTEGER ::= 1024    -- (for NR UL) Total number of FeatureSets (size of the pool)
maxEUTRA-DL-FeatureSets                 INTEGER ::= 256     -- (for E-UTRA) Total number of FeatureSets (size of the pool)
maxEUTRA-UL-FeatureSets                 INTEGER ::= 256     -- (for E-UTRA) Total number of FeatureSets (size of the pool)
maxFeatureSetsPerBand                   INTEGER ::= 128     -- (for NR) The number of feature sets associated with one band.
maxPerCC-FeatureSets                    INTEGER ::= 1024    -- (for NR) Total number of CC-specific FeatureSets (size of the pool)
maxFeatureSetCombinations               INTEGER ::= 1024    -- (for MR-DC/NR)Total number of Feature set combinations (size of the pool)

maxInterRAT-RSTD-Freq                   INTEGER ::= 3


-- TAG-MULTIPLICITY-AND-TYPE-CONSTRAINT-DEFINITIONS-STOP
-- ASN1STOP
```

End of NR-RRC-Definitions

```
-- ASN1START

END

-- ASN1STOP
```

6.5 Short Message

Short Messages can be transmitted on PDCCH using P-RNTI with or without associated *Paging* message using Short Message field in DCI format 1_0 (see TS 38.212 [17], clause 7.3.1.2.1).

Table 6.5-1 defines Short Messages. Bit 1 is the most significant bit.

Table 6.5-1: Short Messages

Bit	Short Message
1	***systemInfoModification*** If set to 1: indication of a BCCH modification other than SIB6, SIB7 and SIB8.
2	***etwsAndCmasIndication*** If set to 1: indication of an ETWS primary notification and/or an ETWS secondary notification and/or a CMAS notification.
3 – 8	Not used in this release of the specification, and shall be ignored by UE if received.

7 Variables and constants

7.1 Timers

7.1.1 Timers (Informative)

Timer	Start	Stop	At expiry
T300	*Upon transmission of RRCSetupRequest.*	Upon reception of *RRCSetup* or *RRCReject* message, cell re-selection and upon abortion of connection establishment by upper layers.	Perform the actions as specified in 5.3.3.7.
T301	Upon transmission of *RRCReestabilshmentRequest*	Upon reception of *RRCReestablishment* or *RRCSetup*message as well as when the selected cell becomes unsuitable	Go to RRC_IDLE
T302	Upon reception of *RRCReject* while performing RRC connection establishment or resume, upon reception of *RRCRelease* with waitTime.	Upon entering RRC_CONNECTED, upon cell re-selection and upon reception of *RRCReject* message.	Inform upper layers about barring alleviation as specified in 5.3.14.4
T304	Upon reception of *RRCReconfiguration* message including *reconfigurationWithSync*	Upon successful completion of random access on the corresponding SpCell For T304 of SCG, upon SCG release	For T304 of MCG, in case of the handover from NR or intra-NR handover, initiate the RRC re-establishment procedure; In case of handover to NR, perform the actions defined in the specifications applicable for the source RAT. For T304 of SCG, inform network about the reconfiguration with sync failure by initiating the SCG failure information procedure as specified in 5.7.3.
T310	Upon detecting physical layer problems for the SpCell i.e. upon receiving N310 consecutive out-of-sync indications from lower layers.	Upon receiving N311 consecutive in-sync indications from lower layers for the SpCell, upon receiving RRCReconfiguration with *reconfigurationWithSync* for that cell group, and upon initiating the connection re-establishment procedure. Upon SCG release, if the T310 is kept in SCG.	If the T310 is kept in MCG: If security is not activated: go to RRC_IDLE else: initiate the connection re-establishment procedure. If the T310 is kept in SCG, Inform E-UTRAN/NR about the SCG radio link failure by initiating the SCG failure information procedure as specified in 5.7.3.

Timer	Start	Stop	At expiry
T311	Upon initiating the RRC connection re-establishment procedure	Upon selection of a suitable NR cell or a cell using another RAT.	Enter RRC_IDLE
T319	*Upon transmission of RRCResumeRequest* or *RRCResumeRequest1.*	Upon reception of *RRCResume, RRCSetup, RRCRelease, RRCRelease with suspendConfig* or *RRCReject* message, cell re-selection and upon abortion of connection establishment by upper layers.	Perform the actions as specified in 5.3.13.5.
T320	*Upon reception of t320 or upon cell (re)selection to NR from another RAT with validity time configured for dedicated priorities (in which case the remaining validity time is applied).*	Upon entering RRC_CONNECTED, upon reception of *RRCRelease*, when PLMN selection is performed on request by NAS, or upon cell (re)selection to another RAT (in which case the timer is carried on to the other RAT).	Discard the cell reselection priority information provided by dedicated signalling.
T321	Upon receiving *measConfig* including a *reportConfig* with the purpose set to *reportCGI*	Upon acquiring the information needed to set all fields of *cgi-info*, upon receiving *measConfig* that includes removal of the *reportConfig* with the *purpose* set to *reportCGI* and upon detecting that a cell is not broadcasting SIB1.	Initiate the measurement reporting procedure, stop performing the related measurements and remove the corresponding *measId.*
T325	Upon reception of *RRCRelease* message with *deprioritisationTimer*.		Stop deprioritisation of all frequencies or NR signalled by *RRCRelease.*
T342	Upon transmitting UEAssistanceInformation message with DelayBudgetReport.	Upon initiating the connection re-establishment/resume procedures, and upon receiving *delayBudgetReportingConfig* set to *release.*	No action.
T345	Upon transmitting *UEAssistanceInformation* message with *overheatingAssistance*	Upon initiating the connection re-establishment procedure and upon initiating the connection resumption procedure	No action.
T380	Upon reception of t380 in *RRCRelease.*	Upon reception of *RRCResume*, *RRCSetup* or *RRCRelease*.	Perform the actions as specified in 5.3.13.

Timer	Start	Stop	At expiry
T390	When access attempt is barred at access barring check for an Access Category. The UE shall maintain one instance of this timer per Access Category.	Upon cell (re)selection, upon entering RRC_CONNECTED, upon reception of *RRCReconfiguration* including *reconfigurationWithSync*, upon change of PCell while in RRC_CONNECTED, upon reception of *MobilityFromNRCommand*, or upon reception of *RRCRelease*.	Perform the actions as specified in 5.3.14.4.

7.1.2 Timer handling

When the UE applies zero value for a timer, the timer shall be started and immediately expire unless explicitly stated otherwise.

7.2 Counters

Counter	Reset	Incremented	When reaching max value
N310	Upon reception of "in-sync" indication from lower layers; upon receiving RRCReconfiguration with reconfigurationWithSync for that cell group; upon initiating the connection re-establishment procedure.	Upon reception of "out-of-sync" from lower layer while the timer T310 is stopped.	Start timer T310
N311	Upon reception of "out-of-sync" indication from lower layers; upon receiving RRCReconfiguration with reconfigurationWithSync for that cell group; upon initiating the connection re-establishment procedure.	Upon reception of the "in-sync" from lower layer while the timer T310 is running.	Stop the timer T310.

7.3 Constants

Constant	Usage
N310	Maximum number of consecutive "out-of-sync" indications for the SpCell received from lower layers
N311	Maximum number of consecutive "in-sync" indications for the SpCell received from lower layers

7.4 UE variables

NOTE: To facilitate the specification of the UE behavioural requirements, UE variables are represented using ASN.1. Unless explicitly specified otherwise, it is however up to UE implementation how to store the variables. The optionality of the IEs in ASN.1 is used only to indicate that the values may not always be available.

– *NR-UE-Variables*

This ASN.1 segment is the start of the NR UE variable definitions.

```
-- ASN1START
-- NR-UE-VARIABLES-START

NR-UE-Variables DEFINITIONS AUTOMATIC TAGS ::=

BEGIN

IMPORTS
    CellIdentity,
    EUTRA-PhysCellId,
    MeasId,
    MeasIdToAddModList,
    MeasObjectToAddModList,
    PhysCellId,
    RNTI-Value,
    ReportConfigToAddModList,
    RSRP-Range,
    QuantityConfig,
    maxNrofCellMeas,
    maxNrofMeasId
FROM NR-RRC-Definitions;

-- NR-UE-VARIABLES-STOP
-- ASN1STOP
```

– *VarPendingRNA-Update*

The UE variable *VarPendingRNA-Update* indicates whether there is a pending RNA update procedure or not. The setting of this BOOLEAN variable to TRUE means that there is a pending RNA Update procedure.

VarPendingRNA-Update UE variable

```
-- ASN1START
-- TAG-VAR-PENDING-RNA-UPDATE-START

VarPendingRNA-Update ::=                    SEQUENCE {
    pendingRNA-Update                   BOOLEAN                             OPTIONAL
}

-- TAG-VAR-PENDING-RNA-UPDATE-STOP
-- ASN1STOP
```

– *VarMeasConfig*

The UE variable *VarMeasConfig* includes the accumulated configuration of the measurements to be performed by the UE, covering intra-frequency, inter-frequency and inter-RAT mobility related measurements.

VarMeasConfig UE variable

```
-- ASN1START
-- TAG-VAR-MEAS-CONFIG-START

VarMeasConfig ::=                   SEQUENCE {
    -- Measurement identities
    measIdList                          MeasIdToAddModList                  OPTIONAL,
    -- Measurement objects
    measObjectList                      MeasObjectToAddModList              OPTIONAL,
    -- Reporting configurations
    reportConfigList                    ReportConfigToAddModList            OPTIONAL,
    -- Other parameters
    quantityConfig                      QuantityConfig                      OPTIONAL,

    s-MeasureConfig                         CHOICE {
        ssb-RSRP                                RSRP-Range,
        csi-RSRP                                RSRP-Range
    }                                                                       OPTIONAL

}

-- TAG-VAR-MEAS-CONFIG-STOP
-- ASN1STOP
```

– *VarMeasReportList*

The UE variable *VarMeasReportList* includes information about the measurements for which the triggering conditions have been met.

VarMeasReportList UE variable

```
-- ASN1START
```

```
-- TAG-VAR-MEAS-REPORT-START

VarMeasReportList ::=              SEQUENCE (SIZE (1..maxNrofMeasId)) OF VarMeasReport

VarMeasReport ::=                  SEQUENCE {
    -- List of measurement that have been triggered
    measId                             MeasId,
    cellsTriggeredList                 CellsTriggeredList              OPTIONAL,
    numberOfReportsSent                INTEGER
}

CellsTriggeredList ::=             SEQUENCE (SIZE (1..maxNrofCellMeas)) OF CHOICE {
    physCellId                         PhysCellId,
    physCellIdEUTRA                    EUTRA-PhysCellId
    }


-- TAG-VAR-MEAS-REPORT-STOP
-- ASN1STOP
```

– *VarResumeMAC-Input*

The UE variable *VarResumeMAC-Input* specifies the input used to generate the *resumeMAC-I* during RRC Connection Resume procedure.

***VarResumeMAC-Input* variable**

```
-- ASN1START
-- TAG-VAR-RESUMEMACINPUT-START

VarResumeMAC-Input  ::=     SEQUENCE {
    sourcePhysCellId                        PhysCellId,
    targetCellIdentity                      CellIdentity,
    source-c-RNTI                           RNTI-Value

}

-- TAG-VAR-RESUMEMACINPUT-STOP
-- ASN1STOP
```

VarResumeMAC-Input field descriptions
targetCellIdentity An input variable used to calculate the *resumeMAC-I*. Set to the *cellIdentity* of the first *PLMN-Identity* included in the *PLMN-IdentityInfoList* broadcasted in *SIB1* of the target cell i.e. the cell the UE is trying to resume.
source-c-RNTI Set to C-RNTI that the UE had in the PCell it was connected to prior to suspension of the RRC connection.
sourcePhysCellId Set to the physical cell identity of the PCell the UE was connected to prior to suspension of the RRC connection.

– *VarShortMAC-Input*

The UE variable *VarShortMAC-Input* specifies the input used to generate the *shortMAC-I* during RRC Connection Reestablishment procedure.

VarShortMAC-Input variable

```
-- ASN1START
-- TAG-VAR-SHORTMACINPUT-START

VarShortMAC-Input   ::=                 SEQUENCE {
    sourcePhysCellId                        PhysCellId,
    targetCellIdentity                      CellIdentity,
    source-c-RNTI                           RNTI-Value
}

-- TAG-VAR- SHORTMACINPUT-STOP
-- ASN1STOP
```

VarShortMAC-Input field descriptions
targetCellIdentity An input variable used to calculate the *shortMAC-I*. Set to the *cellIdentity* of the first *PLMN-Identity* in the *PLMN-IdentityInfoList* broadcasted in *SIB1* of the target cell i.e. the cell the UE is trying to reestablish the connection.
source-c-RNTI Set to C-RNTI that the UE had in the PCell it was connected to prior to the reestablishment.
sourcePhysCellId Set to the physical cell identity of the PCell the UE was connected to prior to the RRC connection.

– End of *NR-UE-Variables*

```
-- ASN1START

END

-- ASN1STOP
```

8 Protocol data unit abstract syntax

8.1 General

The RRC PDU contents in clause 6 and clause 10 are described using abstract syntax notation one (ASN.1) as specified in ITU-T Rec. X.680 [6] and X.681 [7]. Transfer syntax for RRC PDUs is derived from their ASN.1 definitions by use of Packed Encoding Rules, unaligned as specified in ITU-T Rec. X.691 [8].

The following encoding rules apply in addition to what has been specified in X.691:

- When a bit string value is placed in a bit-field as specified in 15.6 to 15.11 in X.691, the leading bit of the bit string value shall be placed in the leading bit of the bit-field, and the trailing bit of the bit string value shall be placed in the trailing bit of the bit-field;

NOTE: The terms 'leading bit' and 'trailing bit' are defined in ITU-T Rec. X.680. When using the 'bstring' notation, the leading bit of the bit string value is on the left, and the trailing bit of the bit string value is on the right.

- When decoding types constrained with the ASN.1 Contents Constraint ("CONTAINING"), automatic decoding of the contained type should not be performed because errors in the decoding of the contained type should not cause the decoding of the entire RRC message PDU to fail. It is recommended that the decoder first decodes the outer PDU type that contains the OCTET STRING or BIT STRING with the Contents Constraint, and then decodes the contained type that is nested within the OCTET STRING or BIT STRING as a separate step;

- When decoding a) RRC message PDUs, b) BIT STRING constrained with a Contents Constraint, or c) OCTET STRING constrained with a Contents Constraint, PER decoders are required to never report an error if there are extraneous zero or non-zero bits at the end of the encoded RRC message PDU, BIT STRING or OCTET STRING.

8.2 Structure of encoded RRC messages

An RRC PDU, which is the bit string that is exchanged between peer entities/across the radio interface contains the basic production as defined in X.691.

RRC PDUs shall be mapped to and from PDCP SDUs (in case of DCCH) or RLC SDUs (in case of PCCH, BCCH or CCCH) upon transmission and reception as follows:

- when delivering an RRC PDU as an PDCP SDU to the PDCP layer for transmission, the first bit of the RRC PDU shall be represented as the first bit in the PDCP SDU and onwards; and

- when delivering an RRC PDU as an RLC SDU to the RLC layer for transmission, the first bit of the RRC PDU shall be represented as the first bit in the RLC SDU and onwards; and

- upon reception of an PDCP SDU from the PDCP layer, the first bit of the PDCP SDU shall represent the first bit of the RRC PDU and onwards; and

- upon reception of an RLC SDU from the RLC layer, the first bit of the RLC SDU shall represent the first bit of the RRC PDU and onwards.

8.3 Basic production

The 'basic production' is obtained by applying UNALIGNED PER to the abstract syntax value (the ASN.1 description) as specified in X.691. It always contains a multiple of 8 bits.

8.4 Extension

The following rules apply with respect to the use of protocol extensions:

- A transmitter compliant with this version of the specification shall, unless explicitly indicated otherwise on a PDU type basis, set the extension part empty. Transmitters compliant with a later version may send non-empty extensions;

- A transmitter compliant with this version of the specification shall set spare bits to zero.

8.5 Padding

If the encoded RRC message does not fill a transport block, the RRC layer shall add padding bits. This applies to PCCH and BCCH.

Padding bits shall be set to 0 and the number of padding bits is a multiple of 8.

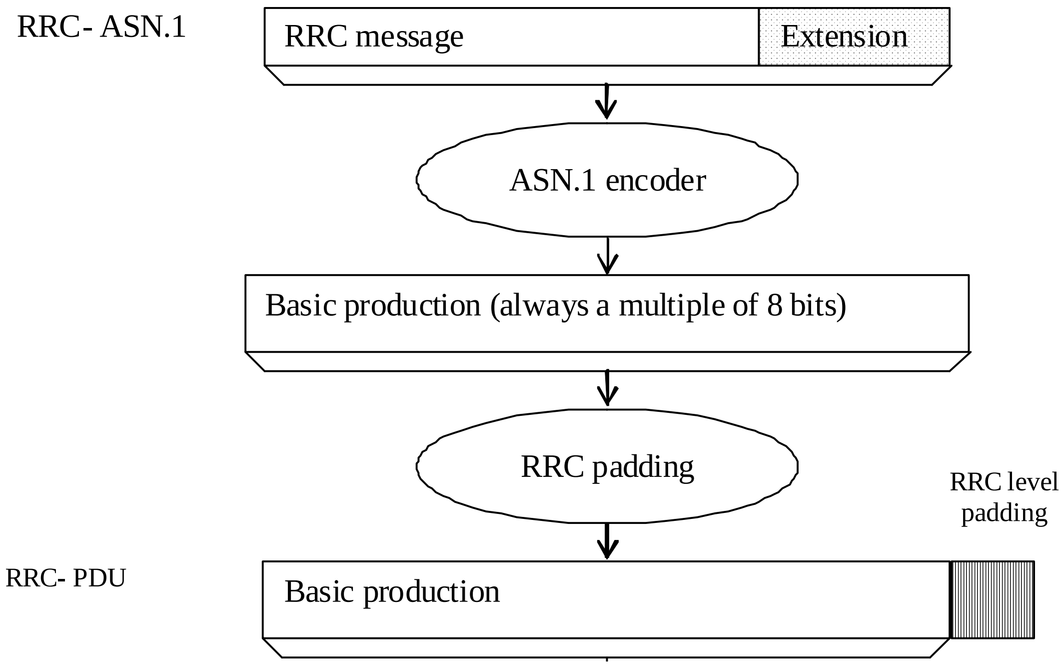

Figure 8.5-1: RRC level padding

9 Specified and default radio configurations

Specified and default configurations are configurations of which the details are specified in the standard. Specified configurations are fixed while default configurations can be modified using dedicated signalling. The default value for the parameters not listed in following subclauses shall be set such as the corresponding features are not configured, i.e. *release* or *false* unless explicitly stated otherwise.

NOTE: The UE applies the default values specified in the field description of ASN.1 parameters only when the parent IE is present. Hence, the UE does not apply all default values in field descriptions when it applies the "default radio configuration" in accordance with this clause.

9.1 Specified configurations

9.1.1 Logical channel configurations

9.1.1.1 BCCH configuration

Parameters

Name	Value	Semantics description	Ver
SDAP configuration	Not used		
PDCP configuration	Not used		
RLC configuration	TM		
Logical channel configuration	Not used		

NOTE: RRC will perform padding, if required due to the granularity of the TF signalling, as defined in 8.5.

9.1.1.2 CCCH configuration

Parameters

Name	Value	Semantics description	Ver
SDAP configuration	Not used		
PDCP configuration	Not used		
RLC configuration	TM		
Logical channel configuration			
>priority	1	Highest priority	
>prioritisedBitRate	infinity		
>bucketSizeDuration	ms1000		
>logicalChannelGroup	0		

9.1.1.3 PCCH configuration

Parameters

Name	Value	Semantics description	Ver
SDAP configuration	Not used		
PDCP configuration	Not used		
RLC configuration	TM		
Logical channel configuration	Not used		

NOTE: RRC will perform padding, if required due to the granularity of the TF signalling, as defined in 8.5.

9.1.2 Void

9.2 Default radio configurations

The following clauses only list default values for REL-15 parameters included in protocol version v15.3.0. For all fields introduced in a later protocol version, the default value is "released" or "false" unless explicitly specified otherwise. If UE is to apply default configuration while it is configured with some critically extended fields, the UE shall apply the original version of those fields with only default values.

NOTE 1: In general, the signalling should preferably support a "release" option for fields introduced after v15.3.0. The "value not applicable" should be used restrictively, mainly limited to for fields which value is relevant only if another field is set to a value other than its default.

NOTE 2: For parameters in *ServingCellConfig*, the default values are specified in the corresponding specification.

9.2.1 Default SRB configurations

Parameters

Name	Value			Semantics description	Ver
	SRB1	SRB2	SRB3		
PDCP-Config *>t-Reordering*	 infinity				
RLC-Config CHOICE	Am				
ul-RLC-Config *>sn-FieldLength* *>t-PollRetransmit* *>pollPDU* *>pollByte* *>maxRetxThreshold*	 size12 ms45 infinity infinity t8				
dl-RLC-Config *>sn-FieldLength* *>t-Reassembly* *>t-StatusProhibit*	 size12 ms35 ms0				
logicalChannelIdentity	1	2	3		
LogicalChannelConfig					
>priority	1	3	1		
>prioritisedBitRate	infinity				
>logicalChannelGroup	0				

9.2.2 Default MAC Cell Group configuration

Parameters

Name	Value	Semantics description	Ver
MAC Cell Group configuration			
bsr-Config			
>periodicBSR-Timer	sf10		
>retxBSR-Timer	sf80		
phr-Config			
>phr-PeriodicTimer	sf10		
>phr-ProhibitTimer	sf10		
>phr-Tx-PowerFactorChange	dB1		

9.2.3 Default values timers and constants

Parameters

Name	Value	Semantics description	Ver
t310	ms1000		
n310	n1		
t311	ms30000		
n311	n1		

10 Generic error handling

10.1 General

The generic error handling defined in the subsequent sub-clauses applies unless explicitly specified otherwise e.g. within the procedure specific error handling.

The UE shall consider a value as not comprehended when it is set:

- to an extended value that is not defined in the version of the transfer syntax supported by the UE;
- to a spare or reserved value unless the specification defines specific behaviour that the UE shall apply upon receiving the concerned spare/reserved value.

The UE shall consider a field as not comprehended when it is defined:

- as spare or reserved unless the specification defines specific behaviour that the UE shall apply upon receiving the concerned spare/reserved field.

10.2 ASN.1 violation or encoding error

The UE shall:

1> when receiving an RRC message on the [BCCH] for which the abstract syntax is invalid [6]:

2> ignore the message.

NOTE: This clause applies in case one or more fields is set to a value, other than a spare, reserved or extended value, not defined in this version of the transfer syntax. E.g. in the case the UE receives value 12 for a field defined as INTEGER (1..11). In cases like this, it may not be possible to reliably detect which field is in the error hence the error handling is at the message level.

10.3 Field set to a not comprehended value

The UE shall, when receiving an RRC message on any logical channel:

1> if the message includes a field that has a value that the UE does not comprehend:

2> if a default value is defined for this field:

3> treat the message while using the default value defined for this field;

2> else if the concerned field is optional:

3> treat the message as if the field were absent and in accordance with the need code for absence of the concerned field;

2> else:

3> treat the message as if the field were absent and in accordance with sub-clause 10.4.

10.4 Mandatory field missing

The UE shall:

1> if the message includes a field that is mandatory to include in the message (e.g. because conditions for mandatory presence are fulfilled) and that field is absent or treated as absent:

2> if the RRC message was received on DCCH or CCCH:

3> ignore the message;

2> else:

3> if the field concerns a (sub-field of) an entry of a list (i.e. a SEQUENCE OF):

4> treat the list as if the entry including the missing or not comprehended field was not present;

3> else if the field concerns a sub-field of another field, referred to as the 'parent' field i.e. the field that is one nesting level up compared to the erroneous field:

4> consider the 'parent' field to be set to a not comprehended value;

4> apply the generic error handling to the subsequent 'parent' field(s), until reaching the top nesting level i.e. the message level;

3> else (field at message level):

4> ignore the message.

NOTE 1: The error handling defined in these sub-clauses implies that the UE ignores a message with the message type or version set to a not comprehended value.

NOTE 2: The nested error handling for messages received on logical channels other than DCCH and CCCH applies for errors in extensions also, even for errors that can be regarded as invalid network operation e.g. the network not observing conditional presence.

The following ASN.1 further clarifies the levels applicable in case of nested error handling for errors in extension fields.

```
-- /example/ ASN1START

-- Example with extension addition group

ItemInfoList ::=                    SEQUENCE (SIZE (1..max)) OFItemInfo

ItemInfo ::=                        SEQUENCE {
    itemIdentity                        INTEGER (1..max),
    field1                              Field1,
    field2                              Field2                  OPTIONAL,           -- Need N
    ...
    [[
    field3-r9                       Field3-r9               OPTIONAL,           -- Cond Cond1
    field4-r9                       Field4-r9               OPTIONAL            -- Need N
    ]]
}

-- Example with traditional non-critical extension (empty sequence)

BroadcastInfoBlock1 ::=             SEQUENCE {
    itemIdentity                        INTEGER (1..max),
    field1                              Field1,
    field2                              Field2                  OPTIONAL,           -- Need N
    nonCriticalExtension                BroadcastInfoBlock1-v940-IEs    OPTIONAL
}

BroadcastInfoBlock1-v940-IEs::= SEQUENCE {
    field3-r9                           Field3-r9               OPTIONAL,           -- Cond Cond1
    field4-r9                           Field4-r9               OPTIONAL,           -- Need N
    nonCriticalExtension                SEQUENCE {}             OPTIONAL            -- Need S
}

-- ASN1STOP
```

The UE shall, apply the following principles regarding the levels applicable in case of nested error handling:

- an extension additon group is not regarded as a level on its own. E.g. in the ASN.1 extract in the previous, a error regarding the conditionality of *field3* would result in the entire itemInfo entry to be ignored (rather than just the extension addition group containing *field3* and *field4*);
- a traditional *nonCriticalExtension* is not regarded as a level on its own. E.g. in the ASN.1 extract in the previous, an error regarding the conditionality of *field3* would result in the entire *BroadcastInfoBlock1* to be ignored (rather than just the non-critical extension containing *field3* and *field4*).

10.5 Not comprehended field

The UE shall, when receiving an RRC message on any logical channel:

1> if the message includes a field that the UE does not comprehend:

2> treat the rest of the message as if the field was absent.

NOTE: This clause does not apply to the case of an extension to the value range of a field. Such cases are addressed instead by the requirements in clause 10.3.

11 Radio information related interactions between network nodes

11.1 General

This clause specifies RRC messages that are transferred between network nodes. These RRC messages may be transferred to or from the UE via another Radio Access Technology. Consequently, these messages have similar characteristics as the RRC messages that are transferred across the NR radio interface, i.e. the same transfer syntax and protocol extension mechanisms apply.

11.2 Inter-node RRC messages

11.2.1 General

This clause specifies RRC messages that are sent either across the X2-, Xn- or the NG-interface, either to or from the gNB, i.e. a single 'logical channel' is used for all RRC messages transferred across network nodes. The information could originate from or be destined for another RAT.

```
-- ASN1START
-- TAG-NR-INTER-NODE-DEFINITIONS-START

NR-InterNodeDefinitions DEFINITIONS AUTOMATIC TAGS ::=

BEGIN

IMPORTS
    ARFCN-ValueNR,
    ARFCN-ValueEUTRA,
    CellIdentity,
    CGI-Info,
    CSI-RS-Index,
    FreqBandIndicatorNR,
    GapConfig,
    maxBandComb,
    maxBands,
    maxFeatureSetsPerBand,
    maxFreqIDC-MRDC,
    maxNrofCombIDC,
    maxNrofSCells,
    maxNrofServingCells,
    maxNrofServingCells-1,
    maxNrofServingCellsEUTRA,
    maxNrofIndexesToReport,
    MeasQuantityResults,
    MeasResultSCG-Failure,
    MeasResultCellListSFTD,
    MeasResultList2NR,
    P-Max,
    PhysCellId,
    RadioBearerConfig,
    RAN-NotificationAreaInfo,
```

```
    RRCReconfiguration,
    ServCellIndex,
    SetupRelease,
    SSB-Index,
    SSB-MTC,
    SSB-ToMeasure,
    SS-RSSI-Measurement,
    ShortMAC-I,
    SubcarrierSpacing,
    UE-CapabilityRAT-ContainerList
FROM NR-RRC-Definitions;

-- TAG-NR-INTER-NODE-DEFINITIONS-STOP
-- ASN1STOP
```

11.2.2 Message definitions

– *HandoverCommand*

This message is used to transfer the handover command as generated by the target gNB.

Direction: target gNB to source gNB/source RAN.

***HandoverCommand* message**

```
-- ASN1START
-- TAG-HANDOVER-COMMAND-START

HandoverCommand ::=                 SEQUENCE {
    criticalExtensions                  CHOICE {
        c1                                  CHOICE{
            handoverCommand                 HandoverCommand-IEs,
            spare3 NULL, spare2 NULL, spare1 NULL
        },
        criticalExtensionsFuture            SEQUENCE {}
    }
}

HandoverCommand-IEs ::=             SEQUENCE {
    handoverCommandMessage              OCTET STRING (CONTAINING RRCReconfiguration),
    nonCriticalExtension                SEQUENCE {}                                         OPTIONAL
}

-- TAG-HANDOVER-COMMAND-STOP
-- ASN1STOP
```

***HandoverCommand* field descriptions**
handoverCommandMessage Contains the *RRCReconfiguration* message used to perform handover within NR or handover to NR, as generated (entirely) by the target gNB.

– *HandoverPreparationInformation*

This message is used to transfer the NR RRC information used by the target gNB during handover preparation, including UE capability information.

Direction: source gNB/source RAN to target gNB.

***HandoverPreparationInformation* message**

```
-- ASN1START
-- TAG-HANDOVER-PREPARATION-INFORMATION-START

HandoverPreparationInformation ::=  SEQUENCE {
    criticalExtensions                  CHOICE {
        c1                                  CHOICE{
            handoverPreparationInformation      HandoverPreparationInformation-IEs,
            spare3 NULL, spare2 NULL, spare1 NULL
        },
        criticalExtensionsFuture            SEQUENCE {}
    }
}

HandoverPreparationInformation-IEs ::= SEQUENCE {
    ue-CapabilityRAT-List               UE-CapabilityRAT-ContainerList,
    sourceConfig                        AS-Config                         OPTIONAL, -- Cond HO
    rrm-Config                          RRM-Config                        OPTIONAL,
    as-Context                          AS-Context                        OPTIONAL,
    nonCriticalExtension                SEQUENCE {}                       OPTIONAL
}

AS-Config ::=               SEQUENCE {
    rrcReconfiguration                  OCTET STRING (CONTAINING RRCReconfiguration),
    ...
}

AS-Context ::=                      SEQUENCE {
    reestablishmentInfo                     ReestablishmentInfo                     OPTIONAL,
    configRestrictInfo                      ConfigRestrictInfoSCG                   OPTIONAL,
    ...,
    [[  ran-NotificationAreaInfo            RAN-NotificationAreaInfo                OPTIONAL
    ]]
}

ReestablishmentInfo ::=             SEQUENCE {
    sourcePhysCellId                        PhysCellId,
    targetCellShortMAC-I                    ShortMAC-I,
    additionalReestabInfoList               ReestabNCellInfoList                    OPTIONAL
}
```

```
ReestabNCellInfoList ::=        SEQUENCE ( SIZE (1..maxCellPrep) ) OF ReestabNCellInfo

ReestabNCellInfo::= SEQUENCE{
    cellIdentity                        CellIdentity,
    key-gNodeB-Star                     BIT STRING (SIZE (256)),
    shortMAC-I                          ShortMAC-I
}

RRM-Config ::=              SEQUENCE {
    ue-InactiveTime             ENUMERATED {
                                    s1, s2, s3, s5, s7, s10, s15, s20,
                                    s25, s30, s40, s50, min1, min1s20, min1s40,
                                    min2, min2s30, min3, min3s30, min4, min5, min6,
                                    min7, min8, min9, min10, min12, min14, min17, min20,
                                    min24, min28, min33, min38, min44, min50, hr1,
                                    hr1min30, hr2, hr2min30, hr3, hr3min30, hr4, hr5, hr6,
                                    hr8, hr10, hr13, hr16, hr20, day1, day1hr12, day2,
                                    day2hr12, day3, day4, day5, day7, day10, day14, day19,
                                    day24, day30, dayMoreThan30}                    OPTIONAL,
    candidateCellInfoList       MeasResultList2NR                                   OPTIONAL,
    ...
}

-- TAG-HANDOVER-PREPARATION-INFORMATION-STOP
-- ASN1STOP
```

***HandoverPreparationInformation* field descriptions**
as-Context Local RAN context required by the target gNB.
sourceConfig The radio resource configuration as used in the source cell.
rrm-Config Local RAN context used mainly for RRM purposes.
ue-CapabilityRAT-List The UE radio access related capabilities concerning RATs supported by the UE. FFS whether certain capabilities are mandatory to provide by source e.g. of target and/or source RAT.

Conditional Presence	**Explanation**
HO	The field is mandatory present in case of handover within NR; The field is optionally present in case of handover from E-UTRA connected to 5GC; otherwise the field is not present.

NOTE 2: The following table indicates per source RAT whether RAT capabilities are included or not.

Source RAT	NR capabilites	E-UTRA capabilities	MR-DC capabilities
NR	Included	May be included	May be included
E-UTRAN	Included	May be included	May be included

NOTE 3: The following table indicates, in case of inter-RAT handover from E-UTRA, which additional IEs are included or not:

Source system	sourceConfig	rrm-Config	as-Context
E-UTRA/EPC	Not included	May be included	Not included
E-UTRA/5GC	May be included, but only *radioBearerConfig* is included in the *RRCReconfiguration*.	May be included	Not included

RRM-Config field descriptions
candidateCellInfoList A list of the best cells on each frequency for which measurement information was available

– *CG-Config*

This message is used to transfer the SCG radio configuration as generated by the SgNB.

Direction: Secondary gNB to master gNB or eNB.

CG-Config **message**

```
-- ASN1START
-- TAG-CG-CONFIG-START

CG-Config ::=                   SEQUENCE {
    criticalExtensions                  CHOICE {
        c1                                  CHOICE{
            cg-Config                   CG-Config-IEs,
            spare3 NULL, spare2 NULL, spare1 NULL
        },
        criticalExtensionsFuture            SEQUENCE {}
    }
}

CG-Config-IEs ::=           SEQUENCE {
    scg-CellGroupConfig                 OCTET STRING (CONTAINING RRCReconfiguration)    OPTIONAL,
    scg-RB-Config                       OCTET STRING (CONTAINING RadioBearerConfig)     OPTIONAL,
    configRestrictModReq                ConfigRestrictModReqSCG                         OPTIONAL,
    drx-InfoSCG                         DRX-Info                                        OPTIONAL,
    candidateCellInfoListSN             OCTET STRING (CONTAINING MeasResultList2NR)     OPTIONAL,
    measConfigSN                        MeasConfigSN                                    OPTIONAL,
    selectedBandCombinationNR           BandCombinationInfoSN                           OPTIONAL,
    fr-InfoListSCG                      FR-InfoList                                     OPTIONAL,
    candidateServingFreqListNR          CandidateServingFreqListNR                      OPTIONAL,
```

```
    nonCriticalExtension                CG-Config-v1540-IEs                             OPTIONAL
}

CG-Config-v1540-IEs ::= SEQUENCE {
    pSCellFrequency                     ARFCN-ValueNR                                   OPTIONAL,
    reportCGI-Request                   SEQUENCE {
        requestedCellInfo                   SEQUENCE {
            ssbFrequency                        ARFCN-ValueNR,
            cellForWhichToReportCGI             PhysCellId
        }                                                                               OPTIONAL
    }                                                                                   OPTIONAL,
    ph-InfoSCG                          PH-TypeListSCG                                  OPTIONAL,
    nonCriticalExtension                SEQUENCE {}                                     OPTIONAL
}

PH-TypeListSCG ::=                      SEQUENCE (SIZE (1..maxNrofServingCells)) OF PH-InfoSCG

PH-InfoSCG ::=                          SEQUENCE {
    servCellIndex                       ServCellIndex,
    ph-Uplink                           PH-UplinkCarrierSCG,
    ph-SupplementaryUplink              PH-UplinkCarrierSCG                             OPTIONAL,
    ...
}

PH-UplinkCarrierSCG ::=                 SEQUENCE{
    ph-Type1or3                             ENUMERATED {type1, type3},
    ...
}

MeasConfigSN ::= SEQUENCE {
    measuredFrequenciesSN               SEQUENCE (SIZE (1..maxMeasFreqsSN)) OF NR-FreqInfo  OPTIONAL,
    ...
}

NR-FreqInfo ::= SEQUENCE {
    measuredFrequency                   ARFCN-ValueNR                                       OPTIONAL,
    ...
}

ConfigRestrictModReqSCG ::=         SEQUENCE {
    requestedBC-MRDC                    BandCombinationInfoSN                               OPTIONAL,
    requestedP-MaxFR1               P-Max                                                   OPTIONAL,
    ...
}

BandCombinationIndex ::= INTEGER (1..maxBandComb)

BandCombinationInfoSN ::=   SEQUENCE {
    bandCombinationIndex                BandCombinationIndex,
    requestedFeatureSets                FeatureSetEntryIndex
}

FR-InfoList ::= SEQUENCE (SIZE (1..maxNrofServingCells-1)) OF FR-Info
```

```
FR-Info ::= SEQUENCE {
    servCellIndex       ServCellIndex,
    fr-Type             ENUMERATED {fr1, fr2}
}

CandidateServingFreqListNR ::= SEQUENCE (SIZE (1.. maxFreqIDC-MRDC)) OF ARFCN-ValueNR


-- TAG-CG-CONFIG-STOP
-- ASN1STOP
```

***CG-Config* field descriptions**
candidateCellInfoListSN Contains information regarding cells that the source secondary node suggests the target secondary gNB to consider configuring.
candidateServingFreqListNR Indicates frequencies of candidate serving cells for In-Device Co-existence Indication (see TS 36.331 [10]).
fr-InfoListSCG Contains information of FR information of serving cells that include PScell and Scells configured in SCG.
measuredFrequenciesSN Used by SN to indicate a list of frequencies measured by the UE.
ph-InfoSCG Power headroom information in SCG that is needed in the reception of PHR MAC CE of MCG
ph-SupplimentaryUplink Power headroom information for supplementary uplink. In the case of EN-DC, this field is only present when two UL carriers are configued for a serving cell and one UL carrier reports type1 PH while the other reports type 3 PH.
ph-Type1or3 Type of power headroom for a certain serving cell in SCG (PSCell and activated SCells). Value *type1* refers to type 1 power headroom, value *type3* refers to type 3 power headroom. (See TS 38.321 [3]).
ph-Uplink Power headroom information for uplink.
pSCellFrequency Indicates the frequency of PSCell.
reportCGI-Request Used by SN to indicate to MN about configuring reportCGI procedure. The request may optionally contain information about the cell for which SN intends to configure reportCGI procedure.
requestedP-MaxFR1 Requested value for the maximum power for the serving cells on frequency range 1 (FR1) in this secondary cell group (see TS 38.104 [12]) the UE can use in NR SCG.
requestedBC-MRDC Used to request configuring an NR band combination and corresponding feature sets which are forbidden to use by MN.
scg-CellGroupConfig Contains the RRCReconfiguration message, used to (re-)configure the SCG configuration upon SCG establishment or modification, as generated (entirely) by the (target) SgNB
scg-RB-Config Contains the IE RadioBearerConfig, used to establish or reconfigure the SCG configuration, used to (re-)configure the SCG RB configuration upon SCG establishment or modification, as generated (entirely) by the (target) SgNB
selectedBandCombinationNR Indicates the band combination selected by SN for the EN-DC.
configRestrictModReq Used by SN to request changes to SCG configuration restrictions previously set by MN to ensure UE capabilities are respected. E.g. can used to request configuring an NR band combination whose use MN has previously forbidden.

BandCombinationInfoSN field descriptions
bandCombinationIndex The position of a band combination in the supportedBandCombinationList
requestedFeatureSets The position in the FeatureSetCombination which identifies one FeatureSetUplink/Downlink for each band entry in the associated band combination

– *CG-ConfigInfo*

This message is used by master eNB or gNB to request the SgNB to perform certain actions e.g. to establish, modify or release an SCG. The message may include additional information e.g. to assist the SgNB to set the SCG configuration. It can also be used by a CU to request a DU to perform certain actions, e.g. to establish, modify or release an MCG or SCG.

Direction: Master eNB or gNB to secondary gNB, alternatively CU to DU.

CG-ConfigInfo message

```
-- ASN1START
-- TAG-CG-CONFIG-INFO-START

CG-ConfigInfo ::=                SEQUENCE {
    criticalExtensions               CHOICE {
        c1                               CHOICE{
            cg-ConfigInfo                CG-ConfigInfo-IEs,
            spare3 NULL, spare2 NULL, spare1 NULL
        },
        criticalExtensionsFuture         SEQUENCE {}
    }
}

CG-ConfigInfo-IEs ::=        SEQUENCE {
    ue-CapabilityInfo            OCTET STRING (CONTAINING UE-CapabilityRAT-ContainerList)          OPTIONAL,-- Cond SN-Addition
    candidateCellInfoListMN          MeasResultList2NR                                             OPTIONAL,
    candidateCellInfoListSN          OCTET STRING (CONTAINING MeasResultList2NR)                   OPTIONAL,
    measResultCellListSFTD           MeasResultCellListSFTD                                        OPTIONAL,
    scgFailureInfo                   SEQUENCE {
        failureType                      ENUMERATED { t310-Expiry, randomAccessProblem,
                                                 rlc-MaxNumRetx, synchReconfigFailure-SCG,
                                                 scg-reconfigFailure,
                                                 srb3-IntegrityFailure},
        measResultSCG                    OCTET STRING (CONTAINING MeasResultSCG-Failure)
    }                                                                                              OPTIONAL,
    configRestrictInfo           ConfigRestrictInfoSCG                                             OPTIONAL,
    drx-InfoMCG                  DRX-Info                                                          OPTIONAL,
    measConfigMN                 MeasConfigMN                                                      OPTIONAL,
    sourceConfigSCG              OCTET STRING (CONTAINING RRCReconfiguration)                      OPTIONAL,
    scg-RB-Config                OCTET STRING (CONTAINING RadioBearerConfig)                       OPTIONAL,
    mcg-RB-Config                OCTET STRING (CONTAINING RadioBearerConfig)                       OPTIONAL,
    mrdc-AssistanceInfo          MRDC-AssistanceInfo                                               OPTIONAL,
    nonCriticalExtension         CG-ConfigInfo-v1540-IEs                                           OPTIONAL
}
```

```
CG-ConfigInfo-v1540-IEs ::= SEQUENCE {
    ph-InfoMCG                  PH-TypeListMCG                                                      OPTIONAL,
    measResultReportCGI         SEQUENCE {
        ssbFrequency                ARFCN-ValueNR,
        cellForWhichToReportCGI     PhysCellId,
        cgi-Info                    CGI-Info
    }                                                                                               OPTIONAL,
    nonCriticalExtension        SEQUENCE {}                                                         OPTIONAL
}

ConfigRestrictInfoSCG ::=       SEQUENCE {
    allowedBC-ListMRDC              BandCombinationInfoList                                         OPTIONAL,
    powerCoordination-FR1               SEQUENCE {
        p-maxNR-FR1                     P-Max                                                       OPTIONAL,
        p-maxEUTRA                      P-Max                                                       OPTIONAL,
        p-maxUE-FR1                     P-Max                                                       OPTIONAL
    }                                                                                               OPTIONAL,
    servCellIndexRangeSCG           SEQUENCE {
        lowBound                        ServCellIndex,
        upBound                         ServCellIndex
    }                                                                                               OPTIONAL,   -- Cond SN-Addition
    maxMeasFreqsSCG-NR                  INTEGER(1..maxMeasFreqsMN)                                  OPTIONAL,
    maxMeasIdentitiesSCG-NR             INTEGER(1..maxMeasIdentitiesMN)                             OPTIONAL,
    ...
}

PH-TypeListMCG ::=              SEQUENCE (SIZE (1..maxNrofServingCells)) OF PH-InfoMCG

PH-InfoMCG ::=                  SEQUENCE {
    servCellIndex                       ServCellIndex,
    ph-Uplink                           PH-UplinkCarrierMCG,
    ph-SupplementaryUplink              PH-UplinkCarrierMCG                                         OPTIONAL,
    ...
}

PH-UplinkCarrierMCG ::=         SEQUENCE{
    ph-Type1or3                         ENUMERATED {type1, type3},
    ...
}

BandCombinationInfoList ::= SEQUENCE (SIZE (1..maxBandComb)) OF BandCombinationInfo

BandCombinationInfo ::=     SEQUENCE {
    bandCombinationIndex        BandCombinationIndex,
    allowedFeatureSetsList      SEQUENCE (SIZE (1..maxFeatureSetsPerBand)) OF FeatureSetEntryIndex
}

FeatureSetEntryIndex ::=    INTEGER (1.. maxFeatureSetsPerBand)

DRX-Info ::=                    SEQUENCE {
    drx-LongCycleStartOffset        CHOICE {
        ms10                            INTEGER(0..9),
        ms20                            INTEGER(0..19),
```

```
        ms32                            INTEGER(0..31),
        ms40                            INTEGER(0..39),
        ms60                            INTEGER(0..59),
        ms64                            INTEGER(0..63),
        ms70                            INTEGER(0..69),
        ms80                            INTEGER(0..79),
        ms128                           INTEGER(0..127),
        ms160                           INTEGER(0..159),
        ms256                           INTEGER(0..255),
        ms320                           INTEGER(0..319),
        ms512                           INTEGER(0..511),
        ms640                           INTEGER(0..639),
        ms1024                          INTEGER(0..1023),
        ms1280                          INTEGER(0..1279),
        ms2048                          INTEGER(0..2047),
        ms2560                          INTEGER(0..2559),
        ms5120                          INTEGER(0..5119),
        ms10240                         INTEGER(0..10239)
    },
    shortDRX                            SEQUENCE {
        drx-ShortCycle                      ENUMERATED  {
                                                ms2, ms3, ms4, ms5, ms6, ms7, ms8, ms10, ms14, ms16, ms20, ms30, ms32,
                                                ms35, ms40, ms64, ms80, ms128, ms160, ms256, ms320, ms512, ms640, spare9,
                                                spare8, spare7, spare6, spare5, spare4, spare3, spare2, spare1 },
        drx-ShortCycleTimer                 INTEGER (1..16)
    }                                                                                                           OPTIONAL
}

MeasConfigMN ::= SEQUENCE {
    measuredFrequenciesMN               SEQUENCE (SIZE (1..maxMeasFreqsMN)) OF NR-FreqInfo        OPTIONAL,
    measGapConfig                   SetupRelease { GapConfig }                                  OPTIONAL,
    gapPurpose                          ENUMERATED {perUE, perFR1}                              OPTIONAL,
    ...
}

MRDC-AssistanceInfo ::= SEQUENCE {
    affectedCarrierFreqCombInfoListMRDC     SEQUENCE (SIZE (1..maxNrofCombIDC)) OF AffectedCarrierFreqCombInfoMRDC,
    ...
}

AffectedCarrierFreqCombInfoMRDC ::= SEQUENCE {
    victimSystemType                    VictimSystemType,
    interferenceDirectionMRDC       ENUMERATED {eutra-nr, nr, other, utra-nr-other, nr-other, spare3, spare2, spare1},
    affectedCarrierFreqCombMRDC         SEQUENCE    {
        affectedCarrierFreqCombEUTRA            AffectedCarrierFreqCombEUTRA                      OPTIONAL,
        affectedCarrierFreqCombNR           AffectedCarrierFreqCombNR
    }       OPTIONAL
}

VictimSystemType ::= SEQUENCE {
    gps                         ENUMERATED {true}               OPTIONAL,
    glonass                     ENUMERATED {true}               OPTIONAL,
    bds                         ENUMERATED {true}               OPTIONAL,
    galileo                     ENUMERATED {true}               OPTIONAL,
```

```
    wlan                            ENUMERATED {true}               OPTIONAL,
    bluetooth                       ENUMERATED {true}               OPTIONAL
}

AffectedCarrierFreqCombEUTRA ::= SEQUENCE (SIZE (1..maxNrofServingCellsEUTRA)) OF ARFCN-ValueEUTRA

AffectedCarrierFreqCombNR ::= SEQUENCE (SIZE (1..maxNrofServingCells)) OF ARFCN-ValueNR

-- TAG-CG-CONFIG-INFO-STOP
-- ASN1STOP
```

***CG-ConfigInfo* field descriptions**
allowedBC-ListMRDC A list of indices referring to band combinations in MR-DC capabilities from which SN is allowed to select an NR band combination. Each entry refers to a band combination numbered according to supportedBandCombinationList in the UE-MRDC-Capability and the Feature Sets allowed for each band entry. All MR-DC band combinations indicated by this field comprise the LTE band combination, which is a superset of the LTE band(s) selected by MN.
candidateCellInfoListMN, ***candidateCellInfoListSN*** Contains information regarding cells that the master node or the source node suggests the target gNB to consider configuring. Including CSI-RS measurement results in candidateCellInfoListMN is not supported in this version of the specification.
configRestrictInfo Includes fields for which SgNB is explictly indicated to observe a configuration restriction.
maxMeasFreqsSCG-NR Indicates the maximum number of NR inter-frequency carriers the SN is allowed to configure with PSCell for measurements.
maxMeasIdentitiesSCG-NR Indicates the maximum number of allowed measurement identities that the SCG is allowed to configure.
measuredFrequenciesMN Used by MN to indicate a list of frequencies measured by the UE.
measGapConfig Indicates the measurement gap configuration configured by MN.
measResultReportCGI Used by MN to provide SN with CGI-Info for the cell as per SN′s request.
mcg-RB-Config Contains the IE RadioBearerConfig of the MN, used to support delta configuration for bearer type change between MN terminated to SN terminated bearer and SN change. It is also used to indicate the PDCP duplication related information (whether duplication is configured and if so, whether it is initially activated) in SN Addition/Modification procedure.
mrdc-AssistanceInfo Contains the IDC assistance information for MR-DC reported by the UE (see TS 36.331 [10]).
p-maxEUTRA Indicates the maximum total transmit power to be used by the UE in the E-UTRA cell group (see TS 36.104 [33]).
p-maxNR-FR1 Indicates the maximum total transmit power to be used by the UE in the NR cell group across all serving cells in frequency range 1 (FR1) (see TS 38.104 [12]) the UE can use in NR SCG.
p-maxUE-FR1 Indicates the maximum total transmit power to be used by the UE across all serving cells in frequency range 1 (FR1).
ph-InfoMCG Power headroom information in MCG that is needed in the reception of PHR MAC CE in SCG.
ph-SupplimentaryUplink Power headroom information for supplementary uplink. For EN-DC, this field is absent.
ph-Type1or3 Type of power headroom for a serving cell in MCG (PCell and activated SCells). "type1" refers to type 1 power headroom, "type3" refers to type 3 power headroom. (See TS 38.321 [3]).
ph-Uplink Power headroom information for uplink.
powerCoordination-FR1 Indicates the maximum power that the UE can use in FR1.

scgFailureInfo Contains SCG failure type and measurement results. In case the sender has no measurement results available, the sender may include one empty entry (i.e. without any optional fields present) in *measResultsPerMOList*.
scg-RB-Config Contains the IE RadioBearerConfig of the SN, used to support delta configuration e.g. during SN change. This field is absent when master eNB uses full configuration option.
servCellIndexRangeSCG Range of serving cell indices that SN is allowed to configure for SCG serving cells.
sourceConfigSCG Includes the current dedicated SCG configuration in the same format as the *RRCReconfiguration* message, i.e. not only CellGroupConfig but also e.g. measConfig. This field is absent when master eNB uses full configuration option.

BandCombinationInfo field descriptions
allowedFeatureSetsList Defines a subset of the entries in a FeatureSetCombination. Each index identifies one FeatureSetUplink/Downlink for each band entry in the associated band combination.
bandCombinationIndex The position of a band combination in the supportedBandCombinationList

Conditional Presence	Explanation
SN-Addition	The field is mandatory present upon SN addition.

– *MeasurementTimingConfiguration*

The *MeasurementTimingConfiguration* message is used to convey assistance information for measurement timing.

Direction: en-gNB to eNB, eNB to en-gNB, gNB to gNB, gNB DU to gNB CU, and gNB CU to gNB DU.

MeasurementTimingConfiguration message

```
-- ASN1START
-- TAG-MEASUREMENT-TIMING-CONFIGURATION-START

MeasurementTimingConfiguration ::=              SEQUENCE {
    criticalExtensions              CHOICE {
        c1                              CHOICE{
            measTimingConf                  MeasurementTimingConfiguration-IEs,
            spare3 NULL, spare2 NULL, spare1 NULL
        },
        criticalExtensionsFuture        SEQUENCE {}
    }
}

MeasurementTimingConfiguration-IEs ::=  SEQUENCE {
    measTiming                              MeasTimingList                          OPTIONAL,
    nonCriticalExtension                    SEQUENCE {}                             OPTIONAL
}
```

```
MeasTimingList ::= SEQUENCE (SIZE (1..maxMeasFreqsMN)) OF MeasTiming

MeasTiming ::= SEQUENCE {
    frequencyAndTiming                      SEQUENCE {
        carrierFreq                             ARFCN-ValueNR,
        ssbSubcarrierSpacing                    SubcarrierSpacing,
        ssb-MeasurementTimingConfiguration      SSB-MTC,
        ss-RSSI-Measurement                     SS-RSSI-Measurement                 OPTIONAL
    }                                                                               OPTIONAL,
...,
    [[
    ssb-ToMeasure-v1540                     SSB-ToMeasure                           OPTIONAL,
    physCellId                              PhysCellId                              OPTIONAL
    ]]
}

-- TAG-MEASUREMENT-TIMING-CONFIGURATION-STOP
-- ASN1STOP
```

***MeasTiming* field descriptions**
carrierFreq, ssbSubcarrierSpacing Indicates the frequency and subcarrier spacing of the SS block of the cell for which this message is included, or of other SS blocks within the same carrier.
ssb-MeasurementTimingConfiguration Indicates the SMTC which can be used to search for SSB of the cell for which the message is included. When the message is included in "Served Cell Information NR", the timing is based on the cell for which the message is included. When the message is included in "NR Neighbour Information", the timing is based on the cell indicated in the "Served Cell Information NR" with which the "NR Neighbour Information" is provided. See TS 36.423, TS 38.423 and TS 38.473.
ss-RSSI-Measurement Provides the configuration which can be used for RSSI measurements of the cell for which the message is included.

***MeasurementTimingConfiguration* field descriptions**
measTiming A list of SMTC information, SSB RSSI measurement information and associated NR frequency exchanged via EN-DC X2 Setup, EN-DC Configuration Update, Xn Setup and NG-RAN Node Configuration Update procedures, or F1 messages between gNB DU and gNB CU.
physCellId Physical Cell Identity of the SSB on the ARFCN indicated by *carrierFreq*.
ssb-ToMeasure The set of SS blocks to be measured within the SMTC measurement duration (see TS 38.215 [9]).

– *UERadioPagingInformation*

This message is used to transfer radio paging information, covering both upload to and download from the AMF.

Direction: gNB to/ from AMF

***UERadioPagingInformation* message**

```
-- ASN1START
-- TAG-UE-RADIO-PAGING-INFORMATION-START

UERadioPagingInformation ::= SEQUENCE {
    criticalExtensions                  CHOICE {
        c1                                  CHOICE{
            ueRadioPagingInformation            UERadioPagingInformation-IEs,
            spare7 NULL,
            spare6 NULL, spare5 NULL, spare4 NULL,
            spare3 NULL, spare2 NULL, spare1 NULL
        },
        criticalExtensionsFuture            SEQUENCE {}
    }
}

UERadioPagingInformation-IEs ::=    SEQUENCE {
    supportedBandListNRForPaging        SEQUENCE (SIZE (1..maxBands)) OF FreqBandIndicatorNR    OPTIONAL,
    nonCriticalExtension                SEQUENCE {}                                             OPTIONAL
}


-- TAG-UE-RADIO-PAGING-INFORMATION-STOP
-- ASN1STOP
```

***UERadioPagingInformation* field descriptions**
supportedBandListNRForPaging Indicates the UE supported NR frequency bands which is derived by the gNB from *UE-NR-Capability*.

– *UERadioAccessCapabilityInformation*

This message is used to transfer UE radio access capability information, covering both upload to and download from the 5GC.

Direction: ng-eNB or gNB to/ from 5GC

***UERadioAccessCapabilityInformation* message**

```
-- ASN1START
-- TAG-UE-RADIO-ACCESS-CAPABILITY-INFORMATION-START

UERadioAccessCapabilityInformation ::= SEQUENCE {
    criticalExtensions                  CHOICE {
        c1                                  CHOICE{
            ueRadioAccessCapabilityInformation    UERadioAccessCapabilityInformation-IEs,
            spare7 NULL,
            spare6 NULL, spare5 NULL, spare4 NULL,
            spare3 NULL, spare2 NULL, spare1 NULL
        },
        criticalExtensionsFuture            SEQUENCE {}
```

```
    }
}

UERadioAccessCapabilityInformation-IEs ::= SEQUENCE {
    ue-RadioAccessCapabilityInfo        OCTET STRING (CONTAINING UE-CapabilityRAT-ContainerList),
    nonCriticalExtension                SEQUENCE {}                                                  OPTIONAL
}

-- TAG-UE-RADIO-ACCESS-CAPABILITY-INFORMATION-STOP
-- ASN1STOP
```

UERadioAccessCapabilityInformation-IEs field descriptions
ue-RadioAccessCapabilityInfo Including NR, MR-DC, E-UTRA radio access capabilities.

11.3 Inter-node RRC information element definitions

-

11.4 Inter-node RRC multiplicity and type constraint values

– Multiplicity and type constraints definitions

```
-- ASN1START
-- TAG-NR-MULTIPLICITY-AND-CONSTRAINTS-START

maxMeasFreqsMN              INTEGER ::= 32  -- Maximum number of MN-configured measurement frequencies
maxMeasFreqsSN              INTEGER ::= 32  -- Maximum number of SN-configured measurement frequencies
maxMeasIdentitiesMN         INTEGER ::= 62  -- Maximum number of measurement identities that a UE can be configured with
maxCellPrep                 INTEGER ::= 32  -- Maximum number of cells prepared for handover

-- TAG-NR-MULTIPLICITY-AND-CONSTRAINTS-STOP
-- ASN1STOP
```

– *End of NR-InterNodeDefinitions*

```
-- ASN1START
-- TAG-NR-INTER-NODE-DEFINITIONS-END-START

END

-- TAG-NR-INTER-NODE-DEFINITIONS-END-STOP
-- ASN1STOP
```

12 Processing delay requirements for RRC procedures

The UE performance requirements for RRC procedures are specified in the following tables. The performance requirement is expressed as the time in [ms] from the end of reception of the network -> UE message on the UE physical layer up to when the UE shall be ready for the reception of uplink grant for the UE -> network response message with no access delay other than the TTI-alignment (e.g. excluding delays caused by scheduling, the random access procedure or physical layer synchronisation). In case the RRC procedure triggers BWP switching, the RRC procedure delay is the value defined in the following table plus the BWP switching delay defined in TS 38.133 [14], FFS section.

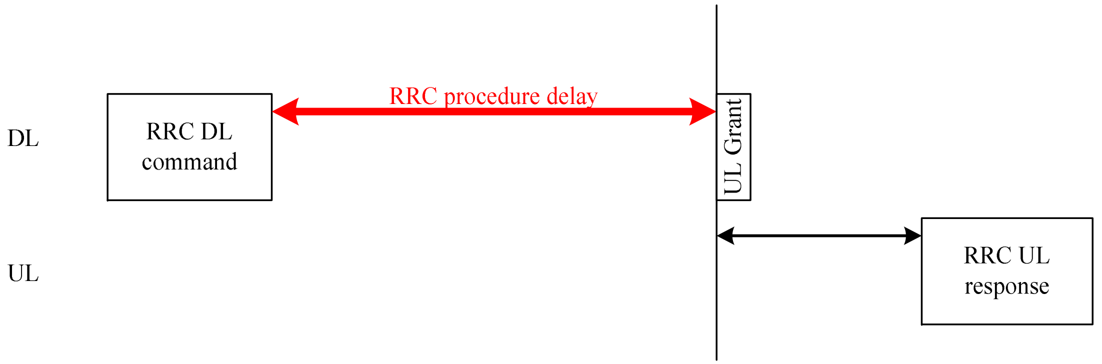

Figure 12.1-1: Illustration of RRC procedure delay

Table 12.1-1: UE performance requirements for RRC procedures for UEs

Procedure title:	Network -> UE	UE -> Network	Value [ms]	Notes
RRC Connection Control Procedures				
RRC reconfiguration	*RRCReconfiguration*	*RRCReconfigurationComplete*	10	
RRC reconfiguration (scell addition/release)	*RRCReconfiguration*	*RRCReconfigurationComplete*	16	
RRC reconfiguration (SCG establishment/ modification/ release)	*RRCReconfiguration*	*RRCReconfigurationComplete*	16	
RRC setup	*RRCSetup*	*RRCSetupComplete*	10	
RRC Release	*RRCRelease*		NA	
RRC re-establishment	*RRCReestablishment*	*RRCReestablishmentComplete*	FFS	
RRC resume	*RRCResume*	*RRCResumeComplete*	10	
RRC resume (scell addition/release)	*RRCResume*	*RRCResumeComplete*	16	
Initial security activation	*SecurityModeCommand*	*SecurityModeComplete/SecurityModeFailure*	5	
Initial security activation + RRC reconfiguration	*SecurityModeCommand, RRCReconfiguration*	*RRCReconfigurationComplete*	FFS	The two DL messages are transmitted in the same TTI
Other procedures				
UE assistance information		*UEAssistanceInformation*	NA	
UE capability transfer	*UECapabilityEnquiry*	*UECapabilityInformation*	FFS	
Counter check	*CounterCheck*	*CounterCheckResponse*	5	

Annex A (informative): Guidelines, mainly on use of ASN.1

A.1 Introduction

The following clauses contain guidelines for the specification of RRC protocol data units (PDUs) with ASN.1.

A.2 Procedural specification

A.2.1 General principles

The procedural specification provides an overall high level description regarding the UE behaviour in a particular scenario.

It should be noted that most of the UE behaviour associated with the reception of a particular field is covered by the applicable parts of the PDU specification. The procedural specification may also include specific details of the UE behaviour upon reception of a field, but typically this should be done only for cases that are not easy to capture in the PDU section e.g. general actions, more complicated actions depending on the value of multiple fields.

Likewise, the procedural specification need not specify the UE requirements regarding the setting of fields within the messages that are sent to the network i.e. this may also be covered by the PDU specification.

A.2.2 More detailed aspects

The following more detailed conventions should be used:

- Bullets:
  - Capitals should be used in the same manner as in other parts of the procedural text i.e. in most cases no capital applies since the bullets are part of the sentence starting with 'The UE shall:'
  - All bullets, including the last one in a sub-clause, should end with a semi-colon i.e. an ';.
- Conditions:
  - Whenever multiple conditions apply, a semi-colon should be used at the end of each conditions with the exception of the last one, i.e. as in 'if cond1, or cond2.

A.3 PDU specification

A.3.1 General principles

A.3.1.1 ASN.1 sections

The RRC PDU contents are formally and completely described using abstract syntax notation (ASN.1), see X.680 [13], X.681 (02/2002) [14].

The complete ASN.1 code is divided into a number of ASN.1 sections in the specifications. In order to facilitate the extraction of the complete ASN.1 code from the specification, each ASN.1 section begins with the following:

- a first text paragraph consisting entirely of an *ASN.1 start tag*, which consists of a double hyphen followed by a single space and the text string "ASN1START" (in all upper case letters);
- a second text paragraph consisting entirely of a *block start tag* is included, which consists of a double hyphen followed by a single space and the text string "TAG-NAME-START" (in all upper case letters), where the "NAME" refers to the main name of the paragraph (in all upper-case letters).

Similarly, each ASN.1 section ends with the following:

- a first text paragraph consisting entirely of a *blockstop tag*, which consists of a double hyphen followed by a single space and the text string "TAG-NAME-STOP" (in all upper-case letters), where the "NAME" refers to the main name of the paragraph (in all upper-case letters);
- a second text paragraph consisting entirely of an *ASN.1 stop tag*, which consists of a double hyphen followed by a singlespace and the text "ASN1STOP" (in all upper case letters).

This results in the following tags:

```
-- ASN1START
-- TAG-NAME-START

-- TAG-NAME-STOP
-- ASN1STOP
```

The text paragraphs containing either of the start and stop tags should not contain any ASN.1 code significant for the complete description of the RRC PDU contents. The complete ASN.1 code may be extracted by copying all the text paragraphs between an ASN.1 start tag and the following ASN.1 stop tag in the order they appear, throughout the specification.

NOTE: A typical procedure for extraction of the complete ASN.1 code consists of a first step where the entire RRC PDU contents description (ultimately the entire specification) is saved into a plain text (ASCII) file format, followed by a second step where the actual extraction takes place, based on the occurrence of the ASN.1 start and stop tags.

A.3.1.2 ASN.1 identifier naming conventions

The naming of identifiers (i.e., the ASN.1 field and type identifiers) should be based on the following guidelines:

- Message (PDU) identifiers should be ordinary mixed case without hyphenation. These identifiers, *e.g.*, the *RRCConnectionModificationCommand*, should be used for reference in the procedure text. Abbreviations should be avoided in these identifiers and abbreviated forms of these identifiers should not be used.

- Type identifiers other than PDU identifiers should be ordinary mixed case, with hyphenation used to set off acronyms only where an adjacent letter is a capital, *e.g.*, *EstablishmentCause, SelectedPLMN* (not *Selected-PLMN*, since the "d" in "Selected" is lowercase), *InitialUE-Identity* and *MeasSFN-SFN-TimeDifference*.

- Field identifiers shall start with a lowercase letter and use mixed case thereafter, *e.g.*, *establishmentCause*. If a field identifier begins with an acronym (which would normally be in upper case), the entire acronym is lowercase (*plmn-Identity*, not *pLMN-Identity*). The acronym is set off with a hyphen (*ue-Identity*, not *ueIdentity*), in order to facilitate a consistent search pattern with corresponding type identifiers.

- Identifiers should convey the meaning of the identifier and should avoid adding unnecessary postfixes (e.g. abstractions like 'Info') for the name.

- Identifiers that are likely to be keywords of some language, especially widely used languages, such as C++ or Java, should be avoided to the extent possible.

- Identifiers, other than PDU identifiers, longer than 25 characters should be avoided where possible. It is recommended to use abbreviations, which should be done in a consistent manner i.e. use 'Meas' instead of 'Measurement' for all occurrences. Examples of typical abbreviations are given in tableA.3.1.2.1-1 below.

- *For future extension:* When an extension is introduced a suffix is added to the identifier of the concerned ASN.1 field and/or type. A suffix of the form "-rX" is used, with X indicating the release, for ASN.1 fields or types introduced in a later release (i.e. a release later than the original/first release of the protocol) as well as for ASN.1 fields or types for which a revision is introduced in a later release replacing a previous version, *e.g.*, *Foo-r9* for the Rel-9 version of the ASN.1 type *Foo*. A suffix of the form "-rXb" is used for the first revision of a field that it appears in the same release (X) as the original version of the field, "-rXc" for a second intra-release revision and so on. A suffix of the form "-vXYZ" is used for ASN.1 fields or types that only are an extension of a corresponding earlier field or type (see sub-clause A.4), e.g., *AnElement-v10b0* for the extension of the ASN.1 type *AnElement* introduced in version 10.11.0 of the specification. A number *0...9, 10, 11, etc.* is used to represent the first part of the version number, indicating the release of the protocol. Lower case letters *a, b, c, etc.* are used to represent the second (and third) part of the version number if they are greater than 9. In the procedural specification, in field descriptions as well as in headings suffices are not used, unless there is a clear need to distinguish the extension from the original field.

- More generally, in case there is a need to distinguish different variants of an ASN.1 field or IE, a suffix should be added at the end of the identifiers e.g. *MeasObjectUTRA*, *ConfigCommon*. When there is no particular need to distinguish the fields (e.g. because the field is included in different IEs), a common field identifier name may be used. This may be attractive e.g. in case the procedural specification is the same for the different variants.

- It should be avoided to use field identifiers with the same name within the elements of a CHOICE, including using a CHOICE inside a SEQUENCE (to avoid certain compiler errors).

TableA.3.1.2-1: Examples of typical abbreviations used in ASN.1 identifiers

Abbreviation	Abbreviated word
Config	Configuration
DL	Downlink
Ext	Extension
Freq	Frequency
Id	Identity
Ind	Indication
Meas	Measurement
MIB	MasterInformationBlock
Neigh	Neighbour(ing)
Param(s)	Parameter(s)
Phys	Physical
PCI	Physical Cell Id
Proc	Process
Reconfig	Reconfiguration
Reest	Re-establishment
Req	Request
Rx	Reception
Sched	Scheduling
SIB	SystemInformationBlock
Sync	Synchronisation
Thr	Threshold
Tx	Transmission
UL	Uplink

NOTE: The tableA.3.1.2.1-1 is not exhaustive. Additional abbreviations may be used in ASN.1 identifiers when needed.

A.3.1.3 Text references using ASN.1 identifiers

A text reference into the RRC PDU contents description from other parts of the specification is made using the ASN.1 field identifier of the referenced type. The ASN.1 field and type identifiers used in text references should be in the *italic font style*. The "do not check spelling and grammar" attribute in Word should be set. Quotation marks (i.e., "") should not be used around the ASN.1 field or type identifier.

A reference to an RRC PDU should be made using the corresponding ASN.1 field identifier followed by the word "message", e.g., a reference to the *RRCRelease* message.

A reference to a specific part of an RRC PDU, or to a specific part of any other ASN.1 type, should be made using the corresponding ASN.1 field identifier followed by the word "field", e.g., a reference to the *prioritisedBitRate* field in the example below.

```
-- /example/ ASN1START

LogicalChannelConfig ::=            SEQUENCE {
    ul-SpecificParameters               SEQUENCE {
        priority                            Priority,
```

```
        prioritisedBitRate                  PrioritisedBitRate,
        bucketSizeDuration                  BucketSizeDuration,
        logicalChannelGroup                 INTEGER (0..3)
    }       OPTIONAL
}

-- ASN1STOP
```

NOTE: All the ASN.1 start tags in the ASN.1 sections, used as examples in this annex to the specification, are deliberately distorted, in order not to include them when the ASN.1 description of the RRC PDU contents is extracted from the specification.

A reference to a specific type of information element should be made using the corresponding ASN.1 type identifier preceded by the acronym "IE", e.g., a reference to the IE *LogicalChannelConfig* in the example above.

References to a specific type of information element should only be used when those are generic, i.e., without regard to the particular context wherein the specific type of information element is used. If the reference is related to a particular context, e.g., an RRC PDU type (message) wherein the information element is used, the corresponding field identifier in that context should be used in the text reference.

A reference to a specific value of an ASN.1 field should be made using the corresponding ASN.1 value without using quotation marks around the ASN.1 value, e.g., 'if the *status* field is set to value *true*'.

A.3.2 High-level message structure

Within each logical channel type, the associated RRC PDU (message) types are alternatives within a CHOICE, as shown in the example below.

```
-- /example/ ASN1START

DL-DCCH-Message ::= SEQUENCE {
    message                 DL-DCCH-MessageType
}

DL-DCCH-MessageType ::= CHOICE {
    c1                      CHOICE {
        dlInformationTransfer                   DLInformationTransfer,
        handoverFromEUTRAPreparationRequest     HandoverFromEUTRAPreparationRequest,
        mobilityFromEUTRACommand                MobilityFromEUTRACommand,
        rrcConnectionReconfiguration            RRCConnectionReconfiguration,
        rrcConnectionRelease                    RRCConnectionRelease,
        securityModeCommand                     SecurityModeCommand,
        ueCapabilityEnquiry                     UECapabilityEnquiry,
        spare1 NULL
    },
    messageClassExtension   SEQUENCE {}
}

-- ASN1STOP
```

A nested two-level CHOICE structure is used, where the alternative PDU types are alternatives within the inner level *c1* CHOICE.

Spare alternatives (i.e., *spare1* in this case) may be included within the *c1* CHOICE to facilitate future extension. The number of such spare alternatives should not extend the total number of alternatives beyond an integer-power-of-two number of alternatives (i.e., eight in this case).

Further extension of the number of alternative PDU types is facilitated using the *messageClassExtension* alternative in the outer level CHOICE.

A.3.3 Message definition

Each PDU (message) type is specified in an ASN.1 section similar to the one shown in the example below.

```
-- /example/ ASN1START

RRCConnectionReconfiguration ::=    SEQUENCE {
    rrc-TransactionIdentifier           RRC-TransactionIdentifier,
    criticalExtensions                  CHOICE {
        c1                                  CHOICE{
            rrcConnectionReconfiguration-r8     RRCConnectionReconfiguration-r8-IEs,
            spare3 NULL, spare2 NULL, spare1 NULL
        },
        criticalExtensionsFuture            SEQUENCE {}
    }
}

RRCConnectionReconfiguration-r8-IEs ::= SEQUENCE {
    -- Enter the IEs here.
    ...
}

-- ASN1STOP
```

Hooks for *critical* and *non-critical* extension should normally be included in the PDU type specification. How these hooks are used is further described in sub-clause A.4.

Critical extensions are characterised by a redefinition of the PDU contents and need to be governed by a mechanism for protocol version agreement between the encoder and the decoder of the PDU, such that the encoder is prevented from sending a critically extended version of the PDU type, which is not comprehended by the decoder.

Critical extension of a PDU type is facilitated by a two-level CHOICE structure, where the alternative PDU contents are alternatives within the inner level *c1* CHOICE. Spare alternatives (i.e., *spare3* down to *spare1* in this case) may be included within the *c1* CHOICE. The number of spare alternatives to be included in the original PDU specification should be decided case by case, based on the expected rate of critical extension in the future releases of the protocol.

Further critical extension, when the spare alternatives from the original specifications are used up, is facilitated using the *criticalExtensionsFuture* in the outer level CHOICE.

In PDU types where critical extension is not expected in the future releases of the protocol, the inner level *c1* CHOICE and the spare alternatives may be excluded, as shown in the example below.

```
-- /example/ ASN1START

RRCConnectionReconfigurationComplete ::= SEQUENCE {
    rrc-TransactionIdentifier           RRC-TransactionIdentifier,
    criticalExtensions                  CHOICE {
        rrcConnectionReconfigurationComplete-r8
```

```
                                            RRCConnectionReconfigurationComplete-r8-IEs,
        criticalExtensionsFuture            SEQUENCE {}
    }
}

RRCConnectionReconfigurationComplete-r8-IEs ::= SEQUENCE {
    -- Enter the fields here.
    ...
}

-- ASN1STOP
```

Non-critical extensions are characterised by the addition of new information to the original specification of the PDU type. If not comprehended, a non-critical extension may be skipped by the decoder, whilst the decoder is still able to complete the decoding of the comprehended parts of the PDU contents.

Non-critical extensions at locations other than the end of the message or other than at the end of a field contained in a BIT or OCTET STRING are facilitated by use of the ASN.1 extension marker "...". The original specification of a PDU type should normally include the extension marker at the end of the sequence of information elements contained.

Non-critical extensions at the end of the message or at the end of a field that is contained in a BIT or OCTET STRING may be facilitated by use of an empty sequence that is marked OPTIONAL e.g. as shown in the following example:

```
-- /example/ ASN1START

RRCMessage-r8-IEs ::=                   SEQUENCE {
    field1                                  InformationElement1,
    field2                                  InformationElement2,

    nonCriticalExtension                    SEQUENCE {}                     OPTIONAL
}

-- ASN1STOP
```

The ASN.1 section specifying the contents of a PDU type may be followed by a *field description* table where a further description of, e.g., the semantic properties of the fields may be included. The general format of this table is shown in the example below. The field description table is absent in case there are no fields for which further description needs to be provided e.g. because the PDU does not include any fields, or because an IE is defined for each field while there is nothing specific regarding the use of this IE that needs to be specified.

***%PDU-TypeIdentifier%* field descriptions**
%field identifier% Field description.
%field identifier% Field description.

The field description table has one column. The header row shall contain the ASN.1 type identifier of the PDU type.

The following rows are used to provide field descriptions. Each row shall include a first paragraph with a *field identifier* (in ***bold and italic*** font style) referring to the part of the PDU to which it applies. The following paragraphs at the same row may include (in regular font style), e.g., semantic description, references to other specifications and/or specification of value units, which are relevant for the particular part of the PDU.

The parts of the PDU contents that do not require a field description shall be omitted from the field description table.

A.3.4 Information elements

Each IE (information element) type is specified in an ASN.1 section similar to the one shown in the example below.

```
-- /example/ ASN1START

PRACH-ConfigSIB ::=                 SEQUENCE {
    rootSequenceIndex                   INTEGER (0..1023),
    prach-ConfigInfo                    PRACH-ConfigInfo
}

PRACH-Config ::=                    SEQUENCE {
    rootSequenceIndex                   INTEGER (0..1023),
    prach-ConfigInfo                    PRACH-ConfigInfo                    OPTIONAL    -- Need N
}

PRACH-ConfigInfo ::=                SEQUENCE {
    prach-ConfigIndex                   ENUMERATED {ffs},
    highSpeedFlag                       ENUMERATED {ffs},
    zeroCorrelationZoneConfig           ENUMERATED {ffs}
}

-- ASN1STOP
```

IEs should be introduced whenever there are multiple fields for which the same set of values apply. IEs may also be defined for other reasons e.g. to break down a ASN.1 definition in to smaller pieces.

A group of closely related IE type definitions, like the IEs *PRACH-ConfigSIB* and *PRACH-Config* in this example, are preferably placed together in a common ASN.1 section. The IE type identifiers should in this case have a common base, defined as the *generic type identifier*. It may be complemented by a suffix to distinguish the different variants. The "*PRACH-Config*" is the generic type identifier in this example, and the "*SIB*" suffix is added to distinguish the variant. The sub-clause heading and generic references to a group of closely related IEs defined in this way should use the generic type identifier.

The same principle should apply if a new version, or an extension version, of an existing IE is created for *critical* or *non-critical* extension of the protocol (see sub-clause A.4). The new version, or the extension version, of the IE is included in the same ASN.1 section defining the original. A suffix is added to the type identifier, using the naming conventions defined in sub-clause A.3.1.2, indicating the release or version of the where the new version, or extension version, was introduced.

Local IE type definitions, like the IE *PRACH-ConfigInfo* in the example above, may be included in the ASN.1 section and be referenced in the other IE types defined in the same ASN.1 section. The use of locally defined IE types should be encouraged, as a tool to break up large and complex IE type definitions. It can improve the readability of the code. There may also be a benefit for the software implementation of the protocol end-points, as these IE types are typically provided by the ASN.1 compiler as independent data elements, to be used in the software implementation.

An IE type defined in a local context, like the IE *PRACH-ConfigInfo*, should not be referenced directly from other ASN.1 sections in the RRC specification. An IE type which is referenced in more than one ASN.1 section should be defined in a separate sub-clause, with a separate heading and a separate ASN.1 section (possibly as one in a set of closely related IE types, like the IEs *PRACH-ConfigSIB* and *PRACH-Config* in the example above). Such IE types are also referred to as 'global IEs'.

NOTE: Referring to an IE type, that is defined as a local IE type in the context of another ASN.1 section, does not generate an ASN.1 compilation error. Nevertheless, using a locally defined IE type in that way makes the IE type definition difficult to find, as it would not be visible at an outline level of the specification. It should be avoided.

The ASN.1 section specifying the contents of one or more IE types, like in the example above, may be followed by a *field description* table, where a further description of, e.g., the semantic properties of the fields of the information elements may be included. This table may be absent, similar as indicated in sub-clause A.3.3 for the specification of the PDU type. The general format of the *field description* table is the same as shown in sub-clause A.3.3 for the specification of the PDU type.

A.3.5 Fields with optional presence

A field with optional presence may be declared with the keyword DEFAULT. It identifies a default value to be assumed, if the sender does not include a value for that field in the encoding:

```
-- /example/ ASN1START

PreambleInfo ::=                    SEQUENCE {
    numberOfRA-Preambles                INTEGER (1..64)                     DEFAULT 1,
    ...
}

-- ASN1STOP
```

Alternatively, a field with optional presence may be declared with the keyword OPTIONAL. It identifies a field for which a value can be omitted. The omission carries semantics, which is different from any normal value of the field:

```
-- /example/ ASN1START

PRACH-Config ::=                SEQUENCE {
    rootSequenceIndex                   INTEGER (0..1023),
    prach-ConfigInfo                    PRACH-ConfigInfo                    OPTIONAL    -- Need N
}

-- ASN1STOP
```

The semantics of an optionally present field, in the case it is omitted, should be indicated at the end of the paragraph including the keyword OPTIONAL, using a short comment text with a need code. The need code includes the keyword "Need", followed by one of the predefined semantics tags (S, M, N or R) defined in sub-clause 6.1. If the semantics tag S is used, the semantics of the absent field are further specified either in the field description table following the ASN.1 section, or in procedure text.

The addition of OPTIONAL keywords for capability groups is based on the following guideline. If there is more than one field in the lower level IE, then OPTIONAL keyword is added at the group level. If there is only one field in the lower level IE, OPTIONAL keyword is not added at the group level.

A.3.6 Fields with conditional presence

A field with conditional presence is declared with the keyword OPTIONAL. In addition, a short comment text shall be included at the end of the paragraph including the keyword OPTIONAL. The comment text includes the keyword "Cond", followed by a condition tag associated with the field ("UL" in this example):

```
-- /example/ ASN1START

LogicalChannelConfig ::=            SEQUENCE {
    ul-SpecificParameters               SEQUENCE {
        priority                            INTEGER (0),
        ...
    }       OPTIONAL                                                                    -- Cond UL
}

-- ASN1STOP
```

When conditionally present fields are included in an ASN.1 section, the field description table after the ASN.1 section shall be followed by a *conditional presence* table. The conditional presence table specifies the conditions for including the fields with conditional presence in the particular ASN.1 section.

Conditional presence	Explanation
UL	Specification of the conditions for including the field associated with the condition tag = "UL". Semantics in case of optional presence under certain conditions may also be specified.

The conditional presence table has two columns. The first column (heading: "Conditional presence") contains the condition tag (in *italic* font style), which links the fields with a condition tag in the ASN.1 section to an entry in the table. The second column (heading: "Explanation") contains a text specification of the conditions and requirements for the presence of the field. The second column may also include semantics, in case of an optional presence of the field, under certain conditions i.e. using the same predefined tags as defined for optional fields in A.3.5.

Conditional presence should primarily be used when presence of a field depends on the presence and/or value of other fields within the same message. If the presence of a field depends on whether another feature/function has been configured, while this function can be configured independently e.g. by another message and/or at another point in time, the relation is best reflected by means of a statement in the field description table.

If the ASN.1 section does not include any fields with conditional presence, the conditional presence table shall not be included.

Whenever a field is only applicable in specific cases e.g. TDD, use of conditional presence should be considered.

A.3.7 Guidelines on use of lists with elements of SEQUENCE type

Where an information element has the form of a list (the SEQUENCE OF construct in ASN.1) with the type of the list elements being a SEQUENCE data type, an information element shall be defined for the list elements even if it would not otherwise be needed.

For example, a list of PLMN identities with reservation flags is defined as in the following example:

```
-- /example/ ASN1START
```

```
PLMN-IdentityInfoList ::=               SEQUENCE (SIZE (1..6)) OF PLMN-IdentityInfo

PLMN-IdentityInfo ::=               SEQUENCE {
    plmn-Identity                       PLMN-Identity,
    cellReservedForOperatorUse          ENUMERATED {reserved, notReserved}
}

-- ASN1STOP
```

rather than as in the following (bad) example, which may cause generated code to contain types with unpredictable names:

```
-- /bad example/ ASN1START

PLMN-IdentityList ::=                   SEQUENCE (SIZE (1..6)) OFSEQUENCE {
    plmn-Identity                           PLMN-Identity,
    cellReservedForOperatorUse              ENUMERATED {reserved, notReserved}
}

-- ASN1STOP
```

A.3.8 Guidelines on use of parameterised SetupRelease type

The usage of the parameterised *SetupRelease* type is like a function call in programming languages where the element type parameter is passed as a parameter. The parameterised type only implies a textual change in abstract syntax where all references to the parameterised type are replaced by the compiler with the release/setup choice. Two examples of the usage are shown below:

```
-- /example/ ASN1START

RRCMessage-r15-IEs ::= SEQUENCE {
    field-r15               SetupRelease { IE-r15 }                 OPTIONAL,   --  Need M
    ...
}


RRCMessage-r15-IEs ::= SEQUENCE {
    field-r15       SetupRelease { Element-r15 }
}                                                                   OPTIONAL,   -- Need M

Element-r15 ::= SEQUENCE {
    field1-r15                  IE1-r15,
    field2-r15                  IE2-r15                             OPTIONAL    -- Need N
}                                                                   OPTIONAL,   -- Need M

-- /example/ ASN1STOP
```

The *SetupRelease* is always be used with only named IEs, i.e. the example below is not allowed:

```
-- /example/ ASN1START
```

```
RRCMessage-r15-IEs ::= SEQUENCE {
    field-r15       SetupRelease { SEQUENCE {   -- Unnamed SEQUENCEs are not allowed!
            field1-r15                  IE1-r15,
            field2-r15                  IE2-r15                          OPTIONAL    -- Need N
        }
    }                                                                    OPTIONAL,   -- Need M
}

-- /example/ ASN1STOP
```

If a field defined using the parameterized SetupRelease type requires procedural text, the field is referred to using the values defined for the type itself, namely, "setup" and "release". For example, procedural text for field-r15 above could be as follows:

1> if *field-r15* is set to "setup":

2> do something;

1> else (*field-r15* is set to "release"):

2> release *field-r15* (if appropriate).

A.3.9 Guidelines on use of ToAddModList and ToReleaseList

In order to benefit from delta signalling when modifying lists with many and/or large elements, so-called add/mod- and release- lists should be used. Instead of a single list containing all elements of the list, the ASN.1 provides two lists. One list is used to convey the actual elements that are to be added to the list or modified in the list. The second list conveys only the identities (IDs) of the list elements that are to be released from the list. In other words, the ASN.1 defines only means to signal modifications to a list maintained in the receiver (typically the UE). An example is provided below:

```
-- /example/ ASN1START

AnExampleIE ::=         SEQUENCE {
    elementsToAddModList    SEQUENCE (SIZE (1..maxNrofElements)) OF Element                                    OPTIONAL,   --  Need N
    elementsToReleaseList   SEQUENCE (SIZE (1..maxNrofElements)) OF ElementId                                  OPTIONAL,   --  Need N
    ...
}

Element ::=         SEQUENCE {
    elementId               ElementId,
    aField                  INTEG ER (0..16777215),
    anotherField            OCTET STRING,
    ...
}

ElementId ::=           INTEGER (0..maxNrofElements-1)

maxNrofElements         INTEGER ::= 50
maxNrofElements-1       INTEGER ::= 49
```

```
-- /example/ ASN1STOP
```

As can be seen, the elements of the list must contain an identity (INTEGER) that identifies the elements unambiguously upon addition, modification and removal. It is recommended to define an IE for that identifier (here ElementId) so that it can be used both for a field inside the element as well as in the *elementsToReleaseList*.

Both lists should be made OPTIONAL and flagged as "Need N". The need code reflects that the UE does not maintain the received lists as such but rather updates its configuration using the information therein. In other words, it is not possible to provide via delta signalling an update to a previously signalled *elementsToAddModList* or elementsToReleaseList (which Need M would imply). The update is always in relation to the UE's internal configuration.

If no procedural text is provided for a set of ToAddModList and ToReleaseList, the following generic procedure applies:

The UE shall:

1> for each *ElementId* in the *elementsToReleaseList*,:

2> if the current UE configuration includes an *Element* with the given *ElementId*:

3> release the *Element* from the current UE configuration;

1> for each *Element* in the *elementsToAddModList*:

2> if the current UE configuration includes an *Element* with the given *ElementId*:

3> modify the configured *Element* in accordance with the received *Element*;

2> else:

3> add received *Element* to the UE configuration.

A.4 Extension of the PDU specifications

A.4.1 General principles to ensure compatibility

It is essential that extension of the protocol does not affect interoperability i.e. it is essential that implementations based on different versions of the RRC protocol are able to interoperate. In particular, this requirement applies for the following kind of protocol extensions:

- Introduction of new PDU types (i.e. these should not cause unexpected behaviour or damage).
- Introduction of additional fields in an extensible PDUs (i.e. it should be possible to ignore uncomprehended extensions without affecting the handling of the other parts of the message).
- Introduction of additional values of an extensible field of PDUs. If used, the behaviour upon reception of an uncomprehended value should be defined.

It should be noted that the PDU extension mechanism may depend on the logical channel used to transfer the message e.g. for some PDUs an implementation may be aware of the protocol version of the peer in which case selective ignoring of extensions may not be required.

The non-critical extension mechanism is the primary mechanism for introducing protocol extensions i.e. the critical extension mechanism is used merely when there is a need to introduce a 'clean' message version. Such a need appears when the last message version includes a large number of non-critical extensions, which results in issues like readability, overhead associated with the extension markers. The critical extension mechanism may also be considered when it is complicated to accommodate the extensions by means of non-critical extension mechanisms.

A.4.2 Critical extension of messages and fields

The mechanisms to critically extend a message are defined in A.3.3. There are both "outer branch" and "inner branch" mechanisms available. The "outer branch" consists of a CHOICE having the name *criticalExtensions*, with two values, *c1* and *criticalExtensionsFuture*. The *criticalExtensionsFuture* branch consists of an empty SEQUENCE, while the c1 branch contains the "inner branch" mechanism.

The "inner branch" structure is a CHOICE with values of the form "*MessageName-rX-IEs*" (e.g., "*RRCConnectionReconfiguration-r8-IEs*") or "*spareX*", with the spare values having type NULL. The "-rX-IEs" structures contain the *complete* structure of the message IEs for the appropriate release; i.e., the critical extension branch for the Rel-10 version of a message includes all Rel-8 and Rel-9 fields (that are not obviated in the later version), rather than containing only the additional Rel-10 fields.

The following guidelines may be used when deciding which mechanism to introduce for a particular message, i.e. only an 'outer branch', or an 'outer branch' in combination with an 'inner branch' including a certain number of spares:

- For certain messages, e.g. initial uplink messages, messages transmitted on a broadcast channel, critical extension may not be applicable.
- An outer branch may be sufficient for messages not including any fields.
- The number of spares within inner branch should reflect the likelihood that the message will be critically extended in future releases (since each release with a critical extension for the message consumes one of the spare values). The estimation of the critical extension likelihood may be based on the number, size and changeability of the fields included in the message.
- In messages where an inner branch extension mechanism is available, all spare values of the inner branch should be used before any critical extensions are added using the outer branch.

The following example illustrates the use of the critical extension mechanism by showing the ASN.1 of the original and of a later release

```
-- /example/ ASN1START                    -- Original release

RRCMessage ::=                            SEQUENCE {
    rrc-TransactionIdentifier                 RRC-TransactionIdentifier,
    criticalExtensions                    CHOICE {
        c1                                    CHOICE{
            rrcMessage-r8                         RRCMessage-r8-IEs,
            spare3 NULL, spare2 NULL, spare1 NULL
        },
        criticalExtensionsFuture              SEQUENCE {}
    }
}
```

```
-- ASN1STOP
```

```
-- /example/ ASN1START                    -- Later release

RRCMessage ::=                            SEQUENCE {
    rrc-TransactionIdentifier                 RRC-TransactionIdentifier,
    criticalExtensions                    CHOICE {
        c1                                    CHOICE{
            rrcMessage-r8                         RRCMessage-r8-IEs,
            rrcMessage-r10                        RRCMessage-r10-IEs,
            rrcMessage-r11                        RRCMessage-r11-IEs,
            rrcMessage-r14                        RRCMessage-r14-IEs
        },
        later                             CHOICE {
            c2                                    CHOICE{
                rrcMessage-r16                        RRCMessage-r16-IEs,
                spare7 NULL, spare6 NULL, spare5 NULL, spare4 NULL,
                spare3 NULL, spare2 NULL, spare1 NULL
            },
            criticalExtensionsFuture              SEQUENCE {}
        }
    }
}

-- ASN1STOP
```

It is important to note that critical extensions may also be used at the level of individual fields i.e. a field may be replaced by a critically extended version. When sending the extended version, the original version may also be included (e.g. original field is mandatory, E-UTRAN is unaware if UE supports the extended version). In such cases, a UE supporting both versions may be required to ignore the original field. The following example illustrates the use of the critical extension mechanism by showing the ASN.1 of the original and of a later release.

```
-- /example/ ASN1START                    -- Original release

RRCMessage ::=                            SEQUENCE {
    rrc-TransactionIdentifier                 RRC-TransactionIdentifier,
    criticalExtensions                    CHOICE {
        c1                                    CHOICE{
            rrcMessage-r8                         RRCMessage-r8-IEs,
            spare3 NULL, spare2 NULL, spare1 NULL
        },
        criticalExtensionsFuture              SEQUENCE {}
    }
}

RRCMessage-rN-IEs ::= SEQUENCE {
    field1-rN                             ENUMERATED {
                                              value1, value2, value3, value4} OPTIONAL,   -- Need N
    field2-rN                             InformationElement2-rN              OPTIONAL,   -- Need N
    nonCriticalExtension                  RRCConnectionReconfiguration-vMxy-IEs   OPTIONAL
}
```

```
RRCConnectionReconfiguration-vMxy-IEs ::= SEQUENCE {
    field2-rM                           InformationElement2-rM          OPTIONAL, -- Cond NoField2rN
    nonCriticalExtension                SEQUENCE {}                     OPTIONAL
}

-- ASN1STOP
```

Conditional presence	Explanation
NoField2rN	The field is optionally present, need N, if field2-rN is absent. Otherwise the field is not present

Finally, it is noted that a critical extension may be introduced in the same release as the one in which the original field was introduced e.g. to correct an essential ASN.1 error. In such cases a UE capability may be introduced, to assist the network in deciding whether or not to use the critically extension.

A.4.3 Non-critical extension of messages

A.4.3.1 General principles

The mechanisms to extend a message in a non-critical manner are defined in A.3.3. W.r.t. the use of extension markers, the following additional guidelines apply:

- When further non-critical extensions are added to a message that has been critically extended, the inclusion of these non-critical extensions in earlier critical branches of the message should be avoided when possible.
- The extension marker ("...") is the primary non-critical extension mechanism that is used but empty sequences may be used if length determinant is not required. Examples of cases where a length determinant is not required:
    - at the end of a message;
    - at the end of a structure contained in a BIT STRING or OCTET STRING.
- When an extension marker is available, non-critical extensions are preferably placed at the location (e.g. the IE) where the concerned parameter belongs from a logical/ functional perspective (referred to as the '*default extension location*').
- It is desirable to aggregate extensions of the same release or version of the specification into a group, which should be placed at the lowest possible level.
- In specific cases it may be preferable to place extensions elsewhere (referred to as the '*actual extension location*') e.g. when it is possible to aggregate several extensions in a group. In such a case, the group should be placed at the lowest suitable level in the message. <TBD: ref to separate example>
- In case placement at the default extension location affects earlier critical branches of the message, locating the extension at a following higher level in the message should be considered.
- In case an extension is not placed at the default extension location, an IE should be defined. The IE's ASN.1 definition should be placed in the same ASN.1 section as the default extension location. In case there are intermediate levels in-between the actual and the default extension location, an IE may be defined for each level. Intermediate levels are primarily introduced for readability and overview. Hence intermediate levels need not always be introduced e.g. they may not be needed when the default and the actual extension location are within the same ASN.1 section. <TBD: ref to separate example>

A.4.3.2 Further guidelines

Further to the general principles defined in the previous section, the following additional guidelines apply regarding the use of extension markers:

- Extension markers within SEQUENCE:
  - Extension markers are primarily, but not exclusively, introduced at the higher nesting levels.
  - Extension markers are introduced for a SEQUENCE comprising several fields as well as for information elements whose extension would result in complex structures without it (e.g. re-introducing another list).
  - Extension markers are introduced to make it possible to maintain important information structures e.g. parameters relevant for one particular RAT.
  - Extension markers are also used for size critical messages (i.e. messages on BCCH, BR-BCCH, PCCH and CCCH), although introduced somewhat more carefully.
  - The extension fields introduced (or frozen) in a specific version of the specification are grouped together using double brackets.
- Extension markers within ENUMERATED:
  - Spare values may be used until the number of values reaches the next power of 2, while the extension marker caters for extension beyond that limit, given that the use of spare values in a later Release is possible without any error cases.
  - A suffix of the form "vXYZ" is used for the identifier of each new value, e.g. "value-vXYZ".
- Extension markers within CHOICE:
  - Extension markers are introduced when extension is foreseen and when comprehension is not required by the receiver i.e. behaviour is defined for the case where the receiver cannot comprehend the extended value (e.g. ignoring an optional CHOICE field). It should be noted that defining the behaviour of a receiver upon receiving a not comprehended choice value is not required if the sender is aware whether or not the receiver supports the extended value.
  - A suffix of the form "vXYZ" is used for the identifier of each new choice value, e.g. "choice-vXYZ".

Non-critical extensions at the end of a message/ of a field contained in an OCTET or BIT STRING:

- When a nonCriticalExtension is actually used, a "Need" code should not be provided for the field, which always is a group including at least one extension and a field facilitating further possible extensions. For simplicity, it is recommended not to provide a "Need" code when the field is not actually used either.

Further, more general, guidelines:

- In case a need code is not provided for a group, a "Need" code is provided for all individual extension fields within the group i.e. including for fields that are not marked as OPTIONAL. The latter is to clarify the action upon absence of the whole group.

A.4.3.3 Typical example of evolution of IE with local extensions

The following example illustrates the use of the extension marker for a number of elementary cases (sequence, enumerated, choice). The example also illustrates how the IE may be revised in case the critical extension mechanism is used.

NOTE In case there is a need to support further extensions of release n while the ASN.1 of release (n+1) has been frozen, without requiring the release n receiver to support decoding of release (n+1) extensions, more advanced mechanisms are needed e.g. including multiple extension markers.

```
-- /example/ ASN1START

InformationElement1 ::=             SEQUENCE {
    field1                              ENUMERATED {
                                            value1, value2, value3, value4-v880,
                                            ..., value5-v960 },
    field2                              CHOICE {
        field2a                             BOOLEAN,
        field2b                             InformationElement2b,
        ...,
        field2c-v960                        InformationElement2c-r9
    },
    ...,
    [[
    field3-r9                           InformationElement3-r9      OPTIONAL        -- Need R
    ]],
    [[
    field3-v9a0                         InformationElement3-v9a0    OPTIONAL,       -- Need R
    field4-r9                           InformationElement4         OPTIONAL        -- Need R
    ]]
}

InformationElement1-r10 ::=         SEQUENCE {
    field1                              ENUMERATED {
                                            value1, value2, value3, value4-v880,
                                            value5-v960, value6-v1170, spare2, spare1, ... },
    field2                              CHOICE {
        field2a                             BOOLEAN,
        field2b                             InformationElement2b,
        field2c-v960                        InformationElement2c-r9,
        ...,
        field2d-v12b0                       INTEGER (0..63)
    },
    field3-r9                           InformationElement3-r10         OPTIONAL,   -- Need R
    field4-r9                           InformationElement4             OPTIONAL,   -- Need R
    field5-r10                          BOOLEAN,
    field6-r10                          InformationElement6-r10         OPTIONAL,   -- Need R
    ...,
    [[
    field3-v1170                        InformationElement3-v1170       OPTIONAL    -- Need R
    ]]
}

-- ASN1STOP
```

Some remarks regarding the extensions of *InformationElement1* as shown in the above example:

- The *InformationElement1* is initially extended with a number of non-critical extensions. In release 10 however, a critical extension is introduced for the message using this IE. Consequently, a new version of the IE *InformationElement1* (i.e. *InformationElement1-r10*) is defined in which the earlier non-critical extensions are incorporated by means of a revision of the original field.

- The *value4-v880* is replacing a spare value defined in the original protocol version for *field1*. Likewise *value6-v1170* replaces *spare3* that was originally defined in the r10 version of *field1*.

- Within the critically extended release 10 version of *InformationElement1*, the names of the original fields/IEs are not changed, unless there is a real need to distinguish them from other fields/IEs. E.g. the *field1* and *InformationElement4* were defined in the original protocol version (release 8) and hence not tagged. Moreover, the *field3-r9* is introduced in release 9 and not re-tagged; although, the *InformationElement3* is also critically extended and therefore tagged *InformationElement3-r10* in the release 10 version of InformationElement1.

A.4.3.4 Typical examples of non critical extension at the end of a message

The following example illustrates the use of non-critical extensions at the end of the message or at the end of a field that is contained in a BIT or OCTET STRING i.e. when an empty sequence is used.

```
-- /example/ ASN1START

RRCMessage-r8-IEs ::=           SEQUENCE {
    field1                          InformationElement1,
    field2                          InformationElement2,
    field3                          InformationElement3                 OPTIONAL,   -- Need N
    nonCriticalExtension            RRCMessage-v860-IEs                 OPTIONAL
}

RRCMessage-v860-IEs ::=         SEQUENCE {
    field4-v860                     InformationElement4                 OPTIONAL,   -- Need S
    field5-v860                     BOOLEAN                             OPTIONAL,   -- Cond C54
    nonCriticalExtension            RRCMessage-v940-IEs                 OPTIONAL
}

RRCMessage-v940-IEs ::=         SEQUENCE {
    field6-v940                     InformationElement6-r9              OPTIONAL,   -- Need R
    nonCriticalExtensions           SEQUENCE {}                         OPTIONAL
}

-- ASN1STOP
```

Some remarks regarding the extensions shown in the above example:

- The *InformationElement4* is introduced in the original version of the protocol (release 8) and hence no suffix is used.

A.4.3.5 Examples of non-critical extensions not placed at the default extension location

The following example illustrates the use of non-critical extensions in case an extension is not placed at the default extension location.

– *ParentIE-WithEM*

The IE *ParentIE-WithEM*is an example of a high level IE including the extension marker (EM). The root encoding of this IE includes two lower level IEs *ChildIE1-WithoutEM* and *ChildIE2-WithoutEM* which not include the extension marker. Consequently, non-critical extensions of the Child-IEs have to be included at the level of the Parent-IE.

The example illustrates how the two extension IEs *ChildIE1-WithoutEM-vNx0* and *ChildIE2-WithoutEM-vNx0* (both in release N) are used to connect non-critical extensions with a default extension location in the lower level IEs to the actual extension location in this IE.

***ParentIE-WithEM* information element**

```
-- /example/ ASN1START

ParentIE-WithEM ::=                 SEQUENCE {
    -- Root encoding, including:
    childIE1-WithoutEM                  ChildIE1-WithoutEM              OPTIONAL,       -- Need N
    childIE2-WithoutEM                  ChildIE2-WithoutEM              OPTIONAL,       -- Need N
    ...,
    [[
    childIE1-WithoutEM-vNx0             ChildIE1-WithoutEM-vNx0     OPTIONAL,       -- Need N
    childIE2-WithoutEM-vNx0             ChildIE2-WithoutEM-vNx0     OPTIONAL        -- Need N
    ]]
}

-- ASN1STOP
```

Some remarks regarding the extensions shown in the above example:

– The fields *childIEx-WithoutEM-vNx0* may not really need to be optional (depends on what is defined at the next lower level).

– In general, especially when there are several nesting levels, fields should be marked as optional only when there is a clear reason.

– *ChildIE1-WithoutEM*

The IE *ChildIE1-WithoutEM* is an example of a lower level IE, used to control certain radio configurations including a configurable feature which can be setup or released using the local IE *ChIE1-ConfigurableFeature*. The example illustrates how the new field *chIE1-NewField* is added in release N to the configuration of the configurable feature. The example is based on the following assumptions:

– When initially configuring as well as when modifying the new field, the original fields of the configurable feature have to be provided also i.e. as if the extended ones were present within the setup branch of this feature.

– When the configurable feature is released, the new field should be released also.

– When omitting the original fields of the configurable feature the UE continues using the existing values (which is used to optimise the signalling for features that typically continue unchanged upon handover).

– When omitting the new field of the configurable feature the UE releases the existing values and discontinues the associated functionality (which may be used to support release of unsupported functionality upon handover to an eNB supporting an earlier protocol version).

The above assumptions, which affect the use of conditions and need codes, may not always apply. Hence, the example should not be re-used blindly.

ChildIE1-WithoutEM information elements

```
-- /example/ ASN1START

ChildIE1-WithoutEM ::=              SEQUENCE {
    -- Root encoding, including:
    chIE1-ConfigurableFeature           ChIE1-ConfigurableFeature       OPTIONAL        -- Need N
}

ChildIE1-WithoutEM-vNx0 ::=     SEQUENCE {
    chIE1-ConfigurableFeature-vNx0      ChIE1-ConfigurableFeature-vNx0  OPTIONAL    -- Cond ConfigF
}

ChIE1-ConfigurableFeature ::=       CHOICE {
    release                             NULL,
    setup                               SEQUENCE {
        -- Root encoding
    }
}

ChIE1-ConfigurableFeature-vNx0 ::=  SEQUENCE {
    chIE1-NewField-rN                   INTEGER (0..31)
}

-- ASN1STOP
```

Conditional presence	Explanation
ConfigF	The field is optional present, need R, in case of chIE1-ConfigurableFeature is included and set to "setup"; otherwise the field is not present and the UE shall delete any existing value for this field.

– *ChildIE2-WithoutEM*

The IE *ChildIE2-WithoutEM* is an example of a lower level IE, typically used to control certain radio configurations. The example illustrates how the new field *chIE1-NewField* is added in release N to the configuration of the configurable feature.

ChildIE2-WithoutEM information element

```
-- /example/ ASN1START

ChildIE2-WithoutEM ::=              CHOICE {
    release                             NULL,
    setup                               SEQUENCE {
        -- Root encoding
    }
}

ChildIE2-WithoutEM-vNx0 ::=         SEQUENCE {
```

```
    chIE2-NewField-rN                    INTEGER (0..31)                 OPTIONAL    -- Cond ConfigF
}

-- ASN1STOP
```

Conditional presence	Explanation
ConfigF	The field is optional present, need R, in case of chIE2-ConfigurableFeature is included and set to "setup"; otherwise the field is not present and the UE shall delete any existing value for this field.

A.5 Guidelines regarding inclusion of transaction identifiers in RRC messages

The following rules provide guidance on which messages should include a Transaction identifier

1: DL messages on CCCH that move UE to RRC-Idle should not include the RRC transaction identifier.

2: All network initiated DL messages by default should include the RRC transaction identifier.

3: All UL messages that are direct response to a DL message with an RRC Transaction identifier should include the RRC Transaction identifier.

4: All UL messages that require a direct DL response message should include an RRC transaction identifier.

5: All UL messages that are not in response to a DL message nor require a corresponding response from the network should not include the RRC Transaction identifier.

A.6 Guidelines regarding use of need codes

The following rule provides guidance for determining need codes for optional downlink fields:

- if the field needs to be stored by the UE (i.e. maintained) when absent:
    - use Need M (=Maintain);
- else, if the field needs to be released by the UE when absent:
    - use Need R (=Release);
- else, if UE shall take no action when the field is absent (i.e. UE does not even need to maintain any existing value of the field):
    - use Need N (=None);
- else (UE behaviour upon absence does not fit any of the above conditions):
    - use Need S (=Specified);

- specify the UE behaviour upon absence of the field in the procedural text or in the field description table.

A.7 Guidelines regarding use of conditions

Conditions are primarily used to specify network restrictions, for which the following types can be distinguished:

- CondM: Message Contents related constraints e.g. that a field B is mandatory present if the same message includes field A and when it is set value X.
- CondC: Configuration Constraints e.g. that a field D can only be signalled if field C is configured and set to value Y. (i.e. regardless of whether field C is present in the same message or previously configured).

The use of these conditions is illustrated by an example.

```
-- /example/ ASN1START

RRCMessage-IEs ::= SEQUENCE {
    fieldA                          FieldA                  OPTIONAL,   -- Need M
    fieldB                          FieldB                  OPTIONAL,   -- CondM-FieldAsetToX
    fieldC                          FieldC                  OPTIONAL,   -- Need M
    fieldD                          FieldD                  OPTIONAL,   -- CondC-FieldCsetToY
    nonCriticalExtension            SEQUENCE {}             OPTIONAL
}

-- /example/ ASN1STOP
```

Conditional presence	Explanation
Message (content) constraints	
CondM-FieldAsetToX	The field is mandatory present if fieldA is included and set to valueX. Otherwise the field is optional present, need R.
Configuration constraints	
CondC- FieldCsetToY	The field is optional present, need M, if fieldC is configured and set to valueY. Otherwise the field is not present and the UE does not maintain the value

Annex B (informative): RRC Information

B.1 Protection of RRC messages (informative)

The following list provides information which messages can be sent (unprotected) prior to security activation and which messages can be sent unprotected after security activation. Those messages indicated "-" in "P" column should never be sent unprotected by gNB or UE. Further requirements are defined in the procedural text.

P…Messages that can be sent (unprotected) prior to security activation

A - I…Messages that can be sent without integrity protection after security activation

A - C…Messages that can be sent unciphered after security activation

NA… Message can never be sent after security activation

Message	P	A-I	A-C	Comment
DLInformationTransfer	+	-	-	
LocationMeasurementIndication	-	-	-	
MIB	+	+	+	
MeasurementReport	-	-	-	Measurement configuration may be sent prior to security activation. But: In order to protect privacy of UEs, MeasurementReport is only sent from the UE after successful security activation.
Paging	+	+	+	
RRCReconfiguration	+	-	-	The message shall not be sent unprotected before security activation if it is used to perform handover or to establish SRB2 and DRBs
RRCReconfigurationComplete	+	-	-	Unprotected, if sent as response to *RRCReconfiguration* which was sent before security activation
RRCReestablishment	-	-	+	Integrity protection applied, but no ciphering.
RRCReestablishmentComplete	-	-	-	
RRCReestablishmentRequest	-	-	+	This message is not protected by PDCP operation. However, a short MAC-I is included.
RRCReject	+	+	+	Justification for A-I and A-C: the message can be sent in SRB0 in RRC_INACTIVE state, after the security is activated.
RRCRelease	+	-	-	Justification for P: If the RRC connection only for signalling not requiring DRBs or ciphered messages, or the signalling connection has to be released prematurely, this message is sent as unprotected. *RRCRelease* message sent before security activation cannot include *deprioritisationReq, suspendConfig, redirectedCarrierInfo, cellReselectionPriorities* information fields
RRCRequest	+	NA	NA	
RRCResume	-	-	-	
RRCResumeRequest	-	-	+	This message is not protected by PDCP operation. However, a resumeMAC-I is included.
RRCResumeRequest1	-	-	+	This message is not protected by PDCP operation. However, a resumeMAC-I is included.
RRCResumeComplete	-	-	-	
RRCSetup	+	+	+	Justification for A-I and A-C: the message can be sent in SRB0 in RRC_INACTIVE state, after the security is activated.
RRCSetupComplete	+	NA	NA	
RRCSystemInfoRequest	+	+	+	Justification for A-I and A-C: the message can be sent in SRB0 in RRC_INACTIVE state, after the security is activated.
SecurityModeCommand	+	NA	NA	Integrity protection applied, but no ciphering (integrity verification done after the message received by RRC)
SecurityModeComplete	-	-	+	The message is sent after security activation. Integrity protection applied, but no ciphering. Ciphering is applied after completing the procedure.
SecurityModeFailure	+	NA	NA	Neither integrity protection nor ciphering applied.
SystemInformation	+	+	+	
SIB1	+	+	+	
UECapabilityEnquiry	+	-	-	
UECapabilityInformation	+	-	-	
ULInformationTransfer	+	-	-	

Annex C (informative): Change history

Change history							
Date	**Meeting**	**TDoc**	**CR**	**Rev**	**Cat**	**Subject/Comment**	**New version**
04/2017	RAN2#97bis	R2-1703395					0.0.1
04/2017	RAN2#97bis	R2-1703922					0.0.2
05/2017	RAN2#98	R2-1705815					0.0.3
06/2017	RAN2#NR2	R2-1707187					0.0.4
08/2017	RAN2#99	R2-1708468					0.0.5
09/2017	RAN2#99bis	R2-1710557					0.1.0
11/2017	RAN2#100	R2-1713629					0.2.0
11/2017	RAN2#100	R2-1714126					0.3.0
12/2017	RAN2#100	R2-1714259					0.4.0
12/2017	RP#78	RP-172570				Submitted for Approval in RAN#78	1.0.0
12/2017	RP#78					Upgraded to Rel-15 (MCC)	15.0.0
03/2018	RP#79	RP-180479	0008	1	F	Corrections for EN-DC (Note: the clause numbering between 15.0.0 and 15.1.0 has changed in some cases).	15.1.0
06/2018	RP-80	RP-181326	0042	7	F	Miscellaneous EN-DC corrections	15.2.0
	RP-80					Correction: Duplicate Foreword section removed & ASN.1 sections touched up	15.2.1
09/2018	RP-81	RP-181942	0100	4	F	Introduction of SA	15.3.0
12/2018	RP-82	RP-182656	0179	3	F	Handling of Resume Failure	15.4.0
	RP-82	RP-182651	0187	1	F	Clarification on the presence of ra-ResponseWindow	15.4.0
	RP-82	RP-182656	0188	3	F	Addition of RAN specific Access Category	15.4.0
	RP-82	RP-182653	0199	2	F	CR for TS38.331 on MIB	15.4.0
	RP-82	RP-182653	0200	1	F	CR for TS38.331 on PDCCH-ConfigSIB	15.4.0
	RP-82	RP-182661	0202	2	F	Handling Cell Reselection during SI Request	15.4.0
	RP-82	RP-182649	0213	2	F	Corrections on security field descriptions	15.4.0
	RP-82	RP-182649	0216	2	F	Remain issue for T302	15.4.0
	RP-82	RP-182649	0219	1	F	[C204] Handling of timer T380	15.4.0
	RP-82	RP-182655	0229	2	F	Clarification on configured grant timer in 38.331	15.4.0
	RP-82	RP-182663	0232	2	F	CR for ServingCellConfigCommon in 38.331	15.4.0
	RP-82	RP-182659	0234	3	F	Introduction of cell level rate matching parameters in ServingCellConfig	15.4.0
	RP-82	RP-182650	0235	2	F	CR for introducing PSCell frequency in CG-Config	15.4.0
	RP-82	RP-182650	0236	2	F	CR for security handling for eLTE in 38.331	15.4.0
	RP-82	RP-182650	0237	1	F	Handling on simultaneously triggered NAS&AS events (I770)	15.4.0
	RP-82	RP-182650	0238	2	F	Handling on security keys for resume procedure (I774)	15.4.0
	RP-82	RP-182664	0239	5	F	RIL I556, I557, I558 on RB handling when resuming	15.4.0
	RP-82	RP-182650	0242	2	F	Security for RRC connection release	15.4.0
	RP-82	RP-182650	0243	4	F	Corrections on reestablishment and security procedures	15.4.0

	RP-82	RP-182650	0244	1	F	RIL I118 on release case to upper layers for CN paging for a UE in RRC_INACTIVE	15.4.0
	RP-82	RP-182650	0246	2	F	CR on SI request procedure in TS38.331	15.4.0
	RP-82	RP-182650	0248	2	F	CR to 38331 on ul-DataSplitThreshold for SRB	15.4.0
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