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Technical Specification

3rd Generation Partnership Project;
Technical Specification Group Radio Access Network;
NR;
Radio Resource Control (RRC) protocol specification
(Release 15)

3GPP

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Contents

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".

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].

Field: The individual contents of an information element are referred 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 a 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.

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.

SRB1S: The SCG part of MCG split SRB1 for EN-DC.

SRB2S: The SCG part of MCG split SRB2 for EN-DC.

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
EPC	Evolved Packet Core
EPS	Evolved Packet System
ETWS	Earthquake and Tsunami Warning System
E-UTRA	Evolved Universal Terrestrial Radio Access
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
PCell	Primary Cell
PDCP	Packet Data Convergence Protocol
PDU	Protocol Data Unit
PLMN	Public Land Mobile Network
PSCell	Primary Secondary Cell
QoS	Quality of Service
RAN	Radio Access Network
RAT	Radio Access Technology
RLC	Radio Link Control
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

Editor's note The state model is still a subject for discussion.FFS

4.2.1 UE states and state transitions including inter RAT

Editor's Note: For EN_DC, only RRC_CONNECTED is applicable.

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 a Paging channel;
    - Performs neighbouring cell measurements and cell (re-)selection;

  - Acquires system information.
- **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 AS context;
  - The UE:
    - Monitors a Paging channel;
    - Performs neighbouring cell measurements and cell (re-)selection;
    - Performs RAN-based notification area updates when moving outside the RAN-based notification area;

Editor's Note: FFS Whether a RAN-based notification area is always configured or not.

Editor's Note: FFS UE behavior if it is decided that a RAN-based notification area is not always configured.

    - Acquires system information.
- **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-UTRAN;
  - The UE:
    - Monitors a Paging channel;
    - 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.

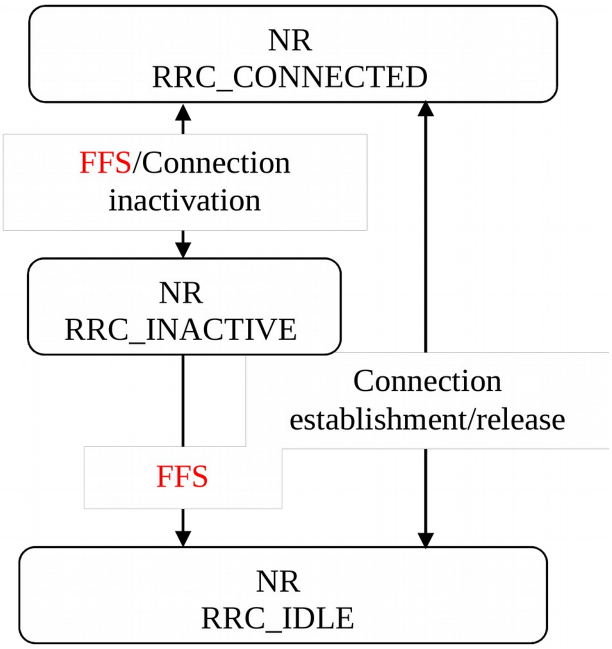

Figure 4.2.1-1: UE state machine and state transitions in NR

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/NGC and E-UTRAN/EPC.

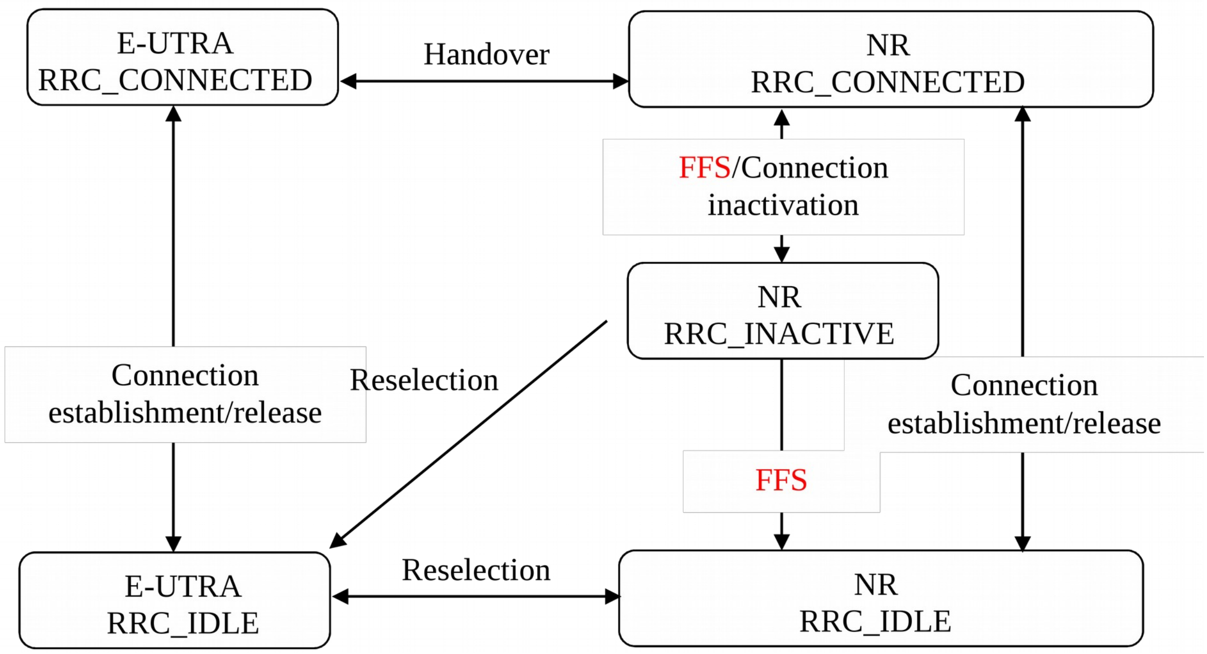

Figure 4.2.1-2: UE state machine and state transitions between NR/NGC and E-UTRAN/EPC

The UE state machine, state transition and mobility procedures between NR/NGC and E-UTRA/NGC is FFS.

4.2.2 Signalling radio bearers

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 [FFS, for ETWS, for 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:

- PDCP: integrity protection, ciphering and in-sequence delivery of information without duplication [FFS if duplication need to be listed];
- RLC: reliable transfer of information, without introducing duplicates and with support for segmentation.

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;
  - [FFS 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), establishment/modification/release of SRBs, access class barring;

Editor's Note: The terminology for establishment/modification/suspension/resumption is FFS.

  - Initial security activation, i.e. initial configuration of AS integrity protection (SRBs) 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/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);
  - 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 measurements (e.g. intra-frequency, inter-frequency and inter- RAT measurements);
  - Setup and release of measurement gaps;
  - Measurement reporting.
- Other functions including e.g. transfer of dedicated NAS information, transfer of UE radio access capability information [FFS support for RAN sharing (multiple PLMN identities)].

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.

5.2 System information

Editor's Note: Targeted for completion in September2018. For EN_DC, only parts related to MIB acquisition, in sub-clauses 5.2.2.3.1 and 5.2.2.4.1, are applicable.

5.2.1 Introduction

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

- the *MasterInformationBlock* (MIB) is always transmitted on the BCH with a periodicity of 80 ms and repetitions made within 80 ms [38.212, Section 7.1] and it includes parameters that are needed to acquire *SystemInformationBlockType1* (SIB1) from the cell;
- the *SystemInformationBlockType1* (SIB1) is transmitted on the DL-SCH with a periodicity of [X] and repetitions made within [X]. SIB1 includes information regarding the availability and scheduling (e.g. periodicity, SI-window size) of other SIBs. It also indicates whether they (i.e. other SIBs) are provided via periodic broadcast basis or only on-demand basis (refer Figure 5.2.2.X.X FFS_Ref). If other SIBs are provided on-demand then SIB1 includes information for the UE to perform SI request;
- SIBs other than *SystemInformationBlockType1* are carried in *SystemInformation* (SI) messages, which are transmitted on the DL-SCH. Each SI message is transmitted within periodically occurring time domain windows (referred to as SI-windows);
- For PSCell and SCells, RAN provides the required SI by dedicated signalling. 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.

Editor's Note: Reference to RAN1 specification may be used for the MIB/SIB1 periodicities [X].FFS

5.2.2 System information acquisition

5.2.2.1 General UE requirements

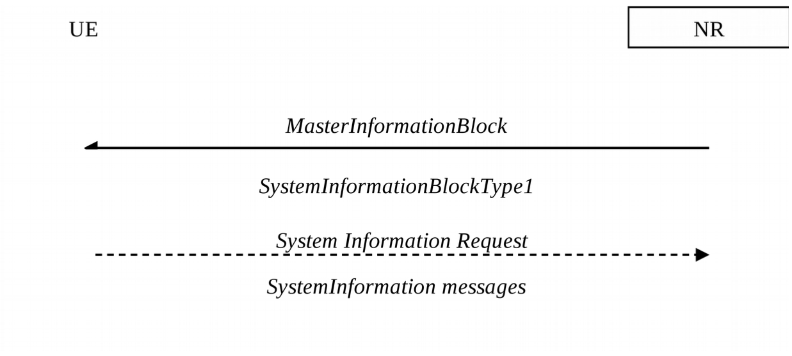

Figure 5.2.2.1-1: System information acquisition

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 *MasterInformationBlock*, *SystemInformationBlockType1* as well as *SystemInformationBlockTypeX* through *SystemInformationBlockTypeY* (depending on support of the concerned RATs for UE controlled mobility).

The UE in RRC_CONNECTED shall ensure having a valid version of (at least) the *MasterInformationBlock*, *SystemInformationBlockType1* as well as *SystemInformationBlockTypeX* (depending on support of mobility towards the concerned RATs).

The UE shall store relevant SI acquired from the currently camped/serving cell. A version of the SI that the UE acquires and stores remains valid only for a certain time. The UE may use such a stored version of the SI e.g. after cell re-selection, upon return from out of coverage or after SI change indication.

Editor's Note: [FFS_Standalone if the UE is required to store SI other than for the currently camped/serving cell].

Editor's Note: [FFS_Standalone if different versions of SIBs are provided].

Editor's Note: [FFS_Standalone UE may or shall store several versions of SI].

Editor's Note: FFS_Standalone To be updated when above is resolved. Another sub-clause under 5.2.2.2 can be considered depending on the resolution of above.

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

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 RAN from another RAT; whenever the UE does not have a valid version in the stored SI.

Editor's Note: [FFS_Standalone if upon receiving HO command the SI acquisition depend on stored SI]

When the UE acquires a *MasterInformationBlock* or a *SystemInformationBlockType1* or a SI message in a currently camped/serving cell as described in clause 5.2.2.3, the UE shall store the acquired SI.

5.2.2.2.1 SI validity

The UE shall:

1> delete any stored version of SI after [FFS] hours from the moment it was successfully confirmed as valid;

1> if the UE does not have in the stored SI a valid version for the required SI corresponding to the *systemInfoAreaIdentifier* and *systemInfoValueTag*/*systemInfoConfigurationIndex* of that SI in the currently camped/serving cell:

2> (re)acquire the SI as specified in clause 5.2.2.3.

NOTE: At the SI acquisition procedure, the UE may assume the acquired SI in the currently camped/serving cell to be valid in other cells than the currently camped/serving cell based on *systemInfoAreaIdentifier* and *systemInfoValueTag*/*systemInfoConfigurationIndex*.

Editor's Note: [FFS_Standalone terminology to be used is systemInfoValueTag or systemInfoConfigurationIndex]

Editor's Note: [FFS_Standalone terminology to be used for area ID is systemInfoAreaIdentifier]

Editor's Note: [FFS_Standalone whether the area ID and valuetag is separately signalled or as a single identifier]

Editor's Note: [FFS_Standalone whether the area ID is associated to each SIB/SI message or associated to a group of SIBs/SI messages or all SIBs/SI messages]

5.2.2.2.2 SI change indication and PWS notification

A modification period is used, i.e. updated SI is provided in the modification period following the one where SI change indication is transmitted. RAN transmits SI change indication and PWS notification through paging. Repetitions of SI change indication may occur within preceding modification period.

Editor's Note : The above descriptive text can remain in this sub-clause or moved under 5.2.1. FFS_Standalone

If the UE is in RRC_CONNECTED or is configured to use a DRX cycle smaller than the modification period in RRC_IDLE or in RRC_INACTIVE and receives a Paging message:

1> if the received Paging message includes the *etws*/*cmasNotification*;

2> the UE shall immediately re-acquire the SIB1 and apply the SI acquisition procedure as defined in sub-clause [X.X.X.X FFS_Ref];

1> else, if the received Paging message includes the *systemInfoModification*;

2> the UE shall apply the SI acquisition procedure as defined in sub-clause [X.X.X.X FFS_Ref] from the start of the next modification period.

NOTE For PWS notification the SIB1 is re-acquired to know the scheduling information for the PWS messages.

Editor's Note: [FFS_Standalone if upon receiving a SI change indication the SI acquisition depend on stored SI]

Editor's Note: [FFS_Standalone if value tags and area identifier included in paging message to reacquire SIB1]

Editor's Note: [FFS_Standalone the update mechanism for access control notifications and other non-access control configuration updates]

Editor's Note: [FFS_StandaloneWhether to make a generic bit to indicate immediate acquisition of SI will be considered after AC discussion has progressed]

Editor's Note: [FFS_Standalone terminology to be used for PWS Notification]

5.2.2.3 Acquisition of System Information

5.2.2.3.1 Acquisition of *MIB* and *SIB1*

The UE shall:

1> if the cell is a PSCell:

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

2> perform the actions specified in section 5.2.2.4.1;

1> else:

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> follow the actions as specified in clause 5.2.2.5;

2> else:

3> perform the actions specified in section 5.2.2.4.1.

2> acquire the SystemInformationBlockType1 as specified in [X];

2> if the UE is unable to acquire the SystemInformationBlockType1:

3> follow the actions as specified in clause 5.2.2.5;

2> else:

3>perform the actions specified in section 5.2.2.4.2.

Editor's Note: Reference to RAN1 [X] specification may be used for the scheduling of SIB1.FFS_Standalone

5.2.2.3.2 Acquisition of an SI message

When acquiring an SI message, the UE shall:

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

Editor's Note: [FFS_Standalone the details of the mapping to subframes/slots where the SI messages are scheduled]

Editor's Note: [FFS_Standalone if there are any exceptions on e.g. subframes where SI messages cannot be transmitted]

Editor's Note: [FFS_Standalone if the SI-windows of different SI messages do not overlap].

Editor's Note: [FFS_Standalone if multiple SI messages can be mapped to same SI window]

Editor's Note: [FFS_Standalone if the length of SI-window is common for all SI messages or if it is configured per SI message]

Editor's Note: [FFS_Standalone if the UE may accumulate the SI-Message transmissions across several SI-Windows within the Modification Period]

1> if SI message acquisition not triggered due to UE request:

2> receive DL-SCH using the SI-RNTI 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;

2> 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;

1> if SI message acquisition triggered due to UE request:

2> [FFS_Standalone receive DL-SCH using the SI-RNTI 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];

2> [FFS_Standalone 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];

Editor's Note: [FFS_Standalone on the details of from which SI-window the UE shall receive the DL-SCH upon triggering the SI request.

Editor's Note: [FFS_Standalone on the details of how many SI-windows the UE should monitor for SI message reception if transmission triggered by UE request]

Editor's Note: [FFS_Standalone if UE need to monitor all the TTIs in SI window for receiving SI message]

1> store the acquired SI message as specified in clause 5.2.2.2.

Editor's Note: FFS_Standalone The procedural text for SI message acquisition triggered by UE request will be updated upon finalizing the details.

5.2.2.3.3 Request for on demand system information

When acquiring an SI message, which according to the SystemInformationBlockType1 is indicated to be provided upon UE request, the UE shall:

1> if in RRC_IDLE or in RRC_INACTIVE:

2> if the [FFS_Standalone] field is received in *SIB1*:

3> the UE shall trigger the lower layer to initiate the preamble transmission procedure in accordance with TS 38.321 [3] using the [indicated PRACH preamble] and [indicated PRACH resource];

3> if acknowledgement for SI request is received from lower layer;

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

Editor's Note: To be updated with details of the Msg1 request procedure.FFS_Standalone

2> else

3> the UE shall trigger the lower layer to initiate the random access procedure in accordance with TS 38.321 [3];

3> if acknowledgement for SI request is received;

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

Editor's Note: To be updated with details of the Msg3 request procedure. FFS_Standalone

1> else (in RRC_CONNECTED):

2> [details FFS_Standalone].

Editor's Note: To be updated with details of the on-demand request procedure in RRC_CONNECTED. FFS_Standalone

Editor's Note: [FFS_Standalone if there is a need for a separate sub-clause to describe case where on demand SI is not successfully received by the UE and where it should initiate a new request]

5.2.2.4 Actions upon receipt of SI message

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 if the UE is in RRC_INACTIVE or if the UE is in RRC_CONNECTED while *T311* is running: [FFS]

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

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

2> else,

3> apply the received parameter(s) [FFS] to acquire *SIB1*.

5.2.2.4.2 Actions upon reception of the SystemInformationBlockType1

Upon receiving the SystemInformationBlockType1 the UE shall:

1> store the acquired *SIB1*;

1> if the UE has a stored valid version of the required SIB(s) associated with the *systemInfoAreaIdentifier* and *systemInfoValueTag*/*systemInfoConfigurationIndex* in the acquired *SIB1*:

2> use that stored version of the SIB;

1> else if the *SIB1* message indicates that the SI message(s) is only provided on request:

2> trigger a request to acquire the SI message(s) (if needed) as defined in sub-clause 5.2.2.3;

1> else:

2> acquire the SI message(s) (if needed) as defined in sub-clause 5.2.2.3.2, which are provided according to the schedulingInfoList in the SystemInformationBlockType1.

Editor's Note: [FFS_Standalone Whether there is an additional indication that an on-demand SI is actually being broadcast at this instant in time]

Editor's Note: To be updated when content of the SystemInformationBlockType1 has been agreed. FFS_Standalone.

Editor's Note: To be updated how to capture the UE behaviour when some required SIBs are from broadcast and other required SIBs through SI request.

5.2.2.4.3 Actions upon reception of SystemInformationBlockTypeX

Editor's Note: To be extended with further sub-clauses as more SIBs are defined. FFS_Standalone

5.2.2.5 Essential system information missing

The UE shall:

1> if in RRC_IDLE or in RRC_INACTIVE:

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

2> if the UE is unable to acquire the *SIB1* and UE does not have a stored valid version of SIB1; or

2> [FFS_Standalone if the UE is unable to acquire the [FFS essential SystemInformationBlockTypeX] and UE does not have a stored valid version of SystemInformationBlockTypeX];

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

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

Editor's Note: [FFS_Standalone on details of RRC connection re-establishment procedure and corresponding reading of SI in RRC_CONNECTED].

Editor's Note: [FFS_Standalone whether all the information needed to access the cell is included in SIB1 or if both SIB1 and SIB2 are essential in NR].

5.3 Connection control

Editor's note: FFS The structure and content of this subclause is a subject for discussion, e.g. potential merging of connection establishment and re-establishment messages, mobility aspects etc.

5.3.1 Introduction

5.3.2 Paging

Editor's Note: Targeted for completion in Sept 2018.

5.3.3 RRC connection establishment

Editor's Note: Targeted for completion in Sept 2018.

5.3.4 Initial security activation

Editor's Note: Targeted for completion in Sept 2018.

5.3.5 RRC reconfiguration

5.3.5.1 General

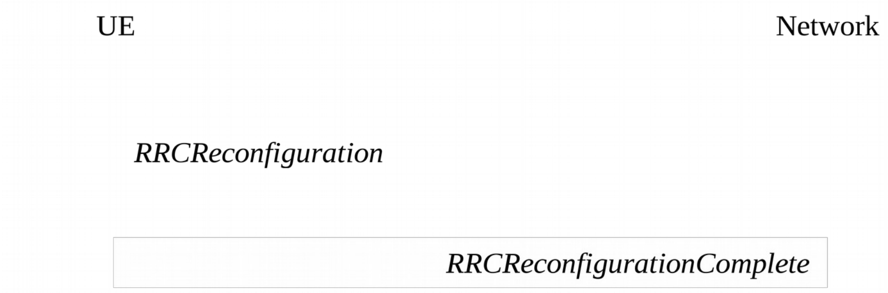

Figure 5.3.5.1-1: RRC reconfiguration, successful

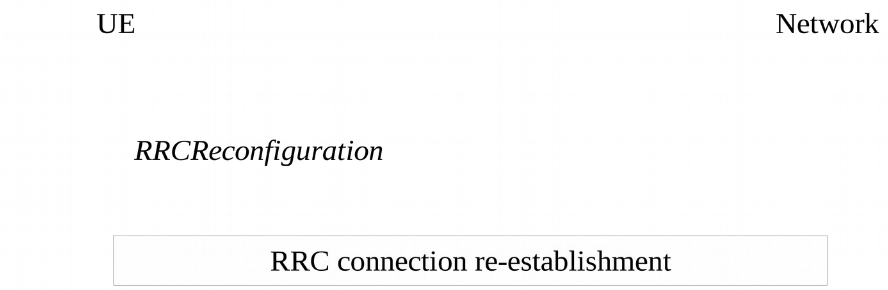

Figure 5.3.5.1-2: RRC reconfiguration, failure

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 reportingto (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-KgNB 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.

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 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 UE is configured with E-UTRA *nr-SecondaryCellGroupConfig* (MCG is E-UTRA):

2> if *RRCReconfiguration* was received via SRB1:

3> construct *RRCReconfigurationComplete* message and submit it via the EUTRA 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: In the case of SRB1, the random access is triggered by RRC layer itself as there is not necessarily other UL transmission. In the case of SRB3, the random access is triggered by the MAC layer due to arrival of *RRCReconfigurationComplete*.

1> if *reconfigurationWithSync* was included in *spCellConfig* of an 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> the procedure ends.

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 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 s*CellToReleaseLis*t:

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> 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 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 frequency of the source SpCell with a physical cell identity indicated by the *physCellId*;

1> start synchronising to the DL of the target SpCell and acquire the *MIB* of the target SpCell as specified in 5.2.2.3.1;

NOTE: 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.

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

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

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 (includes discarding all pending RLC PDUs and RLC SDUs);

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 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:

NOTE: In EN-DC, *rlf-TimersAndConstants* cannot be released.

Editor's Note: Standalone part to be complete by Sept 2018.

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

2> release the value of timer *t310* as well as constants *n310* and *n311* for this cell group;

1> else:

2> reconfigure 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> if the *SpCellConfig* contains *spCellConfigDedicated*:

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

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* and set to true:

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.

5.3.5.6.2 SRB release

The UE shall:

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

2> if the current UE configuration as configured by E-UTRA in TS 36.331 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 reestablishPDCP is set:

3> configure the PDCP entity to apply the integrity protection algorithm and K_{RRCint} key associated with the K_{eNB}/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;

3> configure the PDCP entity to apply the ciphering algorithm and K_{RRCenc} key associated with the K_{eNB}/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;

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

2> else, if *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 (DRB release):

2> release the PDCP entity;

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

2> if the procedure was triggered due to reconfiguration with sync:

3> indicate the release of the DRB and the *eps-BearerIdentity* of the released DRB to upper layers after successful reconfiguration with sync;

2> else:

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

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> configure the PDCP entity with the security algorithms according to *securityConfig* and apply the keys (K_{UPenc}) associated with the K_{eNB}/S-K_{gNB} as indicated in *keyToUse*;

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

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

2> else:

3> 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 reestablishPDCP is set:

3> configure the PDCP entity of this *RadioBearerConfig* to apply the ciphering algorithm and K_{UPenc} key associated with the KeNB/S-KgNB as indicated in *keyToUse*, i.e. the ciphering configuration shall be applied to all subsequent PDCP PDUs received and sent by the UE;

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

2> else, if *recoverPDCP* is set:

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

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

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

NOTE 1: Removal and addition of the same *drb-Identity* in a single *radioResourceConfig* is not supported. In case *drb-Identity* is removed and added due to reconfiguration with sync or re-establishment with the full configuration option, the network can use the same value of *drb-Identity*.

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 (KeNB to S-KeNB 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.

5.3.5.7 Security key update

Upon reception of *sk-Counter* as specified in TS 36.331 [10] the UE shall:

1> update the S-K_{gNB} key based on the K_{eNB} key and using the received *sk-Counter* value, as specified in TS 33.501 [11];

1> derive K_{RRCenc} and K_{UPenc} key as specified in TS 33.501 [11];

1> derive the K_{RRCint} and K_{UPint} key as specified in TS 33.501 [11].

5.3.5.8 Reconfiguration failure

5.3.5.8.1 Integrity check failure

Editor's Note: Removed "SIB3" from heading so that this sub-section can easily be expanded to stand-alone case (if considered necessary). FFS_Standalone

The UE shall:

1> upon integrity check failure indication from NR lower layers for SRB3:

2> initiate the SCG failure information procedure as specified in subclause 5.7.3 to report SRB3 integrity check failure.

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 MCG 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, 5.3.7], upon which the connection reconfiguration procedure ends.

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 a secondary cell group expires:

2> release rach-ContentionFree;

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.

5.3.5.9 Other configuration

Editor's Note: Targeted for completion in Sept 2018.

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 section 5.3.5.4.

5.3.6 Counter check

FFS

5.3.7 RRC connection re-establishment

Editor's Note: Targeted for completion in Sept 2018.

5.3.8 RRC connection release

Editor's Note: Targeted for completion in Sept 2018.

5.3.9 RRC connection release requested by upper layers

Editor's Note: Targeted for completion in Sept 2018.

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 T311 is not running:

2> start timer T310 for the corresponding SpCell.

Editor's Note: FFS: Under which condition physical layer problems detection is performed, e.g. neither T300, T301, T304 nor T311 is running. It's subject to the harmonization of the RRC procedures for RRC Connection establishment/resume/re-establishment and RRC connection reconfiguration.

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 T311 is not running; or

Editor's Note: FFS: Under which condition physical layer problems detection is performed, e.g. neither T300, T301, T304 nor T311 is running. It's subject to the harmonization of the RRC procedures for RRC Connection establishment/resume/re-establishment and RRC connection reconfiguration.

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

Editor's Note: FFS whether maximum ARQ retransmission is only criteria for RLC failure.

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

Editor's Note: FFS Whether indications related to beam failure recovery may affect the declaration of RLF.

Editor's Note: FFS: How to handle RLC failure in CA duplication for MCG DRB and SRB.

Editor's Note: FFS: RLF related measurement reports e.g. *VarRLF-Report* is supported in NR.

2> if AS security has not been activated:

3> perform the actions upon leaving RRC_CONNECTED as specified in x.x.x FFS_Ref, with release cause 'other';

2> else:

3> initiate the connection re-establishment procedure as specified in x.x.x FFS_Ref.

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

Editor's Note: FFS: How to handle RLC failure in CA duplication for SCG DRB and SRB.

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

5.3.11 UE actions upon leaving RRC_CONNECTED

Editor's Note: Targeted for completion in Sept 2018.

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 c1onfigured 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*.

5.4 Inter-RAT mobility

Editor's Note: Targeted for completion in Sept 2018.

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 EUTRA 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 of that measurement type. 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, i.e. no (UL, DL) transmissions are scheduled.

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 intra-frequency object(s), NR inter-frequency 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.

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.

Editor's Note: FFS How the procedure is used for CGI reporting.

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 *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 if 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 and reset the associated information (e.g. *timeToTrigger*) 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 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, whiteCellsToRemoveList, absThreshSS-BlocksConsolidation,absThreshCSI-RS-Consolidation, nrofSS-BlocksToAverage,nroCSI-RS-ResourcesToAverage;

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 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 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 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*.

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 and reset the associated information (e.g. *timeToTrigger*) for this *measId*.

5.5.2.9 Measurement gap configuration

The UE shall:

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

2> if *gapFR2* is set to setup:

3> if an FR2 measurement gap configuration is already setup, release the FR2 measurement gap configuration;

3> 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 and subframe of SCG cells on FR2):

SFN mod *T* = FLOOR(*gapOffset*/10);

subframe = *gapOffset* mod 10;

with *T* = MGRP/10 as defined in TS 38.133 [x];

3> if *mgta* is configured, apply the specified timing advance to the gap occurences calculated above (i.e. the UE starts the measurement *mgta* ms before the gap subframe occurences);

2> else if *gapFR2* is set to release:

3> release the FR2 measurement gap configuration.

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)) mod *T*;

if the *Periodicity* is larger than sf5:

subframe = *Offset* mod 10;

else:

subframe = *Offset* or (*Offset* +5);

with *T* = *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 measurements including RRM measurements.

5.5.2.11 Measurement gap sharing configuration

The UE shall:

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

2> if *gapSharingFR2* is set to setup:

3> if an FR2 measurement gap sharing configuration is already setup, release the measurement gap sharing configuration;

3> setup the FR2 measurement gap sharing configuration indicated by the *measGapSharingConfig* in accordance with the received *measGapSharingScheme* as defined in TS 38.133 [14];

2> else:

3> release the FR2 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 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 reportQuantityRsIndexes and maxNrofRSIndexesToReport:

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 reportQuantityRsIndexes and maxNrofRSIndexesToReport:

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 reportQuantityRsIndexes and maxNrofRSIndexesToReport:

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 reportQuantityRsIndexes and maxNrofRSIndexesToReport:

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 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 reportQuantityRsIndexes and maxNrofRSIndexesToReport for the associated reportConfig are configured:

7> derive layer 3 filtered beam measurements only based on CSI-RS for each measurement quantity indicated in *reportQuantityRsIndexes*, 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 reportQuantityRsIndexes and maxNrofRSIndexesToReport for the associated reportConfig are configured:

7> derive layer 3 beam measurements only based on SS/PBCH block for each measurement quantity indicated in *reportQuantityRsIndexes*, 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:

$$F_n = (1 - a) \cdot F_{n-1} + a \cdot M_n$$

where

$\boldsymbol{M_n}$ is the latest received measurement result from the physical layer;

$\boldsymbol{F_n}$ is the updated filtered measurement result, that is used for evaluation of reporting criteria or for measurement reporting;

$\boldsymbol{F_{n-1}}$is the old filtered measurement result, where $\boldsymbol{F_0}$is set to $\boldsymbol{M_1}$ when the first measurement result from the physical layer is received; and

a = $1/2^{(k/4)}$, where ***k*** is the *filterCoefficient* for the corresponding measurement quantity received by the *quantityConfig*;

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 38.331 [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 *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 average of the power values 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-ResourceCellMobility* including the *physCellId* of the cell in the *CSI-RS-ConfigMobility* 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 *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 average of the power values of the highest beam measurement quantity values above *absThreshCSI-RS-Consolidation* where the total number of averaged beams shall not exceed *nroCSI-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> else:

5> for events involving a serving cell associated with a *measObjectNR* and neighbours associated with another *measObjectNR*, consider any serving cell associated with the other *measObjectNR* to be a neighbouring cell as well;

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;

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> 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> 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;

4> if the *reportAmount* exceeds 1:

5> initiate the measurement reporting procedure,as specified in 5.5.5, immediately after the quantity to be reported becomes available for the NR SpCell;

4> else (i.e. the *reportAmount* is equal to 1):

5> initiate the measurement reportingprocedure, as specified in 5.5.5, immediately after the quantity to be reported becomes available for the NR SpCelland 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.

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 PSCell 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 PSCell 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.

Mnis 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.

5.5.5 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 RSRP, RSRQ and the available SINR for each configured serving cell derived based on the *rsType* indicated in the associated *reportConfig*;

1> set the *measResultServingCell* within *measResultServingMOList* to include for each NR serving cell that is configured with *servingCellMO*, if any, the *servCellId*;

1> if the *reportConfig* associated with the *measId* that triggered the measurement reporting includes *reportQuantityRsIndexes* and *maxNrofRSIndexesToReport*:

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 *reportQuantityRsIndexes* and *maxNrofRSIndexesToReport:*

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> set the *measResultNeighCells* to include the best neighbouring cells up to *maxReportCells* in accordance with the following:

3> if the *reportType* is set to *eventTriggered*:

4> include the cells included in the *cellsTriggeredList* as defined within the *VarMeasReportList* for this *measId*;

3> else:

4> 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> if *reportQuantityRsIndexes* and *maxNrofRSIndexesToReport* are configured, include beam measurement information as described in 5.5.5.2;

3> for each cell that is included in the *measResultNeighCells*, include the *physCellId*;

3> if the *reportType* is set to *eventTriggered*:

4> for each included cell, include the layer 3 filtered measured results in accordance with the *reportConfig* for this *measId*, ordered as follows:

5> if the *measObject* associated with this *measId* concerns NR:

6> if *rsType* in the associated *reportConfig* is set to *ssb*:

7> set *resultsSSB-Cell* within the *measResult* to include the SS/PBCH block based quantity(ies) indicated in the *reportQuantityCell* within the concerned *reportConfig*, in order of decreasing trigger quantity, i.e. the best cell is included first:

8> if *reportQuantityRsIndexes* and *maxNrofRSIndexesToReport* are configured, include beam measurement information as described in 5.5.5.2;

6> else if *rsType* in the associated *reportConfig* is set to *csi-rs*:

7> set *resultsCSI-RS-Cell* within the *measResult* to include the CSI-RS based quantity(ies) indicated in the *reportQuantityCell* within the concerned *reportConfig*, in order of decreasing trigger quantity, i.e. the best cell is included first:

8> if *reportQuantityRsIndexes* and *maxNrofRSIndexesToReport* are, include beam measurement information as described in 5.5.5.2;

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 EUTRA 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 *reportQuantityRsIndexes*;

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 *maxNrofRsIndexesToReport*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 corresponding *measObject*, the remaining beams whose sorting quantity is above *absThreshSS-BlocksConsolidation* defined in the *VarMeasConfig* for the corresponding *measObject*;

3> if *includeBeamMeasurements* is configured, include the SS/PBCH based measurement results for the quantities in *reportQuantityRsIndexes* 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 corresponding *measObject*, the remaining beams whose sorting quantity is above *absThreshCSI-RS-Consolidation* defined in the *VarMeasConfig* for the corresponding *measObject*;

3> if *includeBeamMeasurements*is configured, include the CSI-RS based measurement results for the quantities in *reportQuantityRsIndexes* set to TRUE for each CSI-RS index.

5.6 UE capabilities

5.6.1 UE capability transfer

5.6.1.1 General

Editor's Note: Targeted for completion in Sept 2018

5.6.1.2 Initiation

Editor's Note: Targeted for completion in Sept 2018.

5.6.1.3 Reception of the *UECapabilityEnquiry* by the UE

Editor's Note: Targeted for completion in Sept 2018.

5.6.1.4 Compilation of band combinations supported by the UE

The UE shall:

1> if *FreqBandList* is received:

2> if the received *FreqBandList* contains at least one of *maximumBandwidthRequestedDL*, *maximumBandwidthRequestedUL*, *maximumNumberOfDLCarriersRequested* or *maximumNumberOfULCarriersRequested* for atleast one of the bands:

3> compile a list of band combinations, candidate for inclusion in the *UECapabilityInformation* message, only consisting of bands included in *FreqBandList*, where for each band in the band combination, the parameters of the band do not exceed the corresponding parameters provided by the IEs *maximumBandwidthRequestedDL*, *maximumBandwidthRequestedUL*, *maximumNumberOfDLCarriersRequested* or *maximumNumberOfULCarriersRequested*, whichever are recevied.

2> else:

3> compile a list of band combinations, candidate for inclusion in the *UECapabilityInformation* message, only consisting of bands included in *FreqBandList*, and prioritized in the order of *FreqBandList*, (i.e. first include remaining band combinations containing the first-listed band, then include remaining band combinations containing the second-listed band, and so on);

2> for each band combination included in the candidate list:

3> if it is regarded as a fallback band combination with the same capabilities of another band combination included in the list of candidates as specified in TS 38.306 [xx]:

4> remove the band combination from the list of candidates;

2> include all band combinations in the candidate list into *supportedBandCombination*;

2> include the received FreqBandList in the field appliedFreqBandListFilter of the requested UE capability;

1> else:

2> include all band combinations supported by the UE into *supportedBandCombination*, excluding fallback band combinations with the same capabilities of another band combination included in the list of band combinations supported by the UE.

5.6.1.5 Compilation of baseband processing combinations supported by the UE

The UE shall:

1> for each band combination included in *supportedBandCombination*:

2> include the baseband processing combination supported for the band combination into *supportedBasebandProcessingCombination*, unless it is already included;

2> if there are the fallback baseband processing combinations of this baseband processing combination as specified in TS 38.306 [xx] for which supported baseband capabilities are different from this baseband processing combination:

3> include only these baseband processing combinations into *supportedBasebandProcessingCombination*.

5.7 Other

5.7.1 DL information transfer

Editor's Note: Targeted for completion in Sept 2018.

5.7.2 UL information transfer

Editor's Note: Targeted for completion in Sept 2018.5.7.3 SCG failure information

5.7.3.1 General

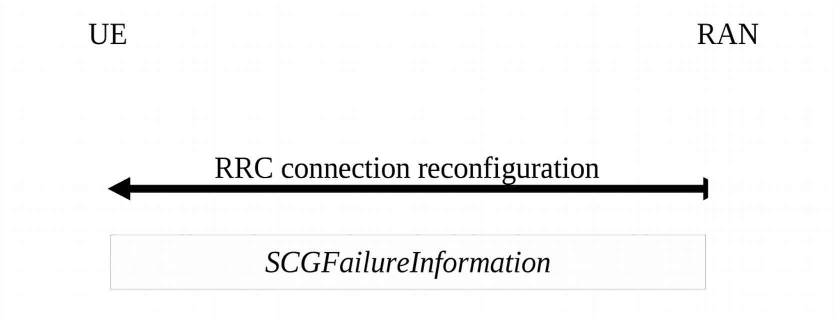

Figure 5.7.3.1-1: SCG failure information

The purpose of this procedure is to inform EUTRAN or NR MN about an SCG failure the UE has experienced i.e. SCG radio link failure, e 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, in accordance with subclause 5.3.5.8.1.

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, 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 scg-ChangeFailure;

Editor's Note: FFS whether to change scg-ChangeFailure to synchronousReconfigurationFailure-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 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.

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
```

– *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,
        spare15 NULL, spare14 NULL, spare13 NULL,
        spare12 NULL, spare11 NULL, spare10 NULL,
        spare9 NULL, spare8 NULL, spare7 NULL,
        spare6 NULL, spare5 NULL, spare4 NULL,
        spare3 NULL, spare2 NULL, spare1 NULL
    },
    messageClassExtension   SEQUENCE {}
}

-- TAG-DL-DCCH-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,
        spare14 NULL, spare13 NULL, spare12 NULL,
        spare11 NULL, spare10 NULL, spare9 NULL,
        spare8 NULL, spare7 NULL, spare6 NULL,
        spare5 NULL, spare4 NULL, spare3 NULL,
        spare2 NULL, spare1 NULL
    },
    messageClassExtension   SEQUENCE {}
}

-- TAG-UL-DCCH-MESSAGE-STOP
-- ASN1STOP
```

6.2.2 Message definitions

– *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                    INTEGER (0..255),
    cellBarred                          ENUMERATED {barred, notBarred},
    intraFreqReselection                ENUMERATED {allowed, notAllowed},
    spare                               BIT STRING (SIZE (1))
}

-- TAG-MIB-STOP
-- ASN1STOP
```

MIB field descriptions
cellBarred Indicates whether the cell allows UEs to camp on this cell, as specified in TS 38.304 [20].
dmrs-TypeA-Position Position of (first) DL DM-RS. Corresponds to L1 parameter 'DL-DMRS-typeA-pos' (see 38.211, section 7.4.1.1.1)
intraFreqReselection Controls cell 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 Corresponds to RMSI-PDCCH-Config in TS 38.213 [13], section 4.1. Determines a bandwidth for PDCCH/SIB, 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], section 13).
ssb-SubcarrierOffset Corresponds to k_{SSB} (see TS 38.213, section 4.1, 13), which is the frequency domain offset between SSB and the overall resource block grid in number of subcarriers. (See 38.211, section 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 38.213 [13]. This field may indicate that this cell does not provide SIB1 and that there is hence no common CORESET (see TS 38.213 [13], section 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 38.213 [13], section 13).
subCarrierSpacingCommon Subcarrier spacing for SIB1, Msg.2/4 for initial access 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).

– *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
```

– *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                    SEQUENCE {}                                                         OPTIONAL
```

```
}

-- TAG-RRCRECONFIGURATION-STOP
-- ASN1STOP
```

RRCReconfiguration-IEs field descriptions
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).

– *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                    SEQUENCE {}                                                         OPTIONAL
}

-- TAG-RRCRECONFIGURATIONCOMPLETE-STOP
-- ASN1STOP
```

– *SIB1*

Editor's Note: Targeted for completion in September 2018. Not used in EN-DC.

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.

Signalling radio bearer: N/A

RLC-SAP: TM

Logical channels: BCCH and BR-BCCH

Direction: Network to UE

SIB1 message

```
-- ASN1START
-- TAG-SIB1-START

SIB1 ::=        SEQUENCE {

    -- FFS / TODO: Add other parameters.
    frequencyOffsetSSB              ENUMERATED {khz-5, khz5}                                                    OPTIONAL,   -- Need R
    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, spare1, spare2},
    ss-PBCH-BlockPower                  INTEGER (-60..50),

    uplinkConfigCommon                  UplinkConfigCommon                                                  OPTIONAL,
    supplementaryUplink                 SEQUENCE {
        uplinkConfigCommon                  UplinkConfigCommon                                              OPTIONAL
        -- FFS: Add additional (selection) criteria determining when/whether the UE shall use the SUL frequency
    }                                                                                                       OPTIONAL, -- Cond SUL

    tdd-UL-DL-Configuration             TDD-UL-DL-ConfigCommon                                              OPTIONAL, -- Cond TDD
    tdd-UL-DL-configurationCommon2      TDD-UL-DL-ConfigCommon                                              OPTIONAL, -- Cond TDD

    pdcch-ConfigCommon                  PDCCH-ConfigCommon                                                  OPTIONAL,
    pucch-ConfigCommon                  PUCCH-ConfigCommon                                                  OPTIONAL,

    lateNonCriticalExtension            OCTET STRING                                                        OPTIONAL,
    nonCriticalExtension                SEQUENCE{}                                                          OPTIONAL
}

-- TAG-SIB1-STOP
-- ASN1STOP
```

SIB1 field descriptions
frequencyOffsetSSB Frequency offset for the SSB of -5kHz (M=-1) or +5kHz (M=1). When the field is absent, the UE applies no offset (M=0). The offset is only applicable for the frequency range 0-2.65GHz. Corresponds to parameter 'M' (see 38.101, section FFS_Section)
groupPresence For above 6 GHz: indicates which groups of SSBs is present
inOneGroup Indicates the presence of the up to 8 SSBs in one group
ss-PBCH-BlockPower TX power that the NW used for SSB transmission. The UE uses it to estimate the RA preamble TX power. (see 38.213, section 7.4)
ssb-PeriodicityServingCell The SSB periodicity in msec for the rate matching purpose (see 38.211, section [7.4.3.1])
ssb-PositionsInBurst Time domain positions of the transmitted SS-blocks in an SS-Burst-Set (see 38.213, section 4.1)
supplementaryUplink FFS: How to indicate the FrequencyInfoUL for the SUL

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

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 38.101, 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 for uplink power control.

```
-- ASN1START
-- TAG-ALPHA-START

Alpha ::=                       ENUMERATED {alpha0, alpha04, alpha05, alpha06, alpha07, alpha08, alpha09, alpha1}

-- TAG-ALPHA-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], section 5.4.2.

```
-- ASN1START
-- TAG-ARFCN-VALUE-NR-START

ARFCN-ValueNR ::=               INTEGER (0..3279165)

-- TAG-ARFCN-VALUE-NR-STOP
-- ASN1STOP
```

– *BWP*

The *BWP* IE is used to configure a bandwidth part as defined in 38.211, section 4.2.2.

For each serving cell the network configures at least an initial bandwidth part comprising of at least a downlink bandwidth part and one (if the serving cell is configured with an uplink) or two (if using supplementary uplink (SUL)) uplink bandwidth parts. Furthermore, the network may configure additional uplink and downlink bandwidth parts for a serving cell.

The bandwidth part configuration is split into uplink and downlink parameters and into common and dedicated parameters. Common parameters (in BWP-UplinkCommon and BWP-DownlinkCommon) 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 information element

```
-- ASN1START
-- TAG-BANDWIDTH-PART-START

BWP ::=                             SEQUENCE {
    locationAndBandwidth                INTEGER (0..37949),
    subcarrierSpacing                   SubcarrierSpacing,
    cyclicPrefix                        ENUMERATED { extended }                                 OPTIONAL    -- Need R
}

BWP-Uplink ::=                      SEQUENCE {
    bwp-Id                              BWP-Id,
    bwp-Common                          BWP-UplinkCommon                                        OPTIONAL,   -- Need M
    bwp-Dedicated                       BWP-UplinkDedicated                                     OPTIONAL,   -- Need M
    ...
}

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
    ...
}

BWP-UplinkDedicated ::=             SEQUENCE {
    pucch-Config                        SetupRelease { PUCCH-Config }                           OPTIONAL,   -- Need M
    pusch-Config                        SetupRelease { PUSCH-Config }                           OPTIONAL,   -- Cond SetupOnly
    configuredGrantConfig               SetupRelease { ConfiguredGrantConfig }                  OPTIONAL,   -- Need M
    srs-Config                          SetupRelease { SRS-Config }                             OPTIONAL,   -- Need M
    beamFailureRecoveryConfig           SetupRelease { BeamFailureRecoveryConfig }              OPTIONAL,   -- Cond SpCellOnly
    ...
}

BWP-Downlink ::=                    SEQUENCE {
    bwp-Id                              BWP-Id,
    bwp-Common                          BWP-DownlinkCommon                                      OPTIONAL,   -- Need M
    bwp-Dedicated                       BWP-DownlinkDedicated                                   OPTIONAL,   -- Need M
    ...
}

BWP-DownlinkCommon ::=              SEQUENCE {
```

```
    genericParameters                   BWP,
    pdcch-ConfigCommon                  SetupRelease { PDCCH-ConfigCommon }                             OPTIONAL,   -- Need M
    pdsch-ConfigCommon                  SetupRelease { PDSCH-ConfigCommon }                             OPTIONAL,   -- Need M
    ...
}

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-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 numerologies and slot formats. Extended CP is supported only for 60 kHz subcarrier spacing. (see 38.211, section 4.2.2)
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 with assumptions as described in TS 38.213, section 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) 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 38.213, section 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 38.211, 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.

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 BWP ID=0 is always associated with the initial BWP and may hence not be used here (in other bandwidth parts). The NW may trigger the UE to swtich UL or DL BWP using a DCI field. The four code points in that DCI field map to the RRC-configured BWP-ID as follows: For up to 3 configured BWPs (in addition to the initial BWP) the DCI code point is equivalent to the BWP ID (initial = 0, first dedicated = 1, ...). If the NW configures 4 dedicated bandwidth parts, they are identified by DCI code points 0 to 3. In this case it is not possible to switch to the initial BWP using the DCI field. Corresponds to L1 parameter 'DL-BWP-index'. (see 38.211, 38.213, section 12)

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 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.
radioLinkMonitoringConfig UE specific configuration of radio link monitoring for detecting cell- and beam radio link failure occasions.

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 BWP ID=0 is always associated with the initial BWP and may hence not be used here (in other bandwidth parts). The NW may trigger the UE to swtich UL or DL BWP using a DCI field. The four code points in that DCI field map to the RRC-configured BWP-ID as follows: For up to 3 configured BWPs (in addition to the initial BWP) the DCI code point is equivalent to the BWP ID (initial = 0, first dedicated = 1, ...). If the NW configures 4 dedicated bandwidth parts, they are identified by DCI code points 0 to 3. In this case it is not possible to switch to the initial BWP using the DCI field. Corresponds to L1 parameter 'UL-BWP-index'. (see 38.211, 38.213, section 12)

BWP-UplinkCommon field descriptions
pucch-ConfigCommon Cell specific parameters for the PUCCH
pusch-ConfigCommon Cell specific parameters for the PUSCH
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. The NW configures SSB-based RA (and hence RACH-ConfigCommon) only for UL BWPs if the linked DL BWPs allows the UE to acquire the SSB associated to the serving cell.

BWP-UplinkDedicated field descriptions
beamFailureRecoveryConfig Determines how the UE performs Beam Failure Recovery upon detection of a Beam Failure (see RadioLinkMonitoringConfig)
configuredGrantConfig A Configured-Grant of typ1 or type2. It may be configured for UL or SUL but in case of type1 [FFS also type2] not for both at a time.
pucch-Config PUCCH configuration for one BWP of the regular 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 (UL or SUL).The network configures PUCCH-Config for each SpCell. 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).
pusch-Config PUSCH configuration for one BWP of the regular 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 38.213, section FFS_Section)
srs-Config Uplink sounding reference signal configuration

Conditional Presence	Explanation
SetupOnly	The field is optionally present, Need M, upon configuration of a new SCell. It is absent otherwise.
SpCellOnly	The field is optionally present, Need M, in the BWP-UplinkDedicated of an SpCell. It is absent otherwise.

– *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
```

– *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 38.321, section 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
    ...
}

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
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. The signalled threshold is applied directly for SSB; a threshold for CSI-RS is determined by linearly scaling singalled value based on Pc_ss corresponding to the CSI-RS resource. (see FFS_Specification, FFS_Section)
ra-prioritization Parameters which apply for prioritized random access procedure for BFR (see 38.321, section 5.1.1).
ra-ssb-OccasionMaskIndex Explicitly signalled PRACH Mask Index for RA Resource selection in TS 36.321. 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.
ssb-perRACH-Occasion Number of SSBs per RACH occasion (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. 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 CF-BFR is configured. It is optionally present otherwise.

– *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
    ...
}



-- 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
    ...
}

SCellConfig ::=                     SEQUENCE {
```

```
    sCellIndex                          SCellIndex,
    sCellConfigCommon                   ServingCellConfigCommon                                                         OPTIONAL,   -- Cond SCellAdd
    sCellConfigDedicated                ServingCellConfig                                                               OPTIONAL,   -- Cond SCellAddMod
    ...
}

-- 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.
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 on-going RLF timers and counter.
sCellToAddModList List of seconary serving cells (SCells) to be added or modified.
sCellToReleaseList List of seconary 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).

SpCellConfig field descriptions
reconfigurationWithSync Parameters for the synchronous reconfiguration to the target SpCell.
servCellIndex Serving cell ID of a PSCell. The PCell of the Master Cell Group uses ID = 0.

Conditional Presence	Explanation
LCH-SetupOnly	The field is mandatory present if the corresponding LCH is being set up; otherwise it is not present.
LCH-Setup	The field is mandatory present if the corresponding LCH is being set up for DRB; otherwise it is optionally present, need M.
ReconfWithSync	The field is mandatory present in case of SpCell change and security key change; otherwise it is optionally present, need M.
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.

– *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
```

– *CodebookConfig*

The IE *CodebookConfig* is used to configure codebooks of Type-I and Type-II (see 38.214, section 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
```

```
                    }
                },
                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,       -- Cond TypeII-PortSelection
                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 38.214 section 5.2.2.2.2
codebookType CodebookType including possibly sub-types and the corresponding parameters for each. Corresponds to L1 parameter 'CodebookType' (see 38.214, section 5.2.2.2)
n1-n2-codebookSubsetRestriction Number of antenna ports in first (n1) and second (n2) dimension and codebook subset restriction. Corresponds to L1 parameters 'CodebookConfig-N1', 'CodebookConfig-N2' The CHOICE name indicates the value of n1 and n2, the CHOICE contents is the codebook subset restriction bitmap Corresponds to L1 parameter ' TypeII-CodebookSubsetRestriction' (see 38.214 section 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. Corresponds to L1 parameters 'CodebookConfig-N1', 'CodebookConfig-N2' 'TypeI-SinglePanel-CodebookSubsetRestriction ' (see 38.214 section 5.2.2.2.1)
ng-n1-n2 Codebook subset restriction for Type I Multi-panel codebook Corresponds to L1 parameter 'TypeI-MultiPanel-CodebookSubsetRestriction' (see 38.214, section 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 Corresponds to L1 parameter 'TypeI-MultiPanel-RI-Restriction' (see 38.214, section 5.2.2.2.2)
subbandAmplitude If subband amplitude reporting is activated (true)
twoTX-CodebookSubsetRestriction Codebook subset restriction for 2TX codebook Corresponds to L1 parameter ' TypeI-SinglePanel-2Tx-CodebookSubsetRestriction' (see 38.214 section 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 Corresponds to L1 parameter 'TypeI-SinglePanel-CodebookSubsetRestriction-i2' (see 38.214 section 5.2.2.2.1)
typeI-SinglePanel-ri-Restriction Restriction for RI for TypeI-SinglePanel-RI-Restriction Corresponds to L1 parameter 'TypeI-SinglePanel-RI-Restriction' (see 38.214, section 5.2.2.2.1)
typeII-PortSelectionRI-Restriction Restriction for RI for TypeII-PortSelection-RI-Restriction Corresponds to L1 parameter 'TypeII-PortSelection-RI-Restriction' (see 38.214, section 5.2.2.4)
typeII-RI-Restriction Restriction for RI for TypeII-RI-Restriction Corresponds to L1 parameter 'TypeII-RI-Restriction' (see 38.214, section 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 {mode1, mode2}                                   OPTIONAL,   -- Need S,
    cg-DMRS-Configuration                   DMRS-UplinkConfig,
    mcs-Table                               ENUMERATED {qam256, spare1}                         OPTIONAL,   -- Need S
    mcs-TableTransformPrecoder              ENUMERATED {qam256, spare1}                                 OPTIONAL,   -- Need S
    uci-OnPUSCH                             SetupRelease { CG-UCI-OnPUSCH },
    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}                                        OPTIONAL,   -- Need S
    nrofHARQ-Processes                      INTEGER(1..16),
    repK                                    ENUMERATED {n1, n2, n4, n8},
    repK-RV                                 ENUMERATED {s1-0231, s2-0303, s3-0000}                      OPTIONAL,   -- Cond RepK
    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,  -- Cond NoTransformPrecoder
            precodingAndNumberOfLayers          INTEGER   (0..63),
            srs-ResourceIndicator               INTEGER   (0..15),
            mcsAndTBS                           INTEGER (0..31),
            frequencyHoppingOffset              INTEGER (1.. maxNrofPhysicalResourceBlocks-1)           OPTIONAL,   -- Need M
            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 anntenna port(s) to be used for this configuration, and the maximum bitwidth is 5. See TS 38.214, section 6.1.2, and TS 38.212, section 7.3.1.
cg-DMRS-Configuration DMRS configuration, corresponds to L1 parameter 'UL-TWG-DMRS' (see TS 38.214, section 6.1.2).
configuredGrantTimer Indicates the initial value of the configured grant timer (see TS 38.321) in number of periodicities.
frequencyDomainAllocation Indicates the frequency domain resource allocation, see TS 38.214, section 6.1.2, and TS 38.212, section 7.3.1).
frequencyHopping Frequency hopping. If not configured, 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. Corresponds to L1 parameter 'Frequency-hopping-offset' (see TS 38.214, section 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 TS38.214, section 6.1.2).
nrofHARQ-Processes The number of HARQ processes configured. It applies for both Type 1 and Type 2. See TS 38.321, section 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. Corresponds to L1 parameter 'UL-TWG-periodicity' (see TS 38.321, section 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} (see 38.214, Table 6.1.2.3-1)
powerControlLoopToUse Closed control loop to apply. Corresponds to L1 parameter 'PUSCH-closed-loop-index' (see TS 38.213, section 7.7.1).
rbg-Size Selection between config 1 and config 2 for RBG size for PUSCH. When the field is absent the UE applies the value config1. Note: rbg-Size is used when the transformPrecoder parameter is disabled.
repK-RV If repetitions is used, this field indicates the redundancy version (RV) sequence to use. See TS 38.214, section 6.1.2.
repK The number or 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 confgured grant may be configured for UL or SUL, but not for both simultaneously.
timeDomainAllocation Indicates a combination of start symbol and length and PUSCH mapping type, see TS 38.214, section 6.1.2 and TS 38.212, section 7.3.1.
timeDomainOffset Offset related to SFN=0, see TS 38.321, section 5.8.2.
transformPrecoder Enable transformer precoder for type1 and type2. If the field is absent, the UE considers the transformer precoder is disabled, see 38.214, section 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.*

Conditional Presence	Explanation
RepK	The field is mandatory present if *repK* is set to *n2, n4,*or *n8*. It is not present if *repK* is set to *n1*.

– *ControlResourceSet*

The IE *ControlResourceSet* is used to configure a time/frequency control resource set (CORESET) in which to search for downlink control information (see 38.213, section 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,    -- Need N
        tci-StatesPDCCH-ToReleaseList           SEQUENCE(SIZE (1..maxNrofTCI-StatesPDCCH)) OF TCI-StateId              OPTIONAL,    -- Need N
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). Corresponds to L1 parameter 'CORESET-CCE-REG-mapping-type' (see 38.211Section sections 7.3.2.2 and 7.4.1.3.2).
controlResourceSetId Corresponds to L1 parameter 'CORESET-ID'. Value 0 identifies the common CORESET configured in MIB and in ServingCellConfigCommon. Values 1..maxNrofControlResourceSets-1 identify CORESETs configured by dedicated signalling. The controlResourceSetId is unique among the BWPs of a ServingCell.
duration Contiguous time duration of the CORESET in number of symbols. Corresponds to L1 parameter 'CORESET-time-duration' (see 38.211, section 7.3.2.2FFS_Section)
frequencyDomainResources Frequency domain resources for the CORESET. Each bit corresponds a group of 6 RBs, with grouping starting from PRB 0, which is fully contained in the bandwidth part within which the CORESET is configured. The most significant bit corresponds to the group of lowest frequency which is fully contained in the bandwidth part within which the CORESET is configured, each next subsequent lower significance bit corresponds to the next lowest frequency group fully contained within the bandwidth part within which the CORESET is configured, if any. Bits corresponding to a group not fully contained within the bandwidth part within which the CORESET is configured are set to zero. Corresponds to L1 parameter 'CORESET-freq-dom'(see 38.211, section 7.3.2.2).
interleaverSize Corresponds to L1 parameter 'CORESET-interleaver-size' (see 38.211, 38.213, section FFS_Section).
pdcch-DMRS-ScramblingID PDCCH DMRS scrambling initalization. Corresponds to L1 parameter 'PDCCH-DMRS-Scrambling-ID' (see 38.211, section 7.4.1). When the field is absent the UE applies the value of the *physCellId* configured for this serving cell.
precoderGranularity Precoder granularity in frequency domain. Corresponds to L1 parameter 'CORESET-precoder-granuality' (see 38.211, sections 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. Corresponds to L1 parameter 'CORESET-REG-bundle-size' (see 38.211, section FFS_Section).
shiftIndex Corresponds to L1 parameter 'CORESET-shift-index'. When the field is absent the UE applies the value of the *physCellId* configured for this serving cell (see 38.211, section 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. Corresponds to L1 parameter 'TCI-PresentInDCI' (see 38,213, section 5.1.5).
tci-StatesPDCCH-ToAddList, tci-StatesPDCCH-ToReleaseList A subset of the TCI states defined in TCI-States used for providing QCL relationships between the DL RS(s) in one RS Set (TCI-State) and the PDCCH DMRS ports. Corresponds to L1 parameter 'TCI-StatesPDCCH' (see 38.213, section10.). The network configures at most *maxNrofTCI-StatesPDCCH* entries.

– *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 configured via PBCH (MIB) and in ServingCellConfigCommon. The ID space is used across the BWPs of a Serving Cell. The number of CORESETs per BWP is limited to 3 (including the initial CORESET).

***ControlResourceSetId* information element**

```
-- ASN1START
-- TAG-CONTROL-RESOURCE-SET-ID-START

ControlResourceSetId ::=                INTEGER (0..maxNrofControlResourceSets-1)

-- TAG-CONTROL-RESOURCE-SET-ID-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)
        }                                                                   -- Cond SCellOnly
    },
    ...
}

-- 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/EPDCCH DCI formats, see TS 38.213 [REF, SECTION].
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 [REF, SECTION]. If *cif-Presence* is set to true, the CIF value indicating a grant or assignment for this cell is 0.
pdsch-Start The starting OFDM symbol of PDSCH for the concerned SCell, see TS [REF]. Values 1, 2, 3 are applicable when *dl-Bandwidth* for the concerned SCell is greater than 10 resource blocks, values 2, 3, 4 are applicable when *dl-Bandwidth* for the concerned SCell is less than or equal to 10 resource blocks, see TS [REF].
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.

Conditional Presence	Explanation
SCellOnly	This field is optionally present, Need M, for SCells. It is absent otherwise

– *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 aperiodic 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-ResourcesforInteference      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-ResourcesforInteference 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). The indicated NZP-CSI-RS-ResourceSet should have exactly the same number of resources like the NZP-CSI-RS-ResourceSet indicated in nzp-CSI-RS-ResourcesforChannel.
qcl-info List of references to TCI-States for providing the QCL source and QCL type for 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. Corresponds to L1 parameter 'QCL-Info-aPeriodicReportingTrigger' (see 38.214, section 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 tocommon 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. Corresponds to L1 parameter 'CSI-IM-RE-pattern' (see 38.214, section 5.2.2.3.4)
freqBand Frequency-occupancy of CSI-IM. Corresponds to L1 parameter 'CSI-IM-FreqBand' (see 38.214, section 5.2.2.3.2)
periodicityAndOffset Periodicity and slot offset for periodic/semi-persistent CSI-IM. Corresponds to L1 parameter 'CSI-IM-timeConfig'
subcarrierLocation-p0 OFDM subcarrier occupancy of the CSI-IM resource for Pattern0. Corresponds to L1 parameter 'CSI-IM-ResourceMapping' (see 38.214, section 5.2.2.3.4)
subcarrierLocation-p1 OFDM subcarrier occupancy of the CSI-IM resource for Pattern1. Corresponds to L1 parameter 'CSI-IM-ResourceMapping' (see 38.214, section 5.2.2.3.4)
symbolLocation-p0 OFDM symbol location of the CSI-IM resource for Pattern0. Corresponds to L1 parameter 'CSI-IM-ResourceMapping' (see 38.214, section 5.2.2.3.4)
symbolLocation-p1 OFDM symbol location of the CSI-IM resource for Pattern1. Corresponds to L1 parameter 'CSI-IM-ResourceMapping' (see 38.214, section 5.2.2.3.4)

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. Corresponds to L1 parameter 'CSI-IM-ResourceConfigList' (see 38.214, section 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 38.214, section 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,
    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 section 5.2.1.1
csi-ResourceConfigToAddModList Configured CSI resource settings as specified in TS 38.214 section 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). Corresponds to L1 parameter 'ReportTriggerSize' (see 38.214, section 5.2)

– *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 38.214, section 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
        },
        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)),
            ...
        }   OPTIONAL    -- Need S

    }                                                                                                                            OPTIONAL,   -- Need R
    timeRestrictionForChannelMeasurements                 ENUMERATED {configured, notConfigured},
    timeRestrictionForInterferenceMeasurements            ENUMERATED {configured, notConfigured},
    codebookConfig                                CodebookConfig                                                                 OPTIONAL,   -- Need R
    nrofCQIsPerReport                             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, spare2, spare1}                                    OPTIONAL,   -- Need R
    subbandSize                               ENUMERATED {value1, value2},
    non-PMI-PortIndication                    SEQUENCE (SIZE (1..maxNrofNZP-CSI-RS-ResourcesPerConfig)) OF PortIndexFor8Ranks 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 38.214, section 5.2.1.4)
cqi-Table Which CQI table to use for CQI calculation. Corresponds to L1 parameter 'CQI-table' (see 38.214, section 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 bwp-Id in that CSI-ResourceConfigToAddMod is the same value like the bwp-Id in the CSI-ResourceConfig indicated by resourcesForChannelMeasurement.
csi-ReportingBand Indicates a contiguous or non-contigous 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. (see 38.214, section 5.2.1.4) The number of subbands is determined according to 38.214 section 5.2.1.4. It 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).
groupBasedBeamReporting Turning on/off group beam based reporting (see 38.214, section 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. Corresponds to L1 parameter 'Non-PMI-PortIndication' (see 38.214, section FFS_Section). 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.
nrofCQIsPerReport Maximum number of CQIs per CSI report (cf. 1 for 1-CW, 2 for 2-CW)
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. FFS: The signaling mechanism for the gNB to select a subset of N beams for the UE to measure and report. FFS: Note: this parameter may not be needed for certain resource and/or report settings FFS_ASN1: Change groupBasedBeamReporting into a CHOICE and include this field into the "no" option? (see 38.214, section FFS_Section) 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-ResourceConfigToAddMod included in the configuration of the serving cell indicated with the field "carrier" above. The bwp-Id in that CSI-ResourceConfigToAddMod is the same value like the bwp-Id in the CSI-ResourceConfigToAddMod indicated by resourcesForChannelMeasurement.
p0alpha Index of the p0-alpha set determining the power control for this CSI report transmission. Corresponds to L1 parameter 'SPCSI-p0alpha' (see 38.214, section FFS_Section)

pdsch-BundleSizeForCSI PRB bundling size to assume for CQI calcuation when reportQuantity is CRI/RI/i1/CQI. Corresponds to L1 parameter 'PDSCH-bundle-size-for-CSI' (see 38.214, section 5.2.1.4)
pmi-FormatIndicator Indicates whether the UE shall report a single (wideband) or multiple (subband) PMI. (see 38.214, section 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 38.214, section 5.2.1.4)
reportQuantity The CSI related quanities to report. Corresponds to L1 parameter 'ReportQuantity' (see 38.214, section REF)
reportSlotConfig Periodicity and slot offset. Corresponds to L1 parameter 'ReportPeriodicity'and 'ReportSlotOffset' (see 38.214, section section 5.2.1.4) as well as to L1 parameter 'Reportperiodicity-spCSI'. (see 38.214, section 5.2.1.1?FFS_Section)
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 38.214, section 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. 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 38.214 table 5.2.1.4-2 Corresponds to L1 parameter 'SubbandSize' (see 38.214, section 5.2.1.4)
timeRestrictionForChannelMeasurements Time domain measurement restriction for the channel (signal) measurements. Corresponds to L1 parameter 'MeasRestrictionConfig-time-channel' (see 38.214, section 5.2.1.1)
timeRestrictionForInterferenceMeasurements Time domain measurement restriction for interference measurements. Corresponds to L1 parameter 'MeasRestrictionConfig-time-interference' (see 38.214, section 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,
            csi-SSB-ResourceSetList             SEQUENCE (SIZE (1..maxNrofCSI-SSB-ResourceSetsPerConfig)) OF CSI-SSB-ResourceSetId  OPTIONAL
```

```
        },
        csi-IM-ResourceSetList              SEQUENCE (SIZE (1..maxNrofCSI-IM-ResourceSetsPerConfig)) OF CSI-IM-ResourceSetId
    },

    bwp-Id                              BWP-Id,
    resourceType                        ENUMERATED { aperiodic, semiPersistent, periodic },
    ...
}

-- TAG-CSI-RESOURCECONFIGTOADDMOD-STOP
-- ASN1STOP
```

CSI-ResourceConfig field descriptions
bwp-Id The DL BWP which the CSI-RS associated with this CSI-ResourceConfig are located in. Corresponds to L1 parameter 'BWP-Info' (see 38.214, section 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. Corresponds to L1 parameter 'ResourceSetConfigList' (see 38.214, section 5.2.1.3.1)
csi-SSB-ResourceSetList List of SSB resources used for beam measurement and reporting in a resource set Corresponds to L1 parameter 'resource-config-SS-list' (see 38,214, section FFS_Section)
resourceType Time domain behavior of resource configuration. Corresponds to L1 parameter 'ResourceConfigType' (see 38.214, section 5.2.2.3.5)

– *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-RESIYRCEPERIODICITYANDOFFSET-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,
    ...
}

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,
    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 38.214, section 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
subcarrierSpacing Subcarrier spacing of CSI-RS. Only the values 15, 30 or 60 kHz (<6GHz), 60 or 120 kHz (>6GHz) are applicable. Corresponds to L1 parameter 'Numerology' (see 38.211, section FFS_Section).

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 can't 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. 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 38.214, section 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. Parameter l0 in 38.211, section 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 38.211, section 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 parmeters 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 Corresponds to L1 parameter 'QCLed-SSB' (see FFS_Spec, section FFS_Section).
sequenceGenerationConfig Scrambling ID for CSI-RS (see 38.211, section 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 38.214, section 5.2.2.3.1)
density Density of CSI-RS resource measured in RE/port/PRB. Corresponds to L1 parameter 'CSI-RS-Density' (see 38.211, section 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. Parameter l1 in 38.211, section 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. Parameter l0 in 38.211, section 7.4.1.5.3. Value 2 is supported only when DL-DMRS-typeA-pos equals 3.
freqBand Wideband or partial band CSI-RS. Corresponds to L1 parameter 'CSI-RS-FreqBand' (see 38.214, section 5.2.2.3.1)
frequencyDomainAllocation Frequency domain allocation within a physical resource block in accordance with 38.211, section 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 column has the 3 values matching, by selecting the row where the column (k bar, l bar) in table 7.4.1.5.3-2 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 38.214, section 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 38.214, section 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-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
```

– 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
```

– *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 R
    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 Table 7.4.1.1.2-4 in 38.211. The four values represent the cases of 1+0, 1+1, 1+1+1. 1+1+1+1 non-adjacent OFDM symbols for DL. If the field is absent, the UE applies the value pos2.
dmrs-Type Selection of the DMRS type to be used for DL (see 38.211, section 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. Corresponds to L1 parameter 'DL-DMRS-max-len' (see 38.214, section 5.1)
phaseTrackingRS Configures downlink PTRS. If absent of released, the UE assumes that downlink PTRS are not present. See 38.214 section 5.1.6.3
scramblingID0 DL DMRS scrambling initalization Corresponds to L1 parameter 'n_SCID 0' (see 38.211, section 7.4.1). When the field is absent the UE applies the value Physical cell ID (physCellId) configured for this serving cell."
scramblingID1 DL DMRS scrambling initalization. Corresponds to L1 parameter 'n_SCID 1' (see 38.211, section 7.4.1). 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 R
    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
        disableSequenceGroupHopping         ENUMERATED {disabled}                                           OPTIONAL,   -- Need S
        sequenceHoppingEnabled              ENUMERATED {enabled}                                            OPTIONAL,   -- Need S
        ...
    }                                                                                                       OPTIONAL,   -- Need R
    ...
}

-- TAG-DMRS-UPLINKCONFIG-STOP
-- ASN1STOP
```

***DMRS-UplinkConfig* field descriptions**
disabled DMRS related parameters for Cyclic Prefix OFDM
disableSequenceGroupHopping Sequence-group hopping for PUSCH can be disabled for a certain UE despite being enabled on a cell basis. For DFT-s-OFDM DMRS when the field is absent, the UE considers group hopping to be enabled. Corresponds to L1 parameter 'Disable-sequence-group-hopping-Transform-precoding' (see 38.211, section FFS_Section)
dmrs-AdditionalPosition Position for additional DM-RS in UL. Corresponds to L1 parameter 'UL-DMRS-add-pos' (see Table 7.4.1.1.2-4 in 38.211) The four values represent the cases of 1+0, 1+1, 1+1+1. 1+1+1+1 non-adjacent OFDM symbols for UL. If the field is absent, the UE applies the value pos2.
dmrs-Type Selection of the DMRS type to be used for UL (see section 38.211, section 6.4.1.1.3) If the field is absent, the UE uses DMRS type 1.
enabled DMRS related parameters for DFT-s-OFDM (Transform Precoding)
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. Corresponds to L1 parameter 'UL-DMRS-max-len' (see 38.214, section 6.4.1.1.2)
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 38.211, section FFS_Section)
phaseTrackingRS Configures uplink PTRS (see 38.211, section x.x.x.x) FFS_Ref
scramblingID0 UL DMRS scrambling initalization for CP-OFDM Corresponds to L1 parameter 'n_SCID 0' (see 38.214, section 6.4.1.1.2) When the field is absent the UE applies the value Physical cell ID (physCellId)
scramblingID1 UL DMRS scrambling initalization for CP-OFDM. Corresponds to L1 parameter 'n_SCID 1' (see 38.214, section 6.4.1.1.2) When the field is absent the UE applies the value Physical cell ID (physCellId)
sequenceHoppingEnabled Determines if sequence hopping is enabled or not. For DFT-s-OFDM DMRS. If the field is absent, the UE considers sequence hopping to be disabled. Corresponds to L1 parameter 'Sequence-hopping-enabled-Transform-precoding' (see 38.211, section FFS_Section)

– *DownlinkConfigCommon*

The IE *DownlinConfigCommon* 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
initialUplinkBWP The initial downlink BWP configuration for a SpCell (PCell of MCG or SCG).

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.

– *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. Corresponds to L1 parameter 'INT-DCI-payload-length' (see 38.213, section 11.2)
int-ConfigurationPerServingCell Indicates (per serving cell) the position of the 14 bit INT values inside the DCI payload. Corresponds to L1 parameter 'INT-cell-to-INT' and 'cell-to-INT' (see 38.213, section 11.2)
int-RNTI RNTI used for indication pre-emption in DL. Corresponds to L1 parameter 'INT-RNTI', where "INT" stands for "interruption" (see 38.213, section 10)
timeFrequencySet Set selection for DL-preemption indication. Corresponds to L1 parameter 'int-TF-unit' (see 38.213, section 10.1) 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. Must be multiples of 14 (bit). Corresponds to L1 parameter 'INT-values' (see 38.213, section 11.2)

– *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
```

– *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),
    subframeAllocation                  CHOICE {
        oneFrame                            BIT STRING (SIZE(6)),
        fourFrames                          BIT STRING (SIZE(24))
    },
    subframeAllocation-v1430            CHOICE {
        oneFrame-v1430                      BIT STRING (SIZE(2)),
        fourFrames-v1430                    BIT STRING (SIZE(8))
    }                                                                                   OPTIONAL,   -- Need R
    ...
}

-- TAG-EUTRA-MBSFN-SUBFRAMECONFIGLIST-STOP
-- ASN1STOP
```

EUTRA-MBSFN-SubframeConfig field descriptions
fourFrames-v1430 Field as defined in MBSFN-SubframeConfig in 36.331
fourFrames Field as defined in MBSFN-SubframeConfig in 36.331
oneFrame-v1430 Field as defined in MBSFN-SubframeConfig in 36.331
oneFrame Field as defined in MBSFN-SubframeConfig in 36.331
radioframeAllocationOffset Field as defined in MBSFN-SubframeConfig in 36.331
radioframeAllocationPeriod Field as defined in MBSFN-SubframeConfig in 36.331
subframeAllocation Field as defined in MBSFN-SubframeConfig in 36.331

– *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 38.101.

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-UL-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. Note that the lower edge of the actual carrier is not defined by this field but rather in the scs-SpecificCarrierList. Corresponds to L1 parameter 'offset-ref-low-scs-ref-PRB' (see 38.211, section FFS_Section)
absoluteFrequencySSB Frequency of the SSB to be used for this serving cell. The frequency provided in this field identifies the position of resource element RE=#0 (subcarrier #0) of resource block RB#10 of the SS block. 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 38.101). 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 of one or multiple frequency bands to which this carrier(s) belongs. Multiple values are only supported in system information but not when the FrequencyInfoDL is provided in dedicated signalling (HO or S(p)Cell addition).
scs-SpecificCarrierList A set of carriers for different subcarrier spacings (numerologies). Defined in relation to Point A. Corresponds to L1 parameter 'offset-pointA-set' (see 38.211, section FFS_Section)

Conditional Presence	Explanation
SpCellAdd	The field is mandatory present if this *FrequencyInfoDL* is for SpCell. Otherwise the field is optionally present, Need R.

– *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. Corresponds to L1 parameter 'offset-ref-low-scs-ref-PRB' (see 38.211, section FFS_Section)
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 of one or multiple frequency bands to which this carrier(s) belongs. Multiple values are only supported in system information but not when the FrequencyInfoDL is provided in dedicated signalling (HO or S(p)Cell addition).
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 FFS_Definition. Corresponds to parameter FFS_RAN4. (see FFS_Spec, section FFS_Section) If the field is absent, the UE applies the value FFS_RAN4.
scs-SpecificCarrierList A set of carriers for different subcarrier spacings (numerologies). Defined in relation to Point A. Corresponds to L1 parameter 'offset-pointA-set' (see 38.211, section FFS_Section)

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.

- *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,   -- Need R
        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,
        ...
    }                                                                                                                   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. 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].
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 Indicates whether SR masking is configured for this logical channel.
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 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
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,
    ...
}

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)
    },
    -- FFS need for finer offset granulary
    -- FFS need for shorter values for long and short cycles
    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)

}

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,
    phr-Type2SpCell                     BOOLEAN,
    phr-Type2OtherCell                  BOOLEAN,
    phr-ModeOtherCG                     ENUMERATED {real, virtual},
    ...
}


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}

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-MAC-CELL-GROUP-CONFIG-STOP
-- ASN1STOP
```

***MAC-CellGroupConfig* field descriptions**
drx-Config Used to configure DRX as specified in TS 38.321 [3].
drx-HARQ-RTT-TimerDL Value in number of symbols.
drx-HARQ-RTT-TimerUL Value in number of symbols.
drx-InactivityTimer Value in multiple integers of 1ms. ms0 corresponds to 0, ms1 corresponds to 1ms, ms2 corresponds to 2ms, and so on.
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-LongCycleStartOffset *drx-LongCycle* in ms and *drx-StartOffset* in multiples of 1ms.
drx-RetransmissionTimerDL Value in number of slot lengths. sl1 corresponds to 1 slot, sl2 corresponds to 2 slots, and so on.
drx-RetransmissionTimerUL Value in number of slot lengths. sl1 corresponds to 1 slot, sl2 corresponds to 2 slots, and so on.
drx-ShortCycle Value in ms. ms1 corresponds to 1ms, ms2 corresponds to 2ms, 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-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.
logicalChannelSR-DelayTimer Value in number of subframes. sf1 corresponds to one subframe, sf2 corresponds to 2 subframes, and so on.
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].
periodicBSR-Timer Value in number of subframes. Value sf1 corresponds to 1 subframe, sf5 corresponds to 5 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-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.
phr-PeriodicTimer Value in number of subframes for PHR reporting as specified in TS 38.321 [3]. sf10 corresponds to 10 subframes, sf20 corresonds 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-Type2SpCell Indicates whether or not PHR type 2 is reported for the SpCell of the MAC entity. It is set to false in this release of the specification.
phr-Type2OtherCell Indicates whether or not PHR type 2 is reported for the SpCell of the other MAC entity or PUCCH SCells of the MAC entity.

***MAC-CellGroupConfig* field descriptions**
retxBSR-Timer Value in number of subframes. Value sf10 corresponds to 10 subframes, sf20 corresponds to 20 subframes and so on.
skipUplinkTxDynamic If configured, indicates whether 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?
tag-ID Indicates the TAG of 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].

– *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
```

Editor's Note: FFS Whether UE speed based TTT scaling (e.g. speedStatePars) is supported in Rel-15 (not applicable for EN-DC).

Editor's Note: FFS Whether measScaleFactor (or equivalent) is supported in Rel-15 (not applicable for EN-DC).

Editor's Note: FFS How to support allowInterruptions in NR (RAN4 input needed) in Rel-15.

***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. The UE is only required to perform measurements on non-serving cells when the SpCell RSRP is below that threshold.
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
    ...
}

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**
gapFR2 Indicates measurement gap configuration applies to FR2 only. 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 section 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
    ...
}

MeasGapSharingScheme ::=        ENUMERATED { scheme00, scheme01, scheme10, scheme11 }
```

```
--TAG-MEAS-GAP-SHARING-CONFIG-STOP
-- ASN1STOP
```

MeasGapSharingConfig field descriptions
gapSharingFR2 Indicates the measurement gaps sharing scheme, 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.

Editor's Note: FFS Details of *measObjectEUTRA* that can be configured via NR (not applicable for EN-DC).

– *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,
    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
    ...
}

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
    useServingCellTimingForSync             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
}

SSB-ToMeasure ::=                   CHOICE {
    shortBitmap                         BIT STRING (SIZE (4)),
    mediumBitmap                        BIT STRING (SIZE (8)),
    longBitmap                          BIT STRING (SIZE (64))
}

ThresholdNR ::=                     SEQUENCE{
    thresholdRSRP                       RSRP-Range                  OPTIONAL,
    thresholdRSRQ                       RSRQ-Range                  OPTIONAL,
    thresholdSINR                       SINR-Range                  OPTIONAL
}

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 values above the threshold are used as input to the derivation of cell measurement results as described in 5.5.3.3 and the L3 filter(s) per CSI-RS resource as described in 5.5.3.2.
absThreshSS-BlocksConsolidation Absolute threshold for the consolidation of measurement results per SS/PBCH block(s) from L1 filter(s). The values above the threshold are used as input to the derivation of cell measurement results as described in 5.5.3.3and the L3 filter(s) per SS/PBCH block index as described in 5.5.3.2.
blackCellsToAddModList List of cells to add/modify in the black list of cells.
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.
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 (e.g. SMTC window, CSI-RS resource, etc.)
refFreqCSI-RS Point A which is used for maping of CSI-RS to physical resources according to TS 38.211 section 7.4.1.5.3.
smtc1 Primary measurement timing configuration. Applicable for intra- and inter-frequency measurements.
smtc2 Secondary measurement timing confguration 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 stricty 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.
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
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 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.
ssb-ToMeasure The set of SS blocks to be measured within the SMTC measurement duration. Corresponds to L1 parameter 'SSB-measured' (see FFS_Spec, section FFS_Section) When the field is absent the UE measures on all SS-blocks FFS_CHECK: Is this IE placed correctly.
useServingCellTimingForSync For intra-frequency measurement this field indicates whether the UE can utilize serving cell timing to derive the index of SS block transmitted by neighbour cell. For inter-frequency measurements, 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 field descriptions
longBitmap bitmap for above 6 GHz
mediumBitmap bitmap for 3-6 GHz
shortBitmap bitmap for sub 3 GHz

Editor's Note: FFS How to support CGI reporting and whether changes are required in MeasObjectNR (e.g. introduction of cellForWhichToReportCGI). Not applicable for EN-DC.

Editor's Note: FFS Whether alternative TTT is supported in Rel-15 (not applicable for EN-DC).

Editor's Note: FFS measCycleSCell. (not applicable for EN-DC)

Editor's Note: FFS reducedMeasPerformance (not applicable for EN-DC).

Conditional presence	Explanation
SSBorAssociatedSSB	This field is mandatory present if *ssb-ConfigMobility* is configured or *associatedSSB* is configured in at least one cell, otherwise, it is absent.
IntraFreqConnected	This field is optionally present in an intra-frequency measurement object and only if ssb-ConfigMobility is configured or associatedSSB is configured in at least one cell, 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,
        ...
    }
}

-- TAG-MEAS-OBJECT-TO-ADD-MOD-LIST-STOP
-- ASN1STOP
```

– *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,
        ...
    }                                                                                               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,
    --FFS: Details of cgi info
    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
    },
    ...
}


MeasQuantityResults ::=             SEQUENCE {
    rsrp                                RSRP-Range                                              OPTIONAL,
    rsrq                                RSRQ-Range                                              OPTIONAL,
    sinr                                SINR-Range                                              OPTIONAL
}

ResultsPerSSB-IndexList::=              SEQUENCE (SIZE (1..maxNrofSSBs)) OF ResultsPerSSB-Index

ResultsPerSSB-Index ::=                     SEQUENCE {
    ssb-Index                                   SSB-Index,
    ssb-Results                                 MeasQuantityResults                         OPTIONAL
}

ResultsPerCSI-RS-IndexList::=               SEQUENCE (SIZE (1..maxNrofCSI-RS)) OF ResultsPerCSI-RS-Index

ResultsPerCSI-RS-Index ::=                  SEQUENCE {
    csi-RS-Index                                CSI-RS-Index,
    csi-RS-Results                              MeasQuantityResults                         OPTIONAL
}

-- TAG-MEAS-RESULTS-STOP
-- ASN1STOP
```

***MeasResultServFreq* field descriptions**
measResultBestNeighCell Measured results of the best detected neighbour cell on the corresponding serving frequency.

Editor's Note: FFS *locationInfo*.

***MeasResults* field descriptions**
csi-rs-Index CSI-RS resource index associated to the measurement information to be reported.
measId Identifies the measurement identity for which the reporting is being performed.
measResult Measured results of an NR cell.
measResultListNR List of measured results for the maximum number of reported best cells for an NR measurement identity.
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.
resultsCSI-RS-Indexes List of measurement information per CSI-RS resource index of an NR cell.
resultsSSB-Indexes List of measurement information per SS/PBCH index of an NR cell.
resultsCSI-RS-Cell Cell level measurement results (e.g. RSRP, RSRQ, SINR) to be reported derived from CSI-RS measurements.
resultsSSB-Cell Cell level measurement results (e.g. RSRP, RSRQ, SINR) to be reported derived on SS/PBCH block measurements.
rsrp Measured SS-RSRP or CSI-RSRP resultsas defined in TS 38.215 [9], either per NR cell from the L1 filter(s) or per (SS/PBCH)/(CSI-RS) index as specified in 5.5.3.3a.
rsrq Measured SS-RSRQ or CSI-RSRQ results as defined in TS 38.215 [9], either per NR cell from the L1 filter(s) or per (SS/PBCH)/(CSI-RS) index as specified in 5.5.3.3a.
sinr Measured SS-SINR or CSI-SINR results as defined in TS 38.215 [9], either per NR cell from the L1 filter(s) or per (SS/PBCH)/(CSI-RS) index as specified in 5.5.3.3a.
ssb-Index SS/PBCH block index associated to the measurement information to be reported.

– *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
}

-- TAG-MEAS-RESULT-SCG-FAILURE-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].

– *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
```

– *NZP-CSI-RS-Resource*

The IE *NZP-CSI-RS-Resource* is used to configure Non-Zero-Power (NZP) CSI-RStransmitted in the cell where the IE is included, which the UE may be configured to measure on (see 38.214, section 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. Corresponds to L1 parameter 'CSI-RS-timeConfig' (see 38.214, section 5.2.2.3.1)
powerControlOffset Power offset of NZP CSI-RS RE to PDSCH RE. Value in dB. Corresponds to L1 parameter Pc (see 38.214, sections 5.2.2.3.1 and 4.1)
powerControlOffsetSS Power offset of NZP CSI-RS RE to SS RE. Value in dB. Corresponds to L1 parameter 'Pc_SS' (see 38.214, section 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 belong to. Corresponds to L1 parameter 'QCL-Info-PeriodicCSI-RS' (see 38.214, section 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 38.214, section 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,
    aperiodicTriggeringOffset           INTEGER(0..4)                                                       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. When the field is absent the UE applies the value 0. Corresponds to L1 parameter 'Aperiodic-NZP-CSI-RS-TriggeringOffset' (see 38,214, section FFS_Section)
nzp-CSI-RS-Resources NZP-CSI-RS-Resources assocaited with this NZP-CSI-RS resource set. Corresponds to L1 parameter 'CSI-RS-ResourceConfigList' (see 38.214, section 5.2). For CSI, there are at most 8 NZP CSI RS resources per resource set
repetition Indicates whether repetition is on/off. If set to set to 'OFF', 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. Corresponds to L1 parameter 'CSI-RS-ResourceRep' (see 38.214, sections 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". Corresponds to L1 parameter 'TRS-Info' (see 38.214, section 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, see TS 38.101 [14].

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 the initial CORESET).
downlinkPreemption Configuration of downlink preemtption indications to be monitored in this cell. Corresponds to L1 parameter 'Preemp-DL' (see 38.214, section 11.2) FFS_RAN1: LS R1-1801281 indicates this is "Per Cell (but association with each configured BWP is needed)" => Unclear, keep on BWP for now.
searchSpacesToAddModList List of UE specifically configured Search Spaces. The network configures at most 10 Search Spaces per BWP per cell (including the initial Search Space).
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 during handover and PSCell/SCell addition.

PDCCH-ConfigCommon information element

```
-- ASN1START
-- TAG-PDCCH-CONFIGCOMMON-START

PDCCH-ConfigCommon ::=              SEQUENCE {
    controlResourceSetZero              INTEGER (0..15)                                                     OPTIONAL,   -- Cond InitialBWP-Only
    commonControlResourceSet            ControlResourceSet                                      OPTIONAL,   -- Need R
    searchSpaceZero                     INTEGER (0..15)                                                 OPTIONAL,   -- Cond InitialBWP-Only
    commonSearchSpace                   SEQUENCE (SIZE(1..4)) OF SearchSpace                                OPTIONAL,   -- Need R
    searchSpaceSIB1                     SearchSpaceId                                                       OPTIONAL,   -- Need R
    searchSpaceOtherSystemInformation   SearchSpaceId                                                       OPTIONAL,   -- Need R
    pagingSearchSpace                   SearchSpaceId                                                       OPTIONAL,   -- Need R
    ra-SearchSpace                      SearchSpaceId                                                       OPTIONAL,   -- Need R
    ...
}

-- TAG-PDCCH-CONFIGCOMMON-STOP
-- ASN1STOP
```

PDCCH-ConfigCommon field descriptions
commonControlResourceSet An additional common control resource setwhich may be configured and used for RAR (see ra-SearchSpace). If the network configures this field, it uses a ControlResourceSetId other than 0 for this ControlResourceSet.
commonSearchSpace An additional common search space.
controlResourceSetZero Parameters of the common CORESET#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) the UE acquires the CORESET#0 irrespective of the currently active BWP as described in FFS_Spec, section FFS_Section).
pagingSearchSpace ID of the Search space for paging. Corresponds to L1 parameter 'paging-SearchSpace' (see 38.213, section 10) If the field is absent, the monitoring occasions are derived as described in 38.213, section 10.1 and section 13.
ra-SearchSpace ID of the Search space for random access procedure. Corresponds to L1 parameter 'ra-SearchSpace' (see 38.214?, section FFS_Section) If the field is absent, the monitoring occasions are derived as described in 38.213, section 10.1 and section 13.
searchSpaceOtherSystemInformation ID of the Search space for other system information, i.e., SIB2 and beyond. Corresponds to L1 parameter 'osi-SearchSpace' (see 38.213, section 10) If the field is absent, the monitoring occasions are derived as described in 38.213, section 10.1 and section 13.
searchSpaceSIB1 ID of the search space for SIB1 message. Corresponds to L1 parameter 'rmsi-SearchSpace' (see 38.213, section 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) the UE acquires the SearchSpace#0 irrespective of the currently active BWP as described in FFS_Spec, section FFS_Section).

Conditional Presence	Explanation
InitialBWP-Only	The field is mandatory present in the PDCCH-ConfigCommon of the initial BWP (BWP#0). It is absent in other BWPs.

– *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 R
            },
            uplinkOnlyROHC          SEQUENCE {
                maxCID                  INTEGER (1..16383)              DEFAULT 15,
                profiles                SEQUENCE {
                    profile0x0006           BOOLEAN
                },
                drb-ContinueROHC            ENUMERATED { true }                                         OPTIONAL    -- Need R
            },
            ...
        },
        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


    ...
}

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
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. This field is configured only in case of reconfiguration with sync where the PDCP termination point is not changed.
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. ROHC should be configured at reconfiguration involving PDCP re-establishment if the RB was previously configured with ROHC. Header compression should not be configured when out-of-order delivery is allowed for PDCP SDUs.
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. FFS: text to indicate where to find the key.
maxCID Indicates the value of the MAX_CID parameter as specified in TS 38.323 [5] FFS: need to specify something with respect to UE capabilities.
moreThanOneRLC FFS / TODO: Handle more than two secondary cell groups
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. The value of this field, when the field is present, indicates whether duplication is activated. The value of this field is always TRUE, when configured for a SRB.
pdcp-SN-Size PDCP sequence number size, 12 or 18 bits.
primaryPath Indicates the cell group ID and LCID of the primary RLC entity as specified in TS 38.323 clause 5.2.1 for UL data tranmission 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.
pdcp-SN-Size PDCP sequence number size, 12 or 18 bits.
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]. For UL DRBs, the value shall be ignored by the UE.
t-Reordering Value in ms of t-Reordering specified in TS 38.323 [5]. Value ms0 corresponds to 0ms, value ms20 corresponds to 20ms, value ms40 corresponds to 40ms, 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 bits, value b100 corresponds to 100 bits, value b200 corresponds to 200 bits, and so on.

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 optional present, need M, n case of radio bearer with more than one associated RLC mapped to different cell groups. If the field is absent when the split bearer is configured for the radio bearer first time, then the default value *infinity* is applied.
ConnectedTo5GC	The field is optionally present, need R, if EN-DC is not configured, and absent if EN-DC is configured.
Setup2	This field is mandatory present in case for radio bearer setup for RLC-AM and RLC-UM. This field is optionally present in case for handover and reestablishment for for RLC-UM..Otherwise, ths 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,
    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, spare1}                         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. Corresponds to L1 parameter ' ZP-CSI-RS-ResourceSetConfigList' (see 38.214, section FFS_Section)
dataScramblingIdentityPDSCH Identifer used to initalite data scrambling (c_init) for PDSCH. Corresponds to L1 parameter 'Data-scrambling-Identity' (see 38.211, section 7.3.1.1).
dmrs-DownlinkForPDSCH-MappingTypeA DMRS configuration for PDSCH transmissions using PDSCH mapping type A (chosen dynamically via PDSCH-TimeDomainResourceAllocation).
dmrs-DownlinkForPDSCH-MappingTypeB DMRS configuration for PDSCH transmissions using PDSCH mapping type B (chosen dynamically via PDSCH-TimeDomainResourceAllocation).
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. Corresponds to L1 parameter 'MCS-Table-PDSCH' (see 38.214, section 5.1.3.1). If the field is absent the UE applies the value 64QAM.
pdsch-AggregationFactor Number of repetitions for data. Corresponds to L1 parameter 'aggregation-factor-DL' (see 38.214, section FFS_Section) When the field is absent the UE applies the value 1
pdsch-AllocationList List of time-domain configurations for timing of DL assignment to DL data. If configured, the values provided herein override the values received in corresponding PDSCH-ConfigCommon.
prb-BundlingType Indicates the PRB bundle type and bundle size(s). Corresponds to L1 parameter 'PRB_bundling' (see 38.214, section 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], section 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). Corresponds to L1 parameter 'Resource-set-group-1'. (see 38.214, section FFS_Section)
rateMatchPatternGroup2 The IDs of a second group of RateMatchPatterns defined in PDSCH-Config -> rateMatchPatternToAddModList (BWP level) or in ServingCellConfig -> rateMatchPatternToAddModList (cell level). Corresponds to L1 parameter 'Resource-set-group-2'. (see 38.214, section FFS_Section)
rateMatchPatternToAddModList Resources patterns which the UE should rate match PDSCH around. The UE rate matches around the union of all resources indicated in the nexted bitmaps. Corresponds to L1 parameter 'Resource-set-BWP' (see 38.214, section 5.1.2.2.3) 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. Corresponds to L1 parameter 'RBG-size-PDSCH' (see 38.214, section 5.1.2.2.1)
resourceAllocation Configuration of resource allocation type 0 and resource allocation type 1 for non-fallback DCI Corresponds to L1 parameter 'Resouce-allocation-config' (see 38.214, section

5.1.2)
sp-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-ResourceSetIds 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. Corresponds to L1 parameter 'ZP-CSI-RS-ResourceSetConfigList' (see 38.214, section FFS_Section).
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 38.214, section 5.1.4)
vrb-ToPRB-Interleaver Interleaving unit configurable between 2 and 4 PRBs Corresponds to L1 parameter 'VRB-to-PRB-interleaver' (see 38.211, section 6.3.1.7). 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. Corresponds to L1 parameter 'ZP-CSI-RS-ResourceConfigList' (see 38.214, section FFS_Section)

– *PDSCH-ConfigCommon*

The IE *PDSCH-ConfigCommon* is used to configure FFS

***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-AllocationList List of time-domain configurations for timing of DL assignment to DL data

– *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
    ...
}

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 38.212, section 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 38.213, section 9.1.1)

PDSCH-ServingCellConfig field descriptions
codeBlockGroupTransmission Enables and configures code-block-group (CBG) based transmission (see 38.213, section 9.1.1)
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. Corresponds to L1 parameter 'number-HARQ-process-PDSCH' (see 38.214, section REF)
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. Corresponds to L1 parameter 'Xoh-PDSCH' (see 38.214, section 5.1.3.2)

Conditional Presence	**Explanation**
SCellAddOnly	It is optionally present, Need M, for SCells when adding a new SCell. The field is absent when reconfiguring SCells. The field is also absent for the SpCells.

– *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 configued 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 The *n1* corresponds to the value 1, *n2* corresponhds to value 2, and so on. Corresponds to L1 parameter 'K0' (see 38.214, section FFS_Section) When the field is absent the UE applies the value 0.
mappingType PDSCH mapping type. Corresponds to L1 parameter 'Mapping-type' (see 38.214, section FFS_Section)
startSymbolAndLength An index into a table/equation in RAN1 specs capturing valid combinations of start symbol and length (jointly encoded). Corresponds to L1 parameter 'Index-start-len' (see 38.214, section FFS_Section)

– *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                                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 R
    ...
}

-- 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 fidld is absent, the spatial bundling is disabled. Corresponds to L1 parameter 'HARQ-ACK-spatial-bundling' (see 38.213, section FFS_Section)
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 fidld is absent, the spatial bundling is disabled. Corresponds to L1 parameter 'HARQ-ACK-spatial-bundling' (see 38.213, section FFS_Section)
p-NR The maximum transmit power to be used by the UE in this NR 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. Corresponds to L1 parameter 'HARQ-ACK-codebook' (see 38.213, section FFS_Section)
sp-CSI-RNTI RNTI for Semi-Persistent CSI reporting on PUSCH (see CSI-ReportConfig). Corresponds to L1 parameter 'SPCSI-RNTI' (see 38.214, section 5.2.1.5.2)
tpc-PUCCH-RNTI RNTI used for PUCCH TPC commands on DCI. Corresponds to L1 parameter 'TPC-PUCCH-RNTI' (see 38.213, section 10).
tpc-PUSCH-RNTI RNTI used for PUSCH TPC commands on DCI. Corresponds to L1 parameter 'TPC-PUSCH-RNTI' (see 38.213, section 10)
tpc-SRS-RNTI RNTI used for SRS TPC commands on DCI. Corresponds to L1 parameter 'TPC-SRS-RNTI' (see 38.213, section 10)

Conditional Presence	**Explanation**
SP-CSI-Report	The field is mandatory present, Need M, when at least one *CSI-ReportConfig* with *reportConfigType* set to *semiPersistentOnPUSCH* is configured; otherwise it is optionally present, need M.

– *PRB-Id*

The *PRB-Id* indentifies 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 38.214 section5.1.6.3)

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. Corresponds to L1 parameter 'DL-PTRS-EPRE-ratio' (see 38.214, section 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. Corresponds to L1 parameter 'DL-PTRS-frequency-density-table' (see 38.214, section 5.1)
resourceElementOffset Indicates the subcarrier offset for DL PTRS. If the field is absent, the UE applies the value offset00. Corresponds to L1 parameter 'DL-PTRS-RE-offset' (see 38.214, section 5.1.6.3)
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 (38.214) If the field is absent, the UE uses L_PT-RS = 1. Corresponds to L1 parameter 'DL-PTRS-time-density-table' (see 38.214, section 5.1)

– *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 {
    modeSpecificParameters                  CHOICE {
        cp-OFDM                                 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}
        },
        dft-S-OFDM                              SEQUENCE {
            sampleDensity                       SEQUENCE (SIZE (5)) OF INTEGER (1..276),
            timeDensityTransformPrecoding       ENUMERATED {d2}                                             OPTIONAL    -- Need S
        }
    }                                                                                                       OPTIONAL,   -- Need M
    ...
}

-- TAG-PTRS-UPLINKCONFIG-STOP
-- ASN1STOP
```

PTRS-UplinkConfig field descriptions
cp-OFDM Configuration of UL PTRS for CP-OFDM
dft-S-OFDM Configuration of UL PTRS for DFT-S-OFDM.
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. Corresponds to L1 parameter 'UL-PTRS-frequency-density-table' (see 38.214, section 6.1)
maxNrofPorts The maximum number of UL PTRS ports for CP-OFDM. Corresponds to L1 parameter 'UL-PTRS-ports' (see 38.214, section 6.2.3.1)
ptrs-Power UL PTRS power boosting factor per PTRS port. Corresponds to L1 parameter 'UL-PTRS-power' (see 38.214, section 6.1, table 6.2.3-5)
resourceElementOffset Indicates the subcarrier offset for UL PTRS for CP-OFDM. Corresponds to L1 parameter 'UL-PTRS-RE-offset' (see 38.214, section 6.1)
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 according to the table in 38.214 FFS_Section. Corresponds to L1 parameter 'UL-PTRS-pre-DFT-density' (see 38.214, section 6.1, 6.2.3-3)
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. Corresponds to L1 parameter 'UL-PTRS-time-density-table' (see 38.214, section 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. Corresponds to L1 parameter 'UL-PTRS-time-density-transform-precoding' (see 38.214, section 6.1)

– *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}

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)

-- 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,                                                      -- Cond InFirstSetOnly
        format1                                 PUCCH-format1,                                                      -- Cond InFirstSetOnly
        format2                                 PUCCH-format2,                                                      -- Cond NotInFirstSet
        format3                                 PUCCH-format3,                                                      -- Cond NotInFirstSet
        format4                                 PUCCH-format4                                                       -- Cond NotInFirstSet
    }
}

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. In this version of the specification only the values [0..8] are applicable. Corresponds to L1 parameter 'Slot-timing-value-K1' (see TS 38.213, section FFS_Section).
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, section 9.2).
resourceToAddModList 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, section FFS_Section and TS 38.213, section 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 Enabling 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). Enabling 4 DMRS sybmols 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, section 9.2.2.
interslotFrequencyHopping Enabling inter-slot frequency hopping when PUCCH Format 1, 3 or 4 is repetead over multiple slots. The field is not applicable for format 2. See TS 38.213, section 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, section 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, section 9.2.6.
pi2BPSK Enabling 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, section 9.2.5.
simultaneousHARQ-ACK-CSI Enabling simultaneous transmission of CSI and HARQ-ACK feedback with or without SR with PUCCH Format 2, 3 or 4. See TS 38.213, section 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, section 9.2.
intraSlotFrequencyHopping See TS 38.213, section 9.2.1.
secondHopPRB Index of starting PRB for second hop of PUCCH in case of FH. This value is appliable for intra-slot frequency hopping. Ssee TS 38.213, section 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 bit. The field is not present in the last configured set since the UE derives its maximum payload size as specified in 38.213. This field can take integer values that are multiples of 4. Corresponds to L1 parameter 'N_2' or 'N_3' (see TS 38.213, section 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 speciied in TS 38.213, section 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,   -- Need R
    pucch-GroupHopping                  ENUMERATED { neither, enable, disable },
    hoppingId                           INTEGER (0..1024)                                                   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 hoppping and sequence hopping if enabled. Corresponds to L1 parameter 'HoppingID' (see 38.211, section 6.3.2.2)
p0-nominal Power control parameter P0 for PUCCH transmissions. Value in dBm. Only even values (step size 2) allowed. Corresponds to L1 parameter 'p0-nominal-pucch' (see 38.213, section 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. Corresponds to L1 parameter 'PUCCH-GroupHopping' (see 38.211, section 6.4.1.3)
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 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. Corresponds to L1 parameter 'PUCCH-resource-common' (see 38.213, section 9.2)

– *PUCCH-PathlossReferenceRS-Id*

The IE *PUCCH-PathlossReferenceRS-Id* is an ID for a referemce signal (RS) configured as PUCCH pathloss reference. It corresponds to L1 parameter 'pucch-pathlossreference-index' (see 38.213, section 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 FFS

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 38.213, section 7.2)
deltaF-PUCCH-f1 deltaF for PUCCH format 1 with 1dB step size (see 38.213, section 7.2)
deltaF-PUCCH-f2 deltaF for PUCCH format 2 with 1dB step size (see 38.213, section 7.2)
deltaF-PUCCH-f3 deltaF for PUCCH format 3 with 1dB step size (see 38.213, section 7.2)
deltaF-PUCCH-f4 deltaF for PUCCH format 4 with 1dB step size (see 38.213, section 7.2)
p0-Set A set with dedicated P0 values for PUCCH, i.e., {P01, P02,... }. Corresponds to L1 parameter 'p0-pucch-set' (see 38.213, section 7.2)
pathlossReferenceRSs A set of Reference Signals (e.g. a CSI-RS config or a SSblock) to be used for PUCCH pathloss estimation. Up to maxNrofPUCCH-PathlossReference-RSs may be configured FFS_CHECK: Is it possible not to configure it at all? What does the UE use then? Any SSB? Corresponds to L1 parameter 'pucch-pathlossReference-rs-config' (see 38.213, section 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 applies one (i.e., g(i,0)). Corresponds to L1 parameter 'num-pucch-pcadjustment-states' (see 38.213, section 7.2)

– *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 M
    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 {mode1, mode2}                                           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, spare1}                                     OPTIONAL,   -- Need S
    mcs-TableTransformPrecoder              ENUMERATED {qam256, spare1}                                 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 Corresponds to L1 parameter 'ULCodebookSubset' (see 38.211, section 6.3.1.5).
dataScramblingIdentityPUSCH Identifer used to initalite data scrambling (c_init) for both PUSCH. Corresponds to L1 parameter 'Data-scrambling-Identity' (see 38.211, section 6.3.1.1).
dmrs-UplinkForPUSCH-MappingTypeA DMRS configuration for PUSCH transmissions using PUSCH mapping type A (chosen dynamically via PUSCH-TimeDomainResourceAllocation).
dmrs-UplinkForPUSCH-MappingTypeB DMRS configuration for PUSCH transmissions using PUSCH mapping type B (chosen dynamically via PUSCH-TimeDomainResourceAllocation).
frequencyHopping Configures one of two supported frequency hopping mode. If not configured, frequency hopping is not configured. Corresponds to L1 parameter 'Frequency-hopping-PUSCH' (see 38.214, section 6).
frequencyHoppingOffsetLists Set of frequency hopping offsets used when frequency hopping is enabled for granted transmission (not msg3) and type 2 Corresponds to L1 parameter 'Frequency-hopping-offsets-set' (see 38.214, section 6.3).
maxRank Subset of PMIs addressed by TRIs from 1 to ULmaxRank. Corresponds to L1 parameter 'ULmaxRank' (see 38.211, section 6.3.1.5).
mcs-Table Indicates which MCS table the UE shall use for PUSCH without transform precoder Corresponds to L1 parameter 'MCS-Table-PUSCH' (see 38.214, section 6.1.4) 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 Corresponds to L1 parameter 'MCS-Table-PUSCH-transform-precoding' (see 38.214, section 6.1.4) If the field is absent the UE applies the value 64QAM
pusch-AggregationFactor Number of repetitions for data. Corresponds to L1 parameter 'aggregation-factor-UL' (see 38.214, section FFS_Section). If the field is absent the UE applies the value 1.
pusch-AllocationList List of time domain allocations for timing of UL assignment to UL data. If configured, the values provided herein override the values received in corresponding PUSCH-ConfigCommon.
rbg-Size Selection between config 1 and config 2 for RBG size for PUSCH. When the field is absent the UE applies the value config1. Corresponds to L1 parameter 'RBG-size-PUSCH' (see 38.214, section 6.1.2.2.1).
resourceAllocation Configuration of resource allocation type 0 and resource allocation type 1 for non-fallback DCI Corresponds to L1 parameter 'Resouce-allocation-config' (see 38.214, section 6.1.2).
tp-pi2PBSK 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. When the field is absent the UE applies the value msg3-tp. Corresponds to L1 parameter 'PUSCH-tp' (see 38.211, section 6.3.1.4).
txConfig Whether UE uses codebook based or non-codebook based transmission. Corresponds to L1 parameter 'ulTxConfig' (see 38.214, section 6.1.1). If the field is absent, the UE transmits PUSCH on one antenna port, see 38.214, section 6.1.1.
uci-OnPUSCH 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 section 9.x.x). Corresponds to L1 parameter 'UCI-on-PUSCH' (see 38.213, section 9.3).

UCI-OnPUSCH field descriptions
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. Corresponds to L1 parameter 'uci-on-pusch-scaling' (see 38.212, section 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 38.211, section FFS_Section) This field is Cell specific
msg3-DeltaPreamble Power offset between msg3 and RACH preamble transmission. Actual value = field value * 2 [dB]. Corresponds to L1 parameter 'Delta-preamble-msg3' (see 38.213, section 7.1)
p0-NominalWithGrant P0 value for PUSCH with grant (except msg3). Value in dBm. Only even values (step size 2) allowed. Corresponds to L1 parameter 'p0-nominal-pusch-withgrant' (see 38.213, section 7.1) This field is cell specific
pusch-AllocationList List of time domain allocations for timing of UL assignment to UL data

– *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
}

-- A set of p0-pusch and alpha used for PUSCH with grant. 'PUSCH beam indication' (if present) gives the index of the set to
-- be used for a particular PUSCH transmission.
-- FFS_CHECK: Is the ”PUSCH beam indication” in DCI which schedules the PUSCH? If so, clarify in field description
-- Corresponds to L1 parameter 'p0-pusch-alpha-set' (see 38.213, section 7.1)
P0-PUSCH-AlphaSet ::=               SEQUENCE {
    p0-PUSCH-AlphaSetId                 P0-PUSCH-AlphaSetId,
    p0                                  INTEGER (-16..15)                                                   OPTIONAL,
    alpha                               Alpha                                                               OPTIONAL-- Need S
}

-- ID for a P0-PUSCH-AlphaSet. Corresponds to L1 parameter 'p0alphasetindex' (see 38.213, section 7.1)
```

```
P0-PUSCH-AlphaSetId ::=             INTEGER (0..maxNrofP0-PUSCH-AlphaSets-1)

-- A reference signal (RS) configured as pathloss reference signal for PUSCH power control
-- Corresponds to L1 parameter 'pusch-pathlossReference-rs' (see 38.213, section 7.1)
PUSCH-PathlossReferenceRS ::=       SEQUENCE {
    pusch-PathlossReferenceRS-Id        PUSCH-PathlossReferenceRS-Id,
    referenceSignal                     CHOICE {
        ssb-Index                           SSB-Index,
        csi-RS-Index                        NZP-CSI-RS-ResourceId
    }
}

-- ID for a referemce signal (RS) configured as PUSCH pathloss reference
-- Corresponds to L1 parameter 'pathlossreference-index' (see 38.213, section 7.1)
-- FFS_CHECK: Is this ID used anywhere except inside the PUSCH-PathlossReference-RS itself?
PUSCH-PathlossReferenceRS-Id ::=    INTEGER (0..maxNrofPUSCH-PathlossReferenceRSs-1)


-- A set of PUSCH power control parameters associated with one SRS-ResourceIndex (SRI)
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)

-- A set of beta-offset values
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. Corresponds to L1 parameter 'betaOffset-ACK-Index-1' (see 38.213, section 9.3) When the field is absent the UE applies the value 11
betaOffsetACK-Index2 Up to 11 bits HARQ-ACK. Corresponds to L1 parameter 'betaOffset-ACK-Index-2' (see 38.213, section 9.3) When the field is absent the UE applies the value 11
betaOffsetACK-Index3 Above 11 bits HARQ-ACK. Corresponds to L1 parameter 'betaOffset-ACK-Index-3' (see 38.213, section 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. Corresponds to L1 parameter 'betaOffset-CSI-part-1-Index-1' (see 38.213, section 9.3) When the field is absent the UE applies the value 13
betaOffsetCSI-Part1-Index2 Above 11 bits of CSI part 1 bits. Corresponds to L1 parameter 'betaOffset-CSI-part-1-Index-2' (see 38.213, section 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. Corresponds to L1 parameter 'betaOffset-CSI-part-2-Index-1' (see 38.213, section 9.3) When the field is absent the UE applies the value 13
betaOffsetCSI-Part2-Index2 Above 11 bits of CSI part 2 bits. Corresponds to L1 parameter 'betaOffset-CSI-part-2-Index-2' (see 38.213, section 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 38.213, section 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. Corresponds to L1 parameter 'p0-pusch' (see 38,213, section 7.1)

PUSCH-PowerControl field descriptions
deltaMCS Indicates whether to apply dela MCS. When the field is absent, the UE applies Ks = 0 in delta_TFC formula for PUSCH. Corresponds to L1 parameter 'deltaMCS-Enabled' (see 38.213, section 7.1)
msg3-Alpha Dedicated alpha value for msg3 PUSCH. Corresponds to L1 parameter 'alpha-ue-pusch-msg3' (see 38.213, section 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},...}. Corresponds to L1 parameter 'p0-push-alpha-setconfig' (see 38,213, section 7.1)
p0-NominalWithoutGrant P0 value for UL grant-free/SPS based PUSCH. Value in dBm. Only even values (step size 2) allowed. Corresponds to L1 parameter 'p0-nominal-pusch-withoutgrant' (see 38.213, section 7.1)
pathlossReferenceRSToAddModList A set of Reference Signals (e.g. a CSI-RS config or a SSblock) to be used for PUSCH path loss estimation. Up to maxNrofPUSCH-PathlossReferenceRSs may be configured when 'PUSCH beam indication' is present (FFS: in DCI???). Otherwise, there may be only one entry. Corresponds to L1 parameter 'pusch-pathlossReference-rs-config' (see 38.213, section 7.1)
sri-PUSCH-MappingToAddModList A list of SRI-PUSCH-PowerControl elements among which one is selected by the SRI field in DCI. Corresponds to L1 parameter 'SRI-PUSCHPowerControl-mapping' (see 38.213, section 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. Corresponds to L1 parameter 'Accumulation-enabled' (see 38.213, section 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,1) and fc(i,2)). If the field is absent, it applies one (i.e., fc(i,1)). Corresponds to L1 parameter 'num-pusch-pcadjustment-states' (see 38.213, section 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
    ...
}

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) For 2 codewords, only the values { n2, n4 } are valid.

PUSCH-ServingCellConfig field descriptions
codeBlockGroupTransmission Enables and configures code-block-group (CBG) based transmission (see 38.214, section FFS_Section)
rateMatching Enables LBRM (Limited buffer rate-matching). When the field is absent the UE applies FBRM (Full buffer rate-matchingLBRM). Corresponds to L1 parameter 'LBRM-FBRM-selection' (see 38.212, section 5.4.2)
xOverhead Accounts for overhead from CSI-RS, CORESET, etc. If the field is absent, the UE applies the value 'xoh0'. Corresponds to L1 parameter 'Xoh-PUSCH' (see 38.214, section 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 configued 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 38.214, section FFS_Section) 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. Corresponds to L1 parameter 'Mapping-type' (see 38.214, section FFS_Section)
startSymbolAndLength An index into a table/equation in RAN1 specs capturing valid combinations of start symbol and length (jointly encoded) Corresponds to L1 parameter 'Index-start-len' (see 38.214, section FFS_Section)

– *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

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
```

Editor's Note: FFS Confirm the exact values that are supported.

– *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
    ...
}

QuantityConfigNR::=                 SEQUENCE {
    quantityConfigCell                  QuantityConfigRS,
    quantityConfigRS-Index              QuantityConfigRS                                                        OPTIONAL    -- Need M
}

QuantityConfigRS ::=                SEQUENCE {
    ssb-FilterConfig                    FilterConfig,
    cs-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
cs-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 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 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, spare7, 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,   --Need S
    restrictedSetConfig                     ENUMERATED {unrestrictedSet, restrictedSetTypeA, restrictedSetTypeB},
    msg3-transformPrecoding                 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 FFS_Spec, section FFS_Section)
msg1-SubcarrierSpacing Subcarrier spacing of PRACH. Only the values 15 or 30 kHz (<6GHz), 60 or 120 kHz (>6GHz) are applicable. Corresponds to L1 parameter 'prach-Msg1SubcarrierSpacing' (see 38.211, section FFS_Section). If absent, the UE applies the SCS as derived from the *prach-ConfigurationIndex* in *RACH-ConfigGeneric* (see 38.211, section XXX).
msg3-transformPrecoding Indicates to a UE whether transform precoding is enabled for Msg3 transmission. Absence indicates that it is disabled. Corresponds to L1 parameter 'msg3-tp' (see 38.213, section 8.1)
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 38.321, section 5.1.1). The setting should be consistent with the setting of *ssb-perRACH-OccasionAndCB-PreamblesPerSSB*.
prach-RootSequenceIndex PRACH root sequence index. Corresponds to L1 parameter 'PRACHRootSequenceIndex' (see 38.211, section 6.3.3.1). The value range depends on whether L=839 or L=139
ra-ContentionResolutionTimer The initial value for the contention resolution timer (see 38.321, section 5.1.5). Value *ms8* corresponds to 8 ms, value *ms16* corresponds to 16 ms, and so on.
ra-Msg3SizeGroupA Transport Blocks size threshold in bit below which the UE shall use a contention based RA premable of group A. (see 38.321, section 5.1.2)
rach-ConfigGeneric Generic RACH parameters
restrictedSetConfig Configuration of an unrestricted set or one of two types of restricted sets, see 38.211 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 38.213, section REF)
rsrp-ThresholdSSB-SUL The UE selects SUL carrier to perform random access based on this threshold (see TS 38.321, section 5.1.1).
ssb-perRACH-OccasionAndCB-PreamblesPerSSB Number of SSBs per RACH occasion (L1 parameter 'SSB-per-rach-occasion') and the number of Contention Based preambles per SSB (L1 parameter 'CB-preambles-per-SSB'). 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, excluding preambles used for other purposes (e.g. for SI request). If the field is absent, the UE may use all 64 preambles for RA.

Conditional Presence	**Explanation**
SUL	The field is mandatory present in *initialUplinkBWP* in *supplementaryUplink*; otherwise, the field is absent.

– *RACH-ConfigGeneric*

The *RACH-ConfigGeneric* IE is used to specify the cell specific 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. Corresponds to L1 parameter 'prach-FDM' (see 38.211, section FFS_Section)
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. Corresponds to L1 parameter 'prach-frequency-start' (see 38,211, section FFS_Section)
powerRampingStep Power ramping steps for PRACH (see 38.321,5.1.3)
prach-ConfigurationIndex PRACH configuration index. Corresponds to L1 parameter 'PRACHConfigurationIndex' (see 38.211, section 6.3.3.2)
preambleReceivedTargetPower The target power level at the network receiver side (see 38.213, section 7.4, 38.321, section 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 perfomed before declaring a failure (see 38.321, section 5.1.4, 5.1.5)
ra-ResponseWindow Msg2 (RAR) window length in number of slots. The network configures a value lower than or euqal to 10 ms (see 38.321, section 5.1.4)
zeroCorrelationZoneConfig N-CS configuration, see Table 6.3.3.1-3 in 38.211

– *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

-- FFS_Standlone: resources for msg1-based on-demand SI request

RACH-ConfigDedicated ::=        SEQUENCE {
    cfra                            CFRA                                                                    OPTIONAL,   -- Need N
    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
        }
    },
    ...
}

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.
ra-PreambleIndex The RA preamble index to use in the RA occasions assoicated with this CSI-RS.

CFRA field descriptions
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.
ssb-perRACH-Occasion Number of SSBs per RACH occasion (L1 parameter 'SSB-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 38.321, section 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.

– *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 38,321, section 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,   -- Need N
    srb3-ToRelease                          ENUMERATED{true}                                        OPTIONAL,   -- Need N
    drb-ToAddModList                        DRB-ToAddModList                                        OPTIONAL,   -- Need N
    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{keNB, s-KgNB}                                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 may only be set if the cell groups of all linked logical channels are reset or released Indicates that PDCP should be re-established. Network sets this to TRUE whenever the security key used for this radio bearer changes.
sdap-Config The SDAP configuration determines how to map QoS flows to DRBs when NR connects to the 5GC

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, the UE shall continue to use the currently configured keyToUse and security algorithm for the radio bearers reconfigured with the lists in this radioBearerConfig.
srb3-ToRelease Release SRB3. SRB3 release can only be done at SCG release and reconfiguration with sync.

SecurityConfig field descriptions
keyToUse Indicates if the bearers configured with the list in this radioBearerConfig is using KeNB or S-KgNB for deriving ciphering and/or integrity protection keys. Network should not configure SRB1 and SRB2 with S-KgNB and SRB3 with KeNB. 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.
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.

SRB-ToAddMod field descriptions
reestablishPDCP may only be set if the cell groups of all linked logical channels are reset or released
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.

– *RadioLinkMonitoringConfig*

The *RadioLinkMonitoringConfig* IE is used to configure radio link monitoring for detection of beam- and/or cell radio link failure. See also 38.321, section 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 S
    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 38.321, section FFS_Section). See also the BeamFailureRecoveryConfig IE. Value in number of "periods of Beam Failure Detection" Reference Signal. Value pbfd1 corresponds to 1 period of Beam Failure Detection Reference Signal, value pbfd2 corresponds to 2 periods of Beam Failure Detection Reference Signal and so on. When the network reconfigures this field, the UE resets on-going *beamFailureDetectionTimer* and the counter related to *beamFailureInstanceMaxCount*.
beamFailureInstanceMaxCount This field determines after how many beam failure events the UE triggers beam failure recovery (see 38.321, section 5.17). Value n1 corresponds to 1 beam failure instance, n2 corresponds to 2 beam failure instances and so on. When the network reconfigures this field, the UE resets on-going*beamFailureDetectionTimer* and the counter related to *beamFailureInstanceMaxCount*. If the field is absent, the UE does not trigger beam failure recovery.
failureDetectionResourcesToAddModList A list of reference signals for detecting beam failure and/or cell level radio link failure (RLF). 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. However, if the activated TCI state refers to an aperiodic or semi-persistent CSI-RS, the gNB configures the failure detection resources explicitly (FFS_RAN1: TBC by RAN1). If no RSs are provided in this list at all (neither for Cell- nor for Beam-RLM), the UE performs also Cell-RLM based on the activated TCI-State of PDCCH (FFS_RAN1: TBC by RAN1). When the RS(s) for RLF is reconfigured by the network, the UE resets T310 and the counters related to N310 and N311. When the RS(s) for beam failure detection (BFD) is reconfigured by the network, the UE resets the on-going *beamFailureDetectionTimer* and the counter related to *beamFailureInstanceMaxCount*.

RadioLinkMonitoringRS field descriptions
detectionResource A reference signal that the UE shall use for radio link monitoring.
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
```

– *RateMatchPattern*

The IE *RateMatchPattern* is used to configure one rate matching pattern for PDSCH. Corresponds to L1 IE 'rate-match-PDSCH-resource-set', see 38.214, section FFS_Section.

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
    mode                                ENUMERATED { dynamic, semiStatic },
    ...
}

-- TAG-RATEMATCHPATTERN-STOP
-- ASN1STOP
```

RateMatchPattern field descriptions
controlResourceSet This ControlResourceSet us used as a PDSCH rate matching pattern, i.e., PDSCH reception rate matches around it.
mode FFS_Description, FFS_Section
periodicityAndPattern A time domain repetition pattern. at which the symbolsInResourceBlock pattern recurs. This slot pattern repeats itself continuously. Absence of this field indicates the value n1, i.e., the symbolsInResourceBlock recurs every 14 symbols. Corresponds to L1 parameter 'rate-match-PDSCH-bitmap3' (see 38.214, section FFS_Section)
resourceBlocks A resource block level bitmap in the frequency domain. It indicates the PRBs to which the symbolsInResourceBlock bitmap applies. Corresponds to L1 parameter 'rate-match-PDSCH-bitmap1' (see 38.214, section FFS_Section) FFS_ASN1: Consider multiple options with different number of bits (for narrower carriers)
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. Corresponds to L1 parameter 'resource-pattern-scs' (see 38.214, section FFS_Section)
symbolsInResourceBlock A symbol level bitmap in time domain. It indicates (FFS: with a bit set to true) the symbols which the UE shall rate match around. This pattern recurs (in time domain) with the configured periodicityAndOffset. Corresponds to L1 parameter 'rate-match-PDSCH-bitmap2' (see 38.214, section FFS_Section)

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. Corresponds to L1 parameter 'resource-set-index' (see 38.214, section 5.1.2.2.3)

***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.

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 numbewr of PRBs. Corresponds to L1 parameter 'BW' (see 38.214, section 5.1.4)
carrierFreqDL Center of the LTE carrier. Corresponds to L1 parameter 'center-subcarrier-location' (see 38.214, section 5.1.4)
mbsfn-SubframeConfigList LTE MBSFN subframe configuration. Corresponds to L1 parameter 'MBSFN-subframconfig' (see 38.214, section 5.1.4) FFS_ASN1: Import the LTE MBSFN-SubframeConfigList
nrofCRS-Ports Number of LTE CRS antenna port to rate-match around. Corresponds to L1 parameter 'rate-match-resources-numb-LTE-CRS-antenna-port' (see 38.214, section 5.1.4)
v-Shift Shifting value v-shift in LTE to rate match around LTE CRS Corresponds to L1 parameter 'rate-match-resources-LTE-CRS-v-shift' (see 38.214, section 5.1.4)

– *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
```

– *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 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 is to be completed before the end of Rel-15.
        ...
    }
}

-- FFS / TODO: Consider separating trgger configuration (trigger, periodic, ...) from report configuration.
-- Current structure allows easier definiton of new events and new report types e.g. CGI, etc.
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),

    reportQuantityRsIndexes                     MeasReportQuantity                                  OPTIONAL,   -- Need R
    maxNrofRSIndexesToReport                    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),
```

```
    reportQuantityRsIndexes             MeasReportQuantity                          OPTIONAL,   -- Need R
    maxNrofRsIndexesToReport            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-START
-- ASN1STOP
```

***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.
maxNrofRsIndexesToReport Max number of measurement information per RS index 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 includes 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.
reportQuantityRsIndexes 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**
maxNrofRsIndexesToReport Max number of measurement information per RS index to include in the measurement report for A1-A6 events.
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.
reportQuantityRsIndexes 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,
        ...
    }
}

-- 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

ReportInterval ::=                  ENUMERATED { ms120, ms240, ms480, ms640, ms1024, ms2048, ms5120, ms10240, ms20480, ms40960,
                                                 min1, min6, min12, min30 }

-- ASN1STOP
```

– *RLC-BearerConfig*

The IE *RLC-BearerConfig* is used to configure FFS

***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 R
    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.
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.

– *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.
t-PollRetransmit Timer for RLC AM inTS 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},
    ...
}

-- TAG-RLF-TIMERS-AND-CONSTANTS-STOP
-- ASN1STOP
```

***RLF-TimersAndConstants* field descriptions**
n3xy Constants are described in section 7.3. n1 corresponds with 1, n2 corresponds to 2 and so on.
t3xy Timers are described in section 7.1. Value ms0 corresponds with 0 ms, ms50 corresponds to 50 ms and so on.

– *RNTI-Value*

The *RNTI-Value* IE 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. 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
sr-ConfigIndex Used to modify a SR configuration and to indicate, in LogicalChannelConfig, the SR configuration to which a logical channel is mapped.
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 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 38.213, section 9.2.2).

***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 slots. Corresponds to L1 parameter 'SR-periodicity' and 'SR-offset' (see 38.213, section 9.2.2) 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, sl640 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 sym2, sym7 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). Corresponds to L1 parameter 'SR-resource' (see 38.213, section 9.2.2)
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),
    ...
}

-- 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) Corresponds to L1 parameter 'BW' (see 38.211, section FFS_Section)
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. Corresponds to L1 parameter 'offset-pointA-low-scs' (see 38.211, section FFS_Section)
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. Corresponds to L1 parameter 'ref-scs' (see 38.211, section FFS_Section)

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 [FFS_Ref].

***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 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*.
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.
sdap-HeaderDL Indicates whether or not a SDAP header is present for DL data on this DRB.

– *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 {
                    monitoringPeriodicity                       ENUMERATED {n1, n2, n4, n5, n8, n10, n16, n20 }     OPTIONAL,   -- Cond Setup
                    nrofPDCCH-Candidates                        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 configured in MIB and in ServingCellConfigCommon Values 1..maxNrofControlResourceSets-1 identify CORESETs configured by dedicated signalling
dci-Format0-0-AndFormat1-0 If configured, the UE monitors the DCI formats 0_0 and 1_0 with CRC scrambled by C-RNTI, CS-RNTI (if configured), SP-CSI-RNTI (if configured), RA-RNTI, TC-RNTI, P-RNTI, SI-RNTI
dci-Format2-0 If configured, UE monitors the DCI format format 2_0 with CRC scrambled by SFI-RNTI
dci-Format2-1 If configured, UE monitors the DCI format format 2_1 with CRC scrambled by INT-RNTI
dci-Format2-2 If configured, UE monitors the DCI format 2_2 with CRC scrambled by TPC-PUSCH-RNTI or TPC-PUCCH-RNTI
dci-Format2-3 If configured, UE monitors the DCI format 2_3 with CRC scrambled by TPC-SRS-RNTI
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. The maximum valid duration is periodicity-1 (periodicity as given in the monitoringSlotPeriodicityAndOffset).
monitoringPeriodicity Monitoring periodicity of SRS PDCCH in number of slots for DCI format 2-3. Corresponds to L1 parameter 'SRS-monitoring-periodicity' (see 38.212, 38.213, section 7.3.1, 11.3)
monitoringSlotPeriodicityAndOffset Slots for PDCCH Monitoring configured as periodicity and offset. Corresponds to L1 parameters 'Montoring-periodicity-PDCCH-slot' and 'Montoring-offset-PDCCH-slot' (see 38.213, section 10)
monitoringSymbolsWithinSlot Symbols for PDCCH monitoring in the slots configured for PDCCH monitoring (see monitoringSlotPeriodicityAndOffset). The most significant (left) bit represents the first OFDM in a slot. The least significant (right) bit represents the last symbol. Corresponds to L1 parameter 'Montoring-symbols-PDCCH-within-slot' (see 38.213, section 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. Corresponds to L1 parameters 'SFI-Num-PDCCH-cand' and 'SFI-Aggregation-Level' (see 38.213, section 11.1.1).
nrofCandidates Number of PDCCH candidates per aggregation level. Corresponds to L1 parameter 'Aggregation-level-1' to 'Aggregation-level-8'. 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 38.213, section 10)
nrofPDCCH-Candidates The number of PDCCH candidates for DCI format 2-3 for the configured aggregation level. Corresponds to L1 parameter 'SRS-Num-PDCCH-cand' (see 38.212, 38.213, section 7.3.1, 11.3)
searchSpaceId Identity of the search space. SearchSpaceId = 0 identifies the SearchSpace configured via PBCH (MIB) or ServingCellConfigCommon. 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), TC-RNTI (if a certain condition is met), 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 search space with the *SearchSpaceId* = 0 identifies the search space configured via PBCH (MIB) and in ServingCellConfigCommon. The number of Search Spaces per BWP is limited to 10 including the initial Search Space.

SearchSpaceId information element

```
-- ASN1START
-- TAG-SEARCHSPACEID-START

SearchSpaceId ::=                   INTEGER (0..maxNrofSearchSpaces-1)

-- TAG-SEARCHSPACEID-STOP
-- ASN1STOP
```

– *SecurityAlgorithmConfig*

The IE *SecurityAlgorithmConfig* is used to configure AS integrity protection algorithm (SRBs) and AS ciphering algorithm (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. For EN-DC, the algorithms configured for bearers using KeNB shall be the same as for all bearers using KeNB and the algorithms configured for bearers using KgNB shall be the same as for all bearers using KgNB.
integrityProtAlgorithm 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 KeNB shall be the same as for all SRBs using KeNB and the algorithms configured for bearers using KgNB shall be the same as for all bearers using KgNB. 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,   -- Cond ServCellAdd
    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,   -- Cond ServCellAdd-UL
    supplementaryUplink                 UplinkConfig                                                    OPTIONAL,   -- Cond ServCellAdd-SUL

    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
    ...
}

UplinkConfig ::=                    SEQUENCE {
    initialUplinkBWP                    BWP-UplinkDedicated                                             OPTIONAL,   -- Cond ServCellAdd
    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
    ...
}

-- 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 38.321, section 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 swithching to the default BWP.
crossCarrierSchedulingConfig Indicates whether this SCell is cross-carrier scheduled by another serving cell.
defaultDownlinkBWP-Id Corresponds to L1 parameter 'default-DL-BWP'. The initial bandwidth part is referred to by BWP-Id = 0. ID of the downlink bandwidth part to be used upon expiry of txxx. This field is UE specific. When the field is absent the UE uses the the initial BWP as default BWP. (see 38.211, 38.213, section 12 and 38.321, section 5.15)
downlinkBWP-ToAddModList List of additional downlink bandwidth parts to be added or modified. (see 38.211, 38.213, section 12).
downlinkBWP-ToReleaseList List of additional downlink bandwidth parts to be released. (see 38.211, 38.213, section 12).
firstActiveDownlinkBWP-Id If configured for an SpCell, this field contains the ID of the DL BWP to be activated upon performing the reconfiguration in which it is received. If the field is absent, the RRC reconfiguration does not impose a BWP switch (corresponds to L1 parameter 'active-BWP-DL-Pcell'). 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.
initialDownlinkBWP The dedicated (UE-specific) configuration for the initial downlink bandwidth-part.
pathlossReferenceLinking Indicates whether UE shall apply as pathloss reference either the downlink of PCell or of SCell that corresponds with this uplink (see 38.213, section 7)
pdsch-ServingCellConfig PDSCH releated parameters that are not BWP-specific.
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 aslike 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-CellList-Mobility* 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-CellList-Mobility* 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 Corresponds to L1 parameter 'SRS-CarrierSwitching' (see 38,214, section FFS_Section)
firstActiveUplinkBWP-Id If configured for an SpCell, this field contains the ID of the DL BWP to be activated upon performing the reconfiguration in which it is received. If the field is absent, the RRC reconfiguration does not impose a BWP switch (corresponds to L1 parameter 'active-BWP-UL-Pcell'). 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.
pusch-ServingCellConfig PUSCH related parameters that are not BWP-specific.
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.

Conditional Presence	Explanation
MeasObject	This field is mandatory present for the SpCell, it is optionally present, Need R, for SCells.
SCellOnly	This field is optionally present, Need R, for SCells. It is absent otherwise.
ServCellAdd	This field is mandatory present upon serving cell addition (for PSCell and SCell). It is optionally present, Need M otherwise.
ServCellAdd-UL	This field is mandatory present upon serving cell addition (for PSCell and SCell) provided that the serving cell is configured with uplink. It is optionally present, Need M otherwise.
ServCellAdd-SUL	This field is mandatory present upon serving cell addition (for PSCell and SCell) provided that the serving cell is configured with a supplementary uplink. It is optionally present, Need M 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, PSCell addition/change). The field is mandatory present, Need M, for an SCell upon addition. 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 InterFreqHOAndServCellAdd
```

```
    uplinkConfigCommon                  UplinkConfigCommon                                          OPTIONAL, -- Cond ServCellAdd-UL
    supplementaryUplinkConfig                   UplinkConfigCommon                                  OPTIONAL, -- Cond ServCellAdd-SUL
    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, -- Need S
    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) DL DM-RS (see 38.211, section 7.4.1.1.1)
initialDownlinkBWP The initial downlink BWP configuration for a SpCell (PCell of MCG or SCG). The parameters provided herein should match the parameters configured by MIB and SIB1 of the serving cell.
longBitmap bitmap for above 6 GHz
lte-CRS-ToMatchAround Parameters to determine an LTE CRS pattern that the UE shall rate match around.
mediumBitmap bitmap for 3-6 GHz
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 rangeof this serving cell. See 38.133, 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. Corresponds to L1 parameter 'Resource-set-cekk' (see 38.214, section 5.1.2.2.3)
shortBitmap bitmap for sub 3 GHz
ss-PBCH-BlockPower TX power that the NW used for SSB transmission. The UE uses it to estimate the RA preamble TX power. (see 38.213, section 7.4)
ssb-periodicityServingCell The SSB periodicity in msec for the rate matching purpose. If the field is absent, the UE applies the value ms5. (see 38.211, section [7.4.3.1])
ssb-PositionsInBurst Indicates the time domain positions of the transmitted SS-blocks in an SS-burst. 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. Corresponds to L1 parameter 'SSB-Transmitted' (see 38.213, section 4.1)
subcarrierSpacing Subcarrier spacing of SSB. Used only for non-initial access (e.g. SCells, PCell of SCG). If the field is absent the UE shall assume the default value of the band. Only the values 15 or 30 kHz (<6GHz), 120 or 240 kHz (>6GHz) are applicable.
tdd-UL-DL-ConfigurationCommon A cell-specific TDD UL/DL configuration, see 38.213, section 11.1.

Conditional Presence	Explanation
AbsFreqSSB	The field is absent when absoluteFrequencySSB in frequencyInfoDL is absent, oherwise 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.
InterFreqHOAndServCellAdd	This field is mandatory present for inter-frequency handover and upon serving cell (PSCell/SCell) addition. Otherwise, the field isoptionally present, Need M.
ServCellAdd	This field is mandatory present upon serving cell addition (for PSCell and SCell). It is optionally present, Need M otherwise.
ServCellAdd-UL	This field is mandatory present upon serving cell addition (for PSCell and SCell) provided that the serving cell is configured with uplink. It is optionally present, Need M otherwise.
ServCellAdd-SUL	This field is mandatory present upon serving cell addition (for PSCell and SCell) provided that the serving cell is configured with a supplementary uplink. It is optionally present, Need M otherwise.
TDD	The field is optionally present, Need R, for TDD cells; otherwise it is not present.

– *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
```

– *SlotFormatCombinationsPerCell*

The IE *SlotFormatCombinationsPerCell* is used to configure the SlotFormatCombinations applicable for one serving cell. Corresponds to L1 parameter 'cell-to-SFI' (see 38.213, section 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,
    positionInDCI                       INTEGER(0..maxSFI-DCI-PayloadSize-1)                                OPTIONAL,
    ...
}
```

```
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. Corresponds to L1 parameter 'SFI-index' (see 38.213, section FFS_Section)
slotFormats Slot formats that occur in consecutive slots in time domain order as listed here. The the slot formats are defined in 38.211, table 4.3.2-3 and numbered with 0..255.

***SlotFormatCombinationsPerCell* field descriptions**
positionInDCI The (starting) position (bit) of the slotFormatCombinationId (SFI-Index) for this serving cell (servingCellId) within the DCI payload. Corresponds to L1 parameter 'SFI-values' (see 38.213, section FFS_Section)
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 38.211, section 4.3.2). The total number of slotFormats in the slotFormatCombinations list does not exceed 512. FFS_CHECK: RAN1 indicates that the combinations could be of two different types... but they don't specify the second
subcarrierSpacing2 Reference subcarrier spacing for a Slot Format Combination on an FDD or SUL cell. Corresponds to L1 parameter 'SFI-scs2' (see 38.213, section FFS_Section). 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. Corresponds to L1 parameter 'SFI-scs' (see 38.213, section FFS_Section)

– *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. Corresponds to L1 parameter 'SFI-DCI-payload-length' (see 38.213, section 11.1.1)
sfi-RNTI RNTI used for SFI on the given cell Corresponds to L1 parameter 'SFI-RNTI' (see 38.213, section 11.1.1)
slotFormatCombToAddModList A list of SlotFormatCombinations for the UE's serving cells. Corresponds to L1 parameter 'SFI-cell-to-SFI' (see 38.213, section 11.1.1)

– *SS-RSSI-Measurement*

The IE *SS-RSSI-Measurement* is used to configure RSSI measuremens 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
```

– *SPS-Config*

Editor's Note: FFS: RAN1 indicated in the L1 table: "Note: Multiple configurations is possible, how many needs to be determined". RAN2 agreed that SPS can be used on Pcell and SCell... But each UE can use it on at most one serving cell of a cell group at a time. Are the ”multiple configuration” meant for one carrier? Does the UE then use several SPS-RNTIs?

The *SPS-Config* IE is used to configure downlink semi-persistent transmission. Downlink SPS may be configured on the PCell 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
}

-- TAG-SPS-CONFIG-STOP
-- ASN1STOP
```

***SPS-Config* field descriptions**
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 38.214, section FFS_Section.
nrofHARQ-Processes Number of configured HARQ processes for SPS DL. Corresponds to L1 parameter 'numberOfConfSPS-Processes' (see 38.214, section FFS_Section)
periodicity Periodicity for DL SPS Corresponds to L1 parameter 'semiPersistSchedIntervalDL' (see 38.214 and 38.321, section FFS_Section) FFS-Value: Support also shorter periodicities for DL?

– *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-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
            ...
        },
        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                              BIT STRING (SIZE (10)),
    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) Corresponds to L1 parameter 'Accumulation-enabled-srs' (see 38,213, section 7.3)

SRS-Resource field descriptions
cyclicShift-n2 Cyclic shift configuration. Corresponds to L1 parameter 'SRS-CyclicShiftConfig' (see 38.214, section 6.2.1)
cyclicShift-n4 Cyclic shift configuration. Corresponds to L1 parameter 'SRS-CyclicShiftConfig' (see 38.214, section 6.2.1)
freqDomainPosition Parameter(s) defining frequency domain position and configurable shift to align SRS allocation to 4 PRB grid. Corresponds to L1 parameter 'SRS-FreqDomainPosition' (see 38.214, section 6.2.1)
freqHopping Includes parameters capturing SRS frequency hopping Corresponds to L1 parameter 'SRS-FreqHopping' (see 38.214, section 6.2.1)
groupOrSequenceHopping Parameter(s) for configuring group or sequence hopping Corresponds to L1 parameter 'SRS-GroupSequenceHopping' (see 38.211, section FFS_Section)
periodicityAndOffset-p Periodicity and slot offset for 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. Corresponds to L1 parameter 'SRS-SlotConfig' (see 38.214, section 6.2.1)
periodicityAndOffset-sp Periodicity and slot offset for 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. Corresponds to L1 parameter 'SRS-SlotConfig' (see 38.214, section 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. Corresponds to L1 parameter 'UL-PTRS-SRS-mapping-non-CB' (see 38.214, section 6.1)
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). Corresponds to L1 parameter 'SRS-ResourceMapping' (see 38.214, section 6.2.1 and 38.211, section 6.4.1.4). FFS: Apparently, RAN1 considers replacing these three fields by a table in RAN1 specs and a corresponding index in ASN.1?!
resourceType Time domain behavior of SRS resource configuration. Corresponds to L1 parameter 'SRS-ResourceConfigType' (see 38.214, section 6.2.1). For codebook based uplink transmission, the network configures SRS resources in the same resource set with the same time domain behavior on periodic, aperiodic and semi-persistent SRS. FFS: Add configuration parameters for the different SRS resource types?
sequenceId Sequence ID used to initialize psedo random group and sequence hopping. Corresponds to L1 parameter 'SRS-SequenceId' (see 38.214, section 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 Corresponds to L1 parameter 'SRS-SpatialRelationInfo' (see 38.214, section 6.2.1)
transmissionComb Comb value (2 or 4) and comb offset (0..combValue-1). Corresponds to L1 parameter 'SRS-TransmissionComb' (see 38.214, section 6.2.1)

SRS-ResourceSet field descriptions
alpha alpha value for SRS power control. Corresponds to L1 parameter 'alpha-srs' (see 38.213, section 7.3) When the field is absent the UE applies the value 1
aperiodicSRS-ResourceTrigger The DCI "code point" upon which the UE shall transmit SRS according to this SRS resource set configuration. Corresponds to L1 parameter 'AperiodicSRS-ResourceTrigger' (see 38.214, section 6.1.1.2)
associatedCSI-RS ID of CSI-RS resource associated with this SRS resource set in non-codebook based operation. Corresponds to L1 parameter 'SRS-AssocCSIRS' (see 38.214, section 6.2.1)
csi-RS ID of CSI-RS resource associated with this SRS resource set. (see 38.214, section 6.1.1.2)
p0 P0 value for SRS power control. The value is in dBm. Only even values (step size 2) are allowed. Corresponds to L1 parameter 'p0-srs' (see 38.213, section 7.3)
pathlossReferenceRS A reference signal (e.g. a CSI-RS config or a SSblock) to be used for SRS path loss estimation. Corresponds to L1 parameter 'srs-pathlossReference-rs-config' (see 38.213, section 7.3)
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 Corresponds to L1 parameter 'srs-pcadjustment-state-config' (see 38.213, section 7.3)
srs-ResourceIdList The IDs of the SRS-Resources used in this SRS-ResourceSet
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 vs. used for either codebook based or non-codebook based transmission. Corresponds to L1 parameter 'SRS-SetUse' (see 38.214, section 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-CarrierSwitching*

The IE *SRS-CarrierSwitching* is used to configure FFS

SRS-CarrierSwitching information element

```
-- ASN1START
-- TAG-SRS-CARRIERSWITCHING-START
SRS-CarrierSwitching ::=            SEQUENCE {
    srs-SwitchFromServCellIndex         INTEGER (0..31)                                                                 OPTIONAL,   -- Cond Setup
    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,   -- Cond Setup
    monitoringCells                     SEQUENCE (SIZE (1..maxNrofServingCells)) OF ServCellIndex      OPTIONAL,   -- Cond Setup
    ...
}

-- One trigger configuration for SRS-Carrier Switching. (see 38.212, 38.213, section 7.3.1, 11.3)
SRS-TPC-PDCCH-Config ::=            SEQUENCE {
    srs-CC-SetIndexlist                 SEQUENCE (SIZE(1..4)) OF SRS-CC-SetIndex                       OPTIONAL    -- Cond Setup
}

SRS-CC-SetIndex ::=                 SEQUENCE {
    cc-SetIndex                         INTEGER (0..3)                                                 OPTIONAL,   -- Cond Setup
    cc-IndexInOneCC-Set                 INTEGER (0..7)                                                 OPTIONAL    -- Cond Setup
}

-- 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 38.212, 38.213, section 7.3.1, 11.3)
cc-SetIndex Indicates the CC set index for Type A associated (see 38.212, 38.213, section 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 Corresponds to L1 parameter 'SRS-monitoring-cells' (see 38.212, 38.213, section 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 38.214, section 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. Corresponds to L1 parameter 'typeA-SRS-TPC-PDCCH-Group' (see 38.212, 38.213, section 7.3.1, 11.3)
typeB Type B trigger configuration for SRS transmission on a PUSCH-less SCell. Corresponds to L1 parameter 'typeB-SRS-TPC-PDCCH-Config' (see 38.212, 38.213, section 7.3.1, 11.3)

SRS-TPC-PDCCH-Config field descriptions
srs-CC-SetIndexlist A list of pairs of [cc-SetIndex; cc-IndexInOneCC-Set] (see 38.212, 38.213, section 7.3.1, 11.3)

Conditional Presence	Explanation
Setup	This field is mandatory present upon configuration of SRS-CarrierSwitching or SRS-TPC-PDCCH-Config and optional (Need M) otherwise

– *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,   -- Cond Setup
    fieldTypeFormat2-3                      INTEGER (0..1)                                                              OPTIONAL,   -- Cond Setup
    ...
}

-- 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. (see 38.212, 38.213, section 7.3.1, 11.3)
startingBitOfFormat2-3 The starting bit position of a block within the group DCI with SRS request fields (optional) and TPC commands (see 38.212, 38.213, section 7.3.1, 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..63)

-- 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 38.213, section 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 38.213, section 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.

– *SubcarrierSpacing*

The *SubcarrierSpacing* IE 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
```

– *TCI-State*

The *TCI-State* IE 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 carrier which the RS is located in. 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 typeD. See TS 38.214 section 5.1.5.
referenceSignal Reference signal with which quasi-collocation information is provided as specified in TS 38.3214 subclause 5.1.5.
qcl-Type QCL type as specified in TS 38.214 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),
    ...
}

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 38.211, section FFS_Section)

TDD-UL-DL-Pattern field descriptions
dl-UL-TransmissionPeriodicity Periodicity of the DL-UL pattern, see 38.211, section FFS_Section.
nrofDownlinkSlots Number of consecutive full DL slots at the beginning of each DL-UL pattern, see 38.213, Table 4.3.2-1. 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 38.211¨3, section FFS_Section).
nrofUplinkSlots Number of consecutive full UL slots at the end of each DL-UL pattern, see 38.213, Table 4.3.2-1. 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 38.213, section FFS_Section)

TDD-UL-DL-ConfigDedicated field descriptions
slotSpecificConfigurationsToAddModList The slotSpecificConfiguration allows overriding UL/DL allocations provided in tdd-UL-DL-configurationCommon.

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 38.213, 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 38.213, 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.

– *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

TimeToTrigger ::=                   ENUMERATED {
                                        ms0, ms40, ms64, ms80, ms100, ms128, ms160, ms256,
                                        ms320, ms480, ms512, ms640, ms1024, ms1280, ms2560,
```

```
                                        ms5120}

-- ASN1STOP
```

Editor's Note: Values should be checked.

– *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 InterFreqHOAndServCellAndSIB1
    initialUplinkBWP                        BWP-UplinkCommon                                        OPTIONAL,   -- Cond ServCellAddAndSIB1
    timeAlignmentTimerCommon                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). Corresponds to L1 parameter 'initial-UL-BWP'. (see 38.331, section FFS_Section).

Conditional Presence	Explanation
InterFreqHOAndServCellAddAndSIB1	This field is mandatory present for inter-frequency handover, SIB1 and upon serving cell (PSCell/SCell) addition. Otherwise, the field isoptionally present, Need M.
ServCellAddAndSIB1	This field is mandatory present for SIB1 and upon serving cell addition (for PSCell and SCell). It is optionally present, Need M otherwise.

– *ZP-CSI-RS-Resource*

The IE *ZP-CSI-RS-Resource* is used to configure a Zero-Power (ZP) CSI-RS resource. Corresponds to L1 parameter 'ZP-CSI-RS-ResourceConfig' (see 38.214, section 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. Corresponds to L1 parameter 'ZP-CSI-RS-timeConfig' (see 38.214, section 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. Corresponds to L1 parameter 'ZP-CSI-RS-ResourceConfigId' (see 38.214, section 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

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
}



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
    }
}


-- TAG-BANDCOMBINATIONLIST-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-BandwidthClassEUTRA*

```
-- ASN1START
-- TAG-CA-BANDWIDTHCLASSEUTRA-START

CA-BandwidthClassEUTRA ::=  ENUMERATED {a, b, c, d, e, f, ...}

-- TAG-CA-BANDWIDTHCLASSEUTRA-STOP
```

```
-- ASN1STOP
```

– *CA-ParametersNR*

The IE *CA-ParametersNR* is 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,
    ...
}

-- TAG-CA-PARAMETERSNR-STOP
-- ASN1STOP
```

– *CA-ParametersEUTRA*

The IE *CA-ParameterEUTRA* contains the EUTRA part of band combination parameters for a given MR-DC band combination.

NOTE: If an additional EUTRA band combonation 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,
    ...
}

-- TAG-CA-PARAMETERSEUTRA-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 EUTRA 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 EUTRA, the feature sets referred to from this list are defined in TS 36.331 and conveyed as part of the UE-EUTRA-Capability container. The FeatureSetUL-Id-r15 and FeatureSetDL-Id-r15 in the EUTRA 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 FeatureSetUplink-Id:s/DownlinkPerCC-Id:s shall not exceed the number of carrier supported according to the BWC indicated in the associated BandCombination, if present.

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
    }
}

-- ASN1STOP
-- TAG-FEATURESETCOMBINATION-STOP
```

– *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*).

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,
    crossCarrierSchedulingDL-OtherSCS   ENUMERATED {supported}                                              OPTIONAL,
    scellWithoutSSB                     ENUMERATED {supported}                                              OPTIONAL,
    csi-RS-MeasSCellWithoutSSB          ENUMERATED {supported}                                              OPTIONAL,
    srs-AssocCSI-RS                     ENUMERATED {supported}                                              OPTIONAL,
    type1-3-CSS                         ENUMERATED {supported}                                              OPTIONAL,
    pdcchMonitoringAnyOccasions         ENUMERATED {withoutDCI-Gap, withDCI-Gap}                            OPTIONAL,
    pdcchMonitoringAnyOccasionsWithSpanGap  ENUMERATED {supported}                                          OPTIONAL,
    ue-SpecificUL-DL-Assignment         ENUMERATED {supported}                                              OPTIONAL,
    searchSpaceSharingCA-DL             ENUMERATED {supported}                                              OPTIONAL,
    timeDurationForQCL                  SEQUENCE {
        scs-60kHz                           ENUMERATED {s7, s14, s28}                                       OPTIONAL,
        sch-120kHz                          ENUMERATED {s14, s28}                                           OPTIONAL
    }                                                                                                       OPTIONAL,
    pdsch-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,
    csi-RS-IM-ReceptionForFeedback      CSI-RS-IM-ReceptionForFeedback                                      OPTIONAL,
```

```
    typeI-SinglePanelCodebookList           SEQUENCE (SIZE (1.. maxNrofCodebooks)) OF TypeI-SinglePanelCodebook OPTIONAL,
    typeI-MultiPanelCodebookList            SEQUENCE (SIZE (1.. maxNrofCodebooks)) OF TypeI-MultiPanelCodebook      OPTIONAL,
    typeII-CodebookList                     SEQUENCE (SIZE (1.. maxNrofCodebooks)) OF TypeII-Codebook               OPTIONAL,
    typeII-CodebookPortSelectionList        SEQUENCE (SIZE (1.. maxNrofCodebooks)) OF TypeII-CodebookPortSelection  OPTIONAL

}

CSI-RS-IM-ReceptionForFeedback ::=  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}
}

TypeI-SinglePanelCodebook ::=       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)
}

TypeI-MultiPanelCodebook ::=        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)
}

TypeII-Codebook ::=                 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)
}

TypeII-CodebookPortSelection ::=    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
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
```

– *FeatureSetEUTRA-DownlinkId*

The IE *FeatureSetEUTRA-DownlinkId* identifies a downlink feature set in EUTRA. 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
```

– *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
```

– *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,
```

```
    crossCarrierSchedulingUL-OtherSCS   ENUMERATED {supported}                      OPTIONAL,
    intraBandFreqSeparationUL               FreqSeparationClass                 OPTIONAL,
    searchSpaceSharingCA-UL             ENUMERATED {supported}                      OPTIONAL,
    srs-TxSwitch                        SRS-TxSwitch                                OPTIONAL,
    supportedSRS-Resources              SRS-Resources                               OPTIONAL,
    twoPUCCH-Group                      ENUMERATED {supported}                      OPTIONAL,
    dynamicSwitchSUL                    ENUMERATED {supported}                      OPTIONAL,
    pusch-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,
    csi-ReportFramework                 CSI-ReportFramework                         OPTIONAL
}


CSI-ReportFramework ::=             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
featureSetsPerUplinkCC 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 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 a downlink 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 *FeatureSetUplinkPerCC-Id* = 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
```

– *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
```

– *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,
    simultaneousTxSUL-NonSUL            ENUMERATED {supported}                      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
```

– *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.

***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,
    ...
}

-- ASN1STOP
-- TAG-FEATURESETS-STOP
```

– *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 a specific aggregated bandwidths.

***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         AggregatedBandwith          OPTIONAL,   -- Need N
    maxBandwidthRequestedUL         AggregatedBandwith          OPTIONAL,   -- Need N
    maxCarriersRequestedDL          INTEGER (1.. maxNrofServingCells)       OPTIONAL,   -- Need N
    maxCarriersRequestedUL          INTEGER (1.. maxNrofServingCells)       OPTIONAL    -- Need N
}

AggregatedBandwith ::=          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
```

– *MIMO-Layers*

```
-- ASN1START
-- TAG-MIMO-LAYERS-START

MIMO-LayersDL ::=   ENUMERATED {twoLayers, fourLayers, eightLayers}

MIMO-LayersUL ::=   ENUMERATED {oneLayer, twoLayers, fourLayers}

-- TAG-MIMO-LAYERS-STOP
-- ASN1STOP
```

– *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,
    ...
}

-- TAG-MRDC-PARAMETERS-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, spare2, spare1, ...}

-- TAG-RAT-TYPE-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 NR: the encoding of UE capabilities is defined in UE-NR-Capability. For EUTRA-NR: the encoding of UE capabilities is defined in UE-MRDC-Capability

– *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 [yy].

UE-MRDC-Capability information element

```
-- ASN1START
-- TAG-UE-MRDC-CAPABILITY-START

UE-MRDC-Capability ::=  SEQUENCE {
    measParametersMRDC                  MeasParametersMRDC                  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,
    lateNonCriticalExtension            OCTET STRING                        OPTIONAL,
    nonCriticalExtension                SEQUENCE {}                         OPTIONAL
}
UE-MRDC-CapabilityAddXDD-Mode ::=   SEQUENCE {
    measParametersMRDC-XDD-Diff     MeasParametersMRDC-XDD-Diff     OPTIONAL,
    generalParametersMRDC-XDD-Diff      GeneralParametersMRDC-XDD-Diff      OPTIONAL
}

UE-MRDC-CapabilityAddFRX-Mode ::=   SEQUENCE {
    measParametersMRDC-FRX-Diff     MeasParametersMRDC-FRX-Diff
}

GeneralParametersMRDC-XDD-Diff ::= SEQUENCE {
    splitSRB-WithOneUL-Path             ENUMERATED {supported}      OPTIONAL,
    splitDRB-withUL-Both-MCG-SCG        ENUMERATED {supported}      OPTIONAL,
    srb3                                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.

– *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
}

-- 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.

– *MeasParametersMRDC*

The IE *MeasParametersMRDC* is used to configure FFS

***MeasParametersMRDC* information element**

```
-- ASN1START
-- TAG-MEASPARAMETERSMRDC-START

MeasParametersMRDC ::= SEQUENCE {
    measParametersMRDC-Common       MeasParametersMRDC-Common               OPTIONAL,
```

```
    measParametersMRDC-XDD-Diff     MeasParametersMRDC-XDD-Diff             OPTIONAL,
    measParametersMRDC-FRX-Diff     MeasParametersMRDC-FRX-Diff             OPTIONAL
}

MeasParametersMRDC-Common ::=   SEQUENCE {
    independentGapConfig            ENUMERATED {supported}              OPTIONAL
}

MeasParametersMRDC-XDD-Diff ::= SEQUENCE {
    sftd-MeasPSCell                 ENUMERATED {supported}              OPTIONAL,
    sftd-MeasNR-Cell                ENUMERATED {supported}              OPTIONAL
}

MeasParametersMRDC-FRX-Diff ::= SEQUENCE {
    simultaneousRxDataSSB-DiffNumerology    ENUMERATED {supported}      OPTIONAL
}

-- TAG-MEASPARAMETERSMRDC-STOP
-- ASN1STOP
```

– *UE-NR-Capability*

The IE *UE-NR-Capability* is used to convey the NR UE Radio Access Capability Parameters, see TS 38.306 [yy].

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,
    measParameters                  MeasParameters                      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            SEQUENCE {}                         OPTIONAL
}

UE-NR-CapabilityAddXDD-Mode ::= SEQUENCE {
    phy-ParametersXDD-Diff          Phy-ParametersXDD-Diff          OPTIONAL,
```

```
    mac-ParametersXDD-Diff          MAC-ParametersXDD-Diff          OPTIONAL,
    measParametersXDD-Diff          MeasParametersXDD-Diff          OPTIONAL
}

UE-NR-CapabilityAddFRX-Mode ::= SEQUENCE {
    phy-ParametersFRX-Diff          Phy-ParametersFRX-Diff          OPTIONAL,
    measParametersFRX-Diff          MeasParametersFRX-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.

– *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,
    ...
}

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,
    ...
}

Phy-ParametersFRX-Diff ::=  SEQUENCE {
    dynamicSFI                          ENUMERATED {supported}                      OPTIONAL,
    oneFL-DMRS-TwoAdditionalDMRS        BIT STRING (SIZE (2))                       OPTIONAL,
    twoFL-DMRS                          BIT STRING (SIZE (2))                       OPTIONAL,
    twoFL-DMRS-TwoAdditionalDMRS        BIT STRING (SIZE (2))                       OPTIONAL,
    oneFL-DMRS-ThreeAdditionalDMRS      BIT STRING (SIZE (2))                       OPTIONAL,
    supportedDMRS-TypeDL                ENUMERATED {type1, type2}                   OPTIONAL,
    supportedDMRS-TypeUL                ENUMERATED {type1, type2}                   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           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              ENUMERATED {supported}                      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,
    ...
}

Phy-ParametersFR1 ::=   SEQUENCE {
    pdcchMonitoringSingleOccasion       ENUMERATED {supported}                      OPTIONAL,
    scs-60kHz                           ENUMERATED {supported}                      OPTIONAL,
    pdsch-256QAM-FR1                    ENUMERATED {supported}                      OPTIONAL,
    pdsch-RE-MappingFR1                 ENUMERATED {n10, n20}                       OPTIONAL,
    ...
}

Phy-ParametersFR2 ::=   SEQUENCE {
    calibrationGapPA                    ENUMERATED {supported}                      OPTIONAL,
    pdsch-RE-MappingFR2                 ENUMERATED {n6, n20}                        OPTIONAL,
    ...
}

-- TAG-PHY-PARAMETERS-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
```

```
}

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,
    crossCarrierSchedulingDL-SameSCS        ENUMERATED {supported}                      OPTIONAL,
    crossCarrierSchedulingUL-SameSCS        ENUMERATED {supported}                      OPTIONAL,
    pdsch-256QAM-FR2                ENUMERATED {supported}                      OPTIONAL,
    pusch-256QAM                    ENUMERATED {supported}                      OPTIONAL,
    ue-PowerClass                   ENUMERATED {pc2, pc3}               OPTIONAL,
    rateMatchingLTE-CRS             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.
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.

– *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}                          OPTIONAL,
        maxNumberActiveTCI-PerBWP           ENUMERATED {n1, n2, n4, n8}                                 OPTIONAL
    }                                                                                                   OPTIONAL,
    additionalActiveTCI-StatePDCCH      ENUMERATED {supported}                                          OPTIONAL,
    pusch-TransCoherence                ENUMERATED {nonCoherent, partialNonCoherent, fullCoherent}  OPTIONAL,
    beamCorrespondence                  ENUMERATED {supported}                                          OPTIONAL,
```

```
    periodicBeamReport                  ENUMERATED {supported}                                          OPTIONAL,
    aperiodicBeamReport                 ENUMERATED {supported}                                          OPTIONAL,
    sp-BeamReportPUCCH                  ENUMERATED {supported}                                          OPTIONAL,
    sp-BeamReportPUSCH                  ENUMERATED {supported}                                          OPTIONAL,
    beamManagementSSB-CSI-RS            BeamManagementSSB-CSI-RS                                        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         ENUMERATED {n2, n4, n8, n16, n32},
        maxNumberSRS-ResourceSet            INTEGER (1..8)
    }                                                                                                   OPTIONAL,
    maxNumberCSI-RS-BFR                 INTEGER (1..64)                                                 OPTIONAL,
    maxNumberSSB-BFR                    INTEGER (1..64)                                                 OPTIONAL,
    maxNumberCSI-RS-SSB-BFR             INTEGER (1..256)                                                OPTIONAL,
    twoPortsPTRS-DL                     ENUMERATED {supported}                                          OPTIONAL,
    twoPortsPTRS-UL                     ENUMERATED {supported}                                          OPTIONAL,
    supportedSRS-Resources          SRS-Resources                                                       OPTIONAL,
    srs-TxSwitch                    SRS-TxSwitch                                                        OPTIONAL,
    maxNumberSimultaneousSRS-PerCC      INTEGER (1..4)                                                  OPTIONAL,
    beamReportTiming                    SEQUENCE {
        scs-15kHz                           ENUMERATED {sym2, sym4, sym8}                               OPTIONAL,
        scs-30kHz                           ENUMERATED {sym4, sym8, sym14}                              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,
    csi-RS-ForTracking                  CSI-RS-ForTracking                                              OPTIONAL,
    aperiodicTRS                        ENUMERATED {supported}                                          OPTIONAL,
    ...
}

BeamManagementSSB-CSI-RS ::=    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}
}

CSI-RS-ForTracking ::=              SEQUENCE {
    burstLength                         INTEGER (1..2),
    maxSimultaneousResourceSetsPerCC    INTEGER (1..8),
    maxConfiguredResourceSetsPerCC      INTEGER (1..64),
    maxConfiguredResourceSetsAllCC      INTEGER (1..128)
}

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)
}

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}
}

SRS-TxSwitch ::=    SEQUENCE {
    supportedSRS-TxPortSwitch           ENUMERATED {t1r2, t1r4, t2r4, t1r4-t2r4, tr-equal},
    txSwitchImpactToRx                  ENUMERATED {true}                                       OPTIONAL
}

-- ASN1STOP
-- TAG-MIMO-PARAMETERSPERBAND-STOP
```

– *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,
    ...
}

-- TAG-PDCP-PARAMETERS-STOP
-- ASN1STOP
```

– *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
```

– 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,
    pucch-SpatialRelInfoMAC-CE      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
```

– MeasParameters

The IE *MeasParameters* is used to convey UE capabilities related to measurements for radio resource management (RRM) and radio link monitoring (RLM).

MeasParameters information element

```
-- ASN1START
-- TAG-MEASPARAMETERS-START

MeasParameters ::= SEQUENCE {
    measParametersCommon                MeasParametersCommon            OPTIONAL,
```

```
    measParametersXDD-Diff          MeasParametersXDD-Diff      OPTIONAL,
    measParametersFRX-Diff          MeasParametersFRX-Diff      OPTIONAL
}

MeasParametersCommon ::= SEQUENCE {
    supportedGapPattern             BIT STRING (SIZE (22))          OPTIONAL,
    ...
}

MeasParametersXDD-Diff ::=  SEQUENCE {
    intraAndInterF-MeasAndReport    ENUMERATED {supported}  OPTIONAL,
    eventA-MeasAndReport            ENUMERATED {supported}  OPTIONAL,
    ...
}

MeasParametersFRX-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,
    ...
}

-- TAG-UE-NR-CAPABILITY-STOP
-- ASN1STOP
```

6.3.4 Other information elements

– *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

maxNrofServingCells                     INTEGER ::= 32      -- Max number of serving cells (SpCell + SCells) per cell group
maxNrofServingCells-1                   INTEGER ::= 31      -- Max number of serving cells (SpCell + SCells) per cell group minus 1
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
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              INTEGER ::= 12      -- Max number of CoReSets configurable on a serving cell
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                     INTEGER ::= 40      -- Max number of Search Spaces
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
maxNrofPCI-Ranges                       INTEGER ::= 8       -- Maximum number of PCI ranges

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 in an SRS resource set.
maxNrofSRS-Resources-1                  INTEGER ::= 63      -- Maximum number of SRS resources in an SRS resource set minus 1.
maxNrofSRS-TriggerStates-1              INTEGER ::= 3       -- Maximum number of SRS trigger states minus 1, i.e., the largest code point.
maxRAT-CapabilityContainers             INTEGER ::= 8       -- Maximum number of interworking RAT containers (incl NR and MRDC)
maxSimultaneousBands                    INTEGER ::= 32      -- Maximum number of simultaneously aggregated bands
```

```
maxNrofSlotFormatCombinationsPerCell    INTEGER ::= 16      -- Maximum number of
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-ResourceSet
maxNrofPUCCH-ResourcesPerSet-1          INTEGER ::= 31      -- Maximum number of PUCCH Resources per PUCCH-ResourceSet minus 1.
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, section 7.1)
maxNrofP0-PUSCH-AlphaSets-1             INTEGER ::= 29      -- Maximum number of P0-pusch-alpha-sets minus 1 (see 38,213, section 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.

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 non-serving frequencies in MeasResultSCG-Failure.
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
maxNrofSRS-ResourcesPerSet              INTEGER ::= 16
maxNrofIndexesToReport                  INTEGER ::= 32
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.

maxNrofTCI-StatesPDCCH                  INTEGER ::= 64
maxNrofTCI-States                       INTEGER ::= 64          -- Maximum number of TCI states.
maxNrofTCI-States-1                     INTEGER ::= 63          -- 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

maxNrofSRI-PUSCH-Mappings               INTEGER ::= 16
maxNrofSRI-PUSCH-Mappings-1             INTEGER ::= 15

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 EUTRA) Total number of FeatureSets (size of the pool)
maxEUTRA-UL-FeatureSets             INTEGER ::= 256     -- (for EUTRA) 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)


-- Editor's Note: Targeted for completion in Sept 2018. Not used in EN-DC drop.
CellIdentity ::=                        ENUMERATED {ffsTypeAndValue}
ShortMAC-I ::=                          ENUMERATED {ffsTypeAndValue}

-- TAG-MULTIPLICITY-AND-TYPE-CONSTRAINT-DEFINITIONS-STOP
-- ASN1STOP
```

– End of NR-RRC-Definitions

```
-- ASN1START

END

-- ASN1STOP
```

7 Variables and constants

7.1 Timers

7.1.1 Timers (Informative)

Timer	Start	Stop	At expiry
T304	Reception of *RRCReconfiguration* message including *reconfigurationWithSync*	Successful completion of random access on the corresponding SpCell For T304 of SCG, upon SCG release	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.
T311	Upon initiating the RRC connection re-establishment procedure	Selection of a suitable NR cell or a cell using another RAT.	Enter RRC_IDLE

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

7.3 Constants

Constant	Usage
N310	Maximum number of consecutive "out-of-sync" indications for the PCell received from lower layers
N311	Maximum number of consecutive "in-sync" indications for the PCell 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 DEFINITIONS AUTOMATIC TAGS ::=

BEGIN

IMPORTS
    MeasId,
    MeasIdToAddModList,
    MeasObjectToAddModList,
    PhysCellId,
    ReportConfigToAddModList,
    RSRP-Range,
    QuantityConfig,
    maxNrofCellMeas,
    maxNrofMeasId
FROM NR-RRC-Definitions;

-- 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
```

Editor's Note: FFS Revisit whether we really need *VarMeasConfig*.

– *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,
--  Not needed for EN-DC.
    physCellIdEUTRA                     ENUMERATED {ffsTypeAndValue}
    }
```

```
-- TAG-VAR-MEAS-REPORT-STOP
-- ASN1STOP
```

– 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.

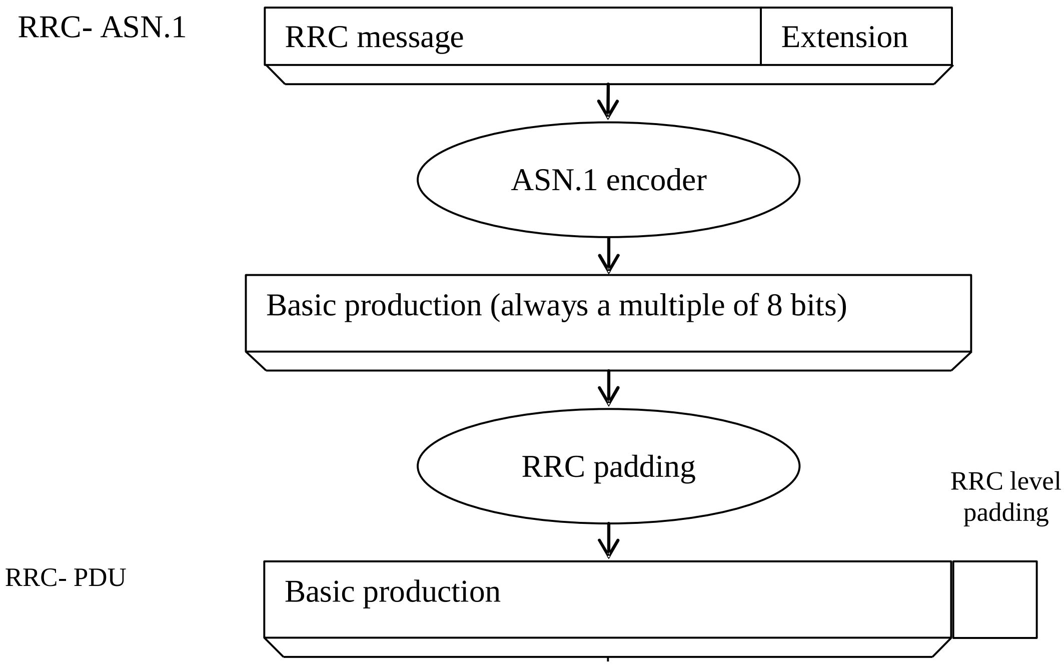

Figure 8.5-1: RRC level padding

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.

Editor's Note: FFS / FIXME: Default configurations

9.1 Specified configurations

Editor's Note: FFS

9.1.1 Logical channel configurations

9.1.2 SRB configurations

9.1.2.1 SRB1/SRB1S

Parameters

Name	Value	Semantics description	Ver
RLC configuration			
logicalChannelIdentity	1		

9.1.2.2 SRB2/SRB2S

Parameters

Name	Value	Semantics description	Ver
RLC configuration			
logicalChannelIdentity	2		

9.1.2.3 SRB3

Parameters

Name	Value	Semantics description	Ver
RLC configuration			
logicalChannelIdentity	3		

9.2 Default radio configurations

9.2.1 SRB configurations

9.2.1.1 SRB1/SRB1S

Parameters (FFS)

Name	Value	Semantics description	Ver
PDCP-Config *>t-Reordering*	 *infinity*		
RLC-Config CHOICE	am		
ul-RLC-Config *>sn-FieldLength* *>t-PollRetransmit* *>pollPDU* *>pollByte* *>maxRetxThreshold*	 size12 ms45 infinity infinity t4		
dl-RLC-Config *>sn-FieldLength* *>t-Reassembly* *>t-StatusProhibit*	 size12 ms35 ms0		
LogicalChannelConfig			
>priority	1	Highest priority	
>prioritisedBitRate	infinity		
>bucketSizeDuration	N/A		
>allowedSubCarrierSpacing	FFS		
>allowedTiming	FFS		
>logicalChannelGroup	0		
>logicalChannelSR-DelayTimerApplied	false		

9.2.1.2 SRB2/SRB2S

Parameters (FFS)

Name	Value	Semantics description	Ver
PDCP-Config *>t-Reordering*	 *infinity*		
RLC-Config CHOICE	am		
ul-RLC-Config *>sn-FieldLength* *>t-PollRetransmit* *>pollPDU* *>pollByte* *>maxRetxThreshold*	 size12 ms45 infinity infinity t4		
dl-RLC-Config *>sn-FieldLength* *>t-Reassembly* *>t-StatusProhibit*	 size12 ms35 ms0		
LogicalChannelConfig			
>priority	3		
>prioritisedBitRate	infinity		
>bucketSizeDuration	N/A		
>allowedSubCarrierSpacing	FFS		
>allowedTiming	FFS		
>logicalChannelGroup	0		
>logicalChannelSR-DelayTimerApplied	false		

9.2.1.3 SRB3

Parameters (FFS)

Name	Value	Semantics description	Ver
PDCP-Config *>t-Reordering*	 *infinity*		
RLC-Config CHOICE	am		
ul-RLC-Config *>sn-FieldLength* *>t-PollRetransmit* *>pollPDU* *>pollByte* *>maxRetxThreshold*	 size12 ms45 infinity infinity t4		
dl-RLC-Config *>sn-FieldLength* *>t-Reassembly* *>t-StatusProhibit*	 size12 ms35 ms0		
LogicalChannelConfig			
>priority	1	Highest priority	
>prioritisedBitRate	infinity		
>bucketSizeDuration	N/A		
>allowedSubCarrierSpacing	FFS		
>allowedTiming	FFS		
>logicalChannelGroup	0		
>logicalChannelSR-DelayTimerApplied	false		

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 section 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)) OF ItemInfo

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, a 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 section 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 section 10.3.

11 Radio information related interactions between network nodes

11.1 General

This section 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 section 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,
    CellIdentity,
    CSI-RS-Index,
    GapConfig,
    maxBandComb,
    maxNrofSCells,
    maxNrofServingCells-1,
    maxNrofIndexesToReport,
    MeasQuantityResults,
    MeasResultList2NR,
    MeasResultSCG-Failure,
    MeasResultCellListSFTD,
    P-Max,
    PhysCellId,
    RadioBearerConfig,
    RRCReconfiguration,
    ServCellIndex,
    SetupRelease,
    SSB-Index,
    SSB-MTC,
    ShortMAC-I,
    UE-CapabilityRAT-ContainerList
```

```
FROM NR-RRC-Definitions;

-- TAG_NR-INTER-NODE-DEFINITIONS-STOP
-- ASN1STOP
```

11.2.2 Message definitions

– *HandoverCommand*

Editor's Note: Targeted for completion in Sept 2018.

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*

Editor's Note: Targeted for completion in Sept 2018.

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                        OCTET STRING (CONTAINING RRCReconfiguration),
    rrm-Config                          RRM-Config                  OPTIONAL,
    as-Context                          AS-Context                  OPTIONAL,
    nonCriticalExtension                SEQUENCE {}                 OPTIONAL
}

AS-Context ::=                          SEQUENCE {
    reestablishmentInfo                     SEQUENCE {
        sourcePhysCellId                    PhysCellId,
        targetCellShortMAC-I                ShortMAC-I,
        additionalReestabInfoList           ReestabNCellInfoList                    OPTIONAL
    }                                                                               OPTIONAL,
    -- FFS Whether to change e.g. move all re-establishment info to Xx
    configRestrictInfo                  ConfigRestrictInfoSCG                       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, min1s20c, 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.

– *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           BandCombinationIndex                            OPTIONAL,
    fr-InfoListSCG                      FR-InfoList                                     OPTIONAL,
    nonCriticalExtension                SEQUENCE {}                                     OPTIONAL
}

MeasConfigSN ::= SEQUENCE {
    measuredFrequenciesSN               SEQUENCE (SIZE (1.. maxMeasFreqsSN))    OF NR-FreqInfo  OPTIONAL,
    ...
}

NR-FreqInfo ::= SEQUENCE {
    measuredFrequency                   ARFCN-ValueNR                                   OPTIONAL,
    ...
}

ConfigRestrictModReqSCG ::=         SEQUENCE {
    requestedBC-MRDC                    BandCombinationIndex                            OPTIONAL,
    requestedP-MaxFR1               P-Max                                               OPTIONAL,
    ...
}

BandCombinationIndex ::= INTEGER (1..maxBandComb)

FR-InfoList ::= SEQUENCE (SIZE (1..maxNrofServingCells-1)) OF FR-Info

FR-Info ::= SEQUENCE {
    servCellIndex       ServCellIndex,
    fr-Type             ENUMERATED {fr1, fr2}
}

-- 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.
fr-InfoListSCG Contains information of FR information of serving cells.
measuredFrequenciesSN Used by SN to indicate a list of frequencies measured by the UE.
requestedP-MaxFR1 IRequested value for the maximum power for FR1 (see TS 38.104 [12]) the UE can use in NR SCG.
requestedBC-MRDC Used to request configuring an NR band combination which is forbidden to use by MN. Each entry refers to a band combination numbered according to supportedBandCombination in the UE-MRDC-Capability.
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.

– *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, scg-ChangeFailure,
                                                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,
    nonCriticalExtension        SEQUENCE {}                                                 OPTIONAL
}

ConfigRestrictInfoSCG ::=       SEQUENCE {
    allowedBC-ListMRDC              BandCombinationIndexList                                OPTIONAL,
    powerCoordination-FR1               SEQUENCE {
        p-maxNR                         P-Max                                               OPTIONAL,
        p-maxEUTRA                      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,
    ...
}

BandCombinationIndexList ::= SEQUENCE (SIZE (1..maxBandComb)) OF BandCombinationIndex

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,
    ...
}


-- TAG-CG-CONFIG-INFO-STOP
-- ASN1STOP
```

CG-ConfigInfo field descriptions
allowedBandCombinationListMRDC 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 supportedBandCombination in the UE-MRDC-Capability. All MR-DC band combinations indicated by this field comprise the same LTE band combination.
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.
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.
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.
p-maxEUTRA Indicates the maximum power for EUTRA (see TS 36.104 [XX]) the UE can use in LTE MCG.
p-maxNR Indicates the maximum power for NR (see TS 38.104 [12]) the UE can use in NR SCG.
powerCoordination-FR1 Indicates the maximum power that the UE can use in FR1.
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.
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.
ConfigRestrictInfo Includes fields for which SgNB is explictly indicated to observe a configuration restriction.
servCellIndexRangeSCG Range of serving cell indices that SN is allowed to configure for SCG serving cells.

Conditional Presence	Explanation
SN-Addition	The field is mandatory present upon SN addition.

– *MeasurementTimingConfiguration*

Editor's Note: Targeted for completion in Sept 2018. Usage and Direction need further RAN2 discussions.

The *MeasurementTimingConfiguration* message is used to convey assistance information for measurement timing betwen master eNB and secondary gNB.

Direction: Secondary gNB to Master eNB, alternatively 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,
        ssb-MeasurementTimingConfiguration      SSB-MTC
    }                                                                               OPTIONAL,
    ...
}

-- TAG-MEASUREMENT-TIMING-CONFIGURATION-STOP
-- ASN1STOP
```

***MeasurementTimingConfiguration* field descriptions**
measTiming A list of SMTC information and associated NR frequency that SN informs MN via EN-DC X2 Setup and EN-DC Configuration Update procedures, or F1 messages from gNB DU to gNB CU.

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).

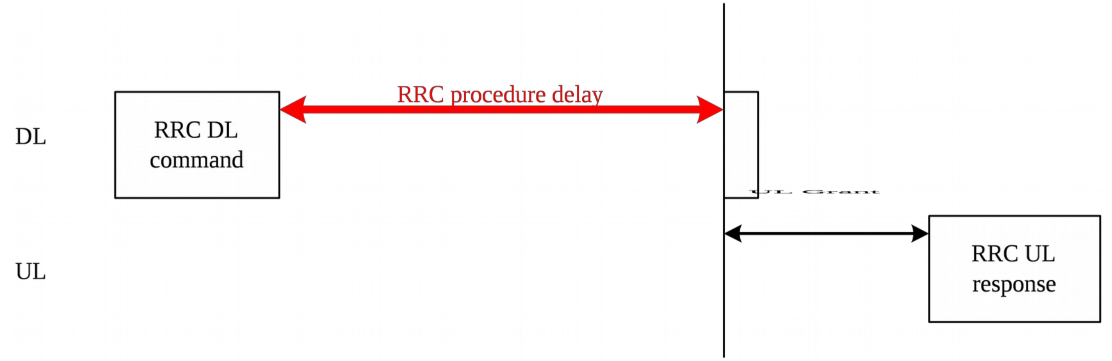

Figure 11.2-1: Illustration of RRC procedure delay

Table 11.2-1: 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*	X	

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 *block stop 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 thestart 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 table A.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).

Table A.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 table A.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)) OF SEQUENCE {
    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                  INTEGER (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 likelyhood 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, EUTRAN 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 preferrable 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 seperate 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 allways 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 seperate 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): 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