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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)**



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Contents

Foreword	11
Foreword	12
1 Scope	13
2 References	13
3 Definitions, symbols and abbreviations	14
3.1 Definitions	14
3.2 Abbreviations	14
4 General	16
4.1 Introduction	16
4.2 Architecture	16
4.2.1 UE states and state transitions including inter RAT	16
4.2.2 Signalling radio bearers	19
4.3 Services	19
4.3.1 Services provided to upper layers	19
4.3.2 Services expected from lower layers	19
4.4 Functions	19
5 Procedures	20
5.1 General	20
5.1.1 Introduction	20
5.1.2 General requirements	20
5.2 System information	20
5.2.1 Introduction	21
5.2.2 System information acquisition	21
5.2.2.1 General UE requirements	21
5.2.2.2 SI validity and need to (re)-acquire SI	22
5.2.2.2.1 SI validity	22
5.2.2.2.2 SI change indication and PWS notification	22
5.2.2.3 Acquisition of System Information	23
5.2.2.3.1 Acquisition of <i>MIB</i> and <i>SIB1</i>	23
5.2.2.3.2 Acquisition of an SI message	23
5.2.2.3.3 Request for on demand system information	24
5.2.2.4 Actions upon receipt of SI message	25
5.2.2.4.1 Actions upon reception of the <i>MIB</i>	25
5.2.2.4.2 Actions upon reception of the <i>SystemInformationBlockType1</i>	25
5.2.2.4.3 Actions upon reception of <i>SystemInformationBlockTypeX</i>	25
5.2.2.5 Essential system information missing	25
5.3 Connection control	26
5.3.1 Introduction	26
5.3.2 Paging	26
5.3.3 RRC connection establishment	26
5.3.4 Initial security activation	26
5.3.5 RRC reconfiguration	26
5.3.5.1 General	26
5.3.5.2 Initiation	27
5.3.5.3 Reception of an <i>RRCReconfiguration</i> by the UE	27
5.3.5.4 Secondary cell group release	28
5.3.5.5 Cell Group configuration	28
5.3.5.5.1 General	28
5.3.5.5.2 Reconfiguration with sync	29
5.3.5.5.3 RLC bearer release	29
5.3.5.5.4 RLC bearer addition/modification	29
5.3.5.5.5 MAC entity configuration	30
5.3.5.5.6 RLF Timers & Constants configuration	30
5.3.5.5.7 SPCell Configuration	31
5.3.5.5.8 SCell Release	31

5.3.5.5.9	SCell Addition/Modification	31
5.3.5.6	Radio Bearer configuration	31
5.3.5.6.1	General	31
5.3.5.6.2	SRB release	32
5.3.5.6.3	SRB addition/modification	32
5.3.5.6.4	DRB release	33
5.3.5.6.5	DRB addition/modification	33
5.3.5.7	Security key update	34
5.3.5.8	Reconfiguration failure	34
5.3.5.8.1	Integrity check failure	34
5.3.5.8.2	Inability to comply with RRCReconfiguration	34
5.3.5.8.3	T304 expiry (Reconfiguration with sync Failure)	35
5.3.5.9	Other configuration	35
5.3.5.10	EN-DC release	35
5.3.6	Counter check	35
5.3.7	RRC connection re-establishment	35
5.3.9	RRC connection release requested by upper layers	35
5.3.10	Radio link failure related actions	35
5.3.10.1	Detection of physical layer problems in RRC_CONNECTED	35
5.3.10.2	Recovery of physical layer problems	36
5.3.10.3	Detection of radio link failure	36
5.3.11	UE actions upon leaving RRC_CONNECTED	36
5.3.12	UE actions upon PUCCH/SRS release request	37
5.4	Inter-RAT mobility	37
5.5	Measurements	37
5.5.1	Introduction	37
5.5.2	Measurement configuration	38
5.5.2.1	General	38
5.5.2.2	Measurement identity removal	39
5.5.2.3	Measurement identity addition/modification	39
5.5.2.4	Measurement object removal	40
5.5.2.5	Measurement object addition/modification	40
5.5.2.6	Reporting configuration removal	41
5.5.2.7	Reporting configuration addition/modification	42
5.5.2.8	Quantity configuration	42
5.5.2.9	Measurement gap configuration	42
5.5.2.10	Reference signal measurement timing configuration	43
5.5.2.11	Measurement gap sharing configuration	43
5.5.3	Performing measurements	43
5.5.3.1	General	43
5.5.3.2	Layer 3 filtering	45
5.5.3.3	Derivation of cell measurement results	45
5.5.3.3a	Derivation of layer 3 beam filtered measurement	46
5.5.4	Measurement report triggering	46
5.5.4.1	General	46
5.5.4.2	Event A1 (Serving becomes better than threshold)	48
5.5.4.3	Event A2 (Serving becomes worse than threshold)	48
5.5.4.4	Event A3 (Neighbour becomes offset better than SpCell)	49
5.5.4.5	Event A4 (Neighbour becomes better than threshold)	50
5.5.4.6	Event A5 (SpCell becomes worse than threshold1 and neighbour becomes better than threshold2)	50
5.5.4.7	Event A6 (Neighbour becomes offset better than SCell)	51
5.5.5	Measurement reporting	52
5.5.5.1	General	52
5.5.5.2	Reporting of beam measurement information	54
5.6	UE capabilities	55
5.6.1	UE capability transfer	55
5.6.1.1	General	55
5.6.1.2	Initiation	55
5.6.1.3	Reception of the <i>UECapabilityEnquiry</i> by the UE	55
5.6.1.4	Compilation of band combinations supported by the UE	55
5.6.1.5	Compilation of baseband processing combinations supported by the UE	55

5.7	Other.....	56
5.7.1	DL information transfer	56
5.7.2	UL information transfer	56
Editor's Note: Targeted for completion in Sept 2018.5.7.3 SCG failure information		56
5.7.3.1	General	56
5.7.3.2	Initiation	56
5.7.3.3	Failure type determination.....	57
5.7.3.4	Setting the contents of <i>MeasResultSCG-Failure</i>	57
6	Protocol data units, formats and parameters (ASN.1)	59
6.1	General	59
6.1.1	Introduction	59
6.1.2	Need codes and conditions for optional downlink fields	59
6.2	RRC messages	60
6.2.1	General message structure	60
–	<i>NR-RRC-Definitions</i>	60
–	<i>BCCH-BCH-Message</i>	60
–	<i>DL-DCCCH-Message</i>	61
–	<i>UL-DCCCH-Message</i>	61
6.2.2	Message definitions	62
–	<i>MIB</i>	62
–	<i>MeasurementReport</i>	63
–	<i>RRCReconfiguration</i>	64
–	<i>RRCReconfigurationComplete</i>	65
–	<i>SIB1</i>	66
6.3	RRC information elements	67
6.3.0	Parameterized types	67
–	<i>SetupRelease</i>	67
6.3.1	System information blocks.....	68
6.3.2	Radio resource control information elements	68
–	<i>AdditionalSpectrumEmission</i>	68
–	<i>Alpha</i>	68
–	<i>ARFCN-ValueNR</i>	68
–	<i>BWP</i>	69
–	<i>BWP-Id</i>	72
–	<i>BeamFailureRecoveryConfig</i>	73
–	<i>CellGroupConfig</i>	75
–	<i>CellGroupId</i>	77
–	<i>CodebookConfig</i>	77
–	<i>ConfiguredGrantConfig</i>	80
–	<i>ControlResourceSet</i>	83
–	<i>ControlResourceSetId</i>	84
–	<i>CrossCarrierSchedulingConfig</i>	85
–	<i>CSI-AperiodicTriggerStateList</i>	86
–	<i>CSI-FrequencyOccupation</i>	87
–	<i>CSI-IM-Resource</i>	88
–	<i>CSI-IM-ResourceId</i>	89
–	<i>CSI-IM-ResourceSet</i>	89
–	<i>CSI-IM-ResourceSetId</i>	90
–	<i>CSI-MeasConfig</i>	90
–	<i>CSI-ReportConfig</i>	91
–	<i>CSI-ReportConfigId</i>	97
–	<i>CSI-ResourceConfig</i>	97
–	<i>CSI-ResourceConfigId</i>	98
–	<i>CSI-ResourcePeriodicityAndOffset</i>	98
–	<i>CSI-RS-ResourceConfigMobility</i>	99
–	<i>CSI-RS-ResourceMapping</i>	101
–	<i>CSI-SemiPersistentOnPUSCH-TriggerStateList</i>	102
–	<i>CSI-SSB-ResourceSetId</i>	103
–	<i>CSI-SSB-ResourceSet</i>	103
–	<i>DMRS-DownlinkConfig</i>	104
–	<i>DMRS-UplinkConfig</i>	104

–	<i>DownlinkConfigCommon</i>	106
–	<i>DownlinkPreemption</i>	107
–	<i>DRB-Identity</i>	108
–	<i>EUTRA-MBSFN-SubframeConfigList</i>	108
–	<i>FilterCoefficient</i>	109
–	<i>FreqBandIndicatorNR</i>	110
–	<i>FrequencyInfoDL</i>	110
–	<i>FrequencyInfoUL</i>	111
–	<i>Hysteresis</i>	112
–	<i>LogicalChannelConfig</i>	113
–	<i>LogicalChannelIdentity</i>	114
–	<i>MAC-CellGroupConfig</i>	115
–	<i>MeasConfig</i>	119
–	<i>MeasGapConfig</i>	120
–	<i>MeasGapSharingConfig</i>	121
–	<i>MeasId</i>	122
–	<i>MeasIdToAddModList</i>	122
–	<i>MeasObjectEUTRA</i>	123
–	<i>MeasObjectId</i>	123
–	<i>MeasObjectNR</i>	123
–	<i>MeasObjectToAddModList</i>	128
–	<i>MeasResults</i>	128
–	<i>MeasResultSCG-Failure</i>	130
–	<i>MeasResultCellListSFTD</i>	131
–	<i>MultiFrequencyBandListNR</i>	132
–	<i>NZP-CSI-RS-Resource</i>	132
–	<i>NZP-CSI-RS-ResourceId</i>	133
–	<i>NZP-CSI-RS-ResourceSet</i>	133
–	<i>NZP-CSI-RS-ResourceSetId</i>	134
–	<i>P-Max</i>	135
–	<i>PCI-List</i>	135
–	<i>PCI-Range</i>	135
–	<i>PCI-RangeElement</i>	136
–	<i>PCI-RangeIndex</i>	136
–	<i>PCI-RangeIndexList</i>	137
–	<i>PDCCCH-Config</i>	137
–	<i>PDCCCH-ConfigCommon</i>	138
–	<i>PDCCCH-ServingCellConfig</i>	139
–	<i>PDCCP-Config</i>	140
–	<i>PDSCH-Config</i>	143
–	<i>PDSCH-ConfigCommon</i>	146
–	<i>PDSCH-ServingCellConfig</i>	146
–	<i>PDSCH-TimeDomainResourceAllocationList</i>	148
–	<i>PhysCellId</i>	148
–	<i>PhysicalCellGroupConfig</i>	149
–	<i>PRB-Id</i>	150
–	<i>PTRS-DownlinkConfig</i>	151
–	<i>PTRS-UplinkConfig</i>	151
–	<i>PUCCH-Config</i>	153
–	<i>PUCCH-ConfigCommon</i>	157
–	<i>PUCCH-PathlossReferenceRS-Id</i>	157
–	<i>PUCCH-PowerControl</i>	158
–	<i>PUCCH-TPC-CommandConfig</i>	159
–	<i>PUSCH-Config</i>	160
–	<i>PUSCH-ConfigCommon</i>	163
–	<i>PUSCH-PowerControl</i>	164
–	<i>PUSCH-ServingCellConfig</i>	167
–	<i>PUSCH-TimeDomainResourceAllocationList</i>	168
–	<i>PUSCH-TPC-CommandConfig</i>	169
–	<i>Q-OffsetRange</i>	170
–	<i>QuantityConfig</i>	170
–	<i>RACH-ConfigCommon</i>	171

–	<i>RACH-ConfigGeneric</i>	173
–	<i>RACH-ConfigDedicated</i>	174
–	<i>RA-Prioritization</i>	176
–	<i>RadioBearerConfig</i>	177
–	<i>RadioLinkMonitoringConfig</i>	179
–	<i>RadioLinkMonitoringRSId</i>	180
–	<i>RateMatchPattern</i>	181
–	<i>RateMatchPatternId</i>	182
–	<i>RateMatchPatternLTE-CRS</i>	182
–	<i>ReportConfigId</i>	183
–	<i>ReportConfigNR</i>	184
–	<i>ReportConfigToAddModList</i>	188
–	<i>ReportInterval</i>	188
–	<i>RLC-BearerConfig</i>	188
–	<i>RLC-Config</i>	189
–	<i>RLF-TimersAndConstants</i>	192
–	<i>RNTI-Value</i>	193
–	<i>RSRP-Range</i>	193
–	<i>RSRQ-Range</i>	193
–	<i>SCellIndex</i>	194
–	<i>SchedulingRequestConfig</i>	194
–	<i>SchedulingRequestId</i>	195
–	<i>SchedulingRequestResourceConfig</i>	195
–	<i>SchedulingRequestResourceId</i>	196
–	<i>ScramblingId</i>	197
–	<i>SCS-SpecificCarrier</i>	197
–	<i>SDAP-Config</i>	198
–	<i>SearchSpace</i>	199
–	<i>SearchSpaceId</i>	202
–	<i>SecurityAlgorithmConfig</i>	202
–	<i>ServCellIndex</i>	203
–	<i>ServingCellConfig</i>	203
–	<i>ServingCellConfigCommon</i>	206
–	<i>SINR-Range</i>	209
–	<i>SlotFormatCombinationsPerCell</i>	209
–	<i>SlotFormatIndicator</i>	210
–	<i>SS-RSSI-Measurement</i>	211
–	<i>SPS-Config</i>	212
–	<i>SRB-Identity</i>	212
–	<i>SRS-Config</i>	213
–	<i>SRS-CarrierSwitching</i>	217
–	<i>SRS-TPC-CommandConfig</i>	219
–	<i>SSB-Index</i>	219
–	<i>SSB-MTC</i>	220
–	<i>SubcarrierSpacing</i>	221
–	<i>TCI-State</i>	221
–	<i>TCI-StateId</i>	222
–	<i>TDD-UL-DL-Config</i>	222
–	<i>TimeToTrigger</i>	224
–	<i>UplinkConfigCommon</i>	225
–	<i>ZP-CSI-RS-Resource</i>	225
–	<i>ZP-CSI-RS-ResourceSet</i>	226
–	<i>ZP-CSI-RS-ResourceSetId</i>	227
6.3.3	UE capability information elements	227
–	<i>AccessStratumRelease</i>	227
–	<i>BandCombinationList</i>	227
–	<i>CA-BandwidthClassNR</i>	228
–	<i>CA-BandwidthClassEUTRA</i>	228
–	<i>CA-ParametersNR</i>	229
–	<i>CA-ParametersEUTRA</i>	229
–	<i>FeatureSetCombination</i>	230
–	<i>FeatureSetCombinationId</i>	231

–	<i>FeatureSetDownlink</i>	231
–	<i>FeatureSetDownlinkId</i>	233
–	<i>FeatureSetEUTRA-DownlinkId</i>	233
–	<i>FeatureSetDownlinkPerCC</i>	234
–	<i>FeatureSetDownlinkPerCC-Id</i>	234
–	<i>FeatureSetUplink</i>	234
–	<i>FeatureSetUplinkId</i>	235
–	<i>FeatureSetEUTRA-UplinkId</i>	236
–	<i>FeatureSetUplinkPerCC</i>	236
–	<i>FeatureSetUplinkPerCC-Id</i>	237
–	<i>FeatureSets</i>	237
–	<i>FreqBandIndicatorEUTRA</i>	238
–	<i>FreqBandList</i>	238
–	<i>FreqSeparationClass</i>	239
–	<i>MIMO-Layers</i>	239
–	<i>ModulationOrder</i>	239
–	<i>MRDC-Parameters</i>	239
–	<i>RAT-Type</i>	240
–	<i>SupportedBandwidth</i>	240
–	<i>UE-CapabilityRAT-ContainerList</i>	241
–	<i>UE-MRDC-Capability</i>	241
–	<i>RF-ParametersMRDC</i>	242
–	<i>MeasParametersMRDC</i>	243
–	<i>UE-NR-Capability</i>	243
–	<i>Phy-Parameters</i>	244
–	<i>RF-Parameters</i>	247
–	<i>MIMO-ParametersPerBand</i>	248
–	<i>PDCP-Parameters</i>	250
–	<i>RLC-Parameters</i>	251
–	<i>MAC-Parameters</i>	251
–	<i>MeasParameters</i>	252
6.3.4	Other information elements	253
–	<i>RRC-TransactionIdentifier</i>	253
6.4	RRC multiplicity and type constraint values	253
–	Multiplicity and type constraint definitions	253
–	End of NR-RRC-Definitions	257
7	Variables and constants	258
7.1	Timers	258
7.1.1	Timers (Informative)	258
7.1.2	Timer handling	258
7.2	Counters	258
7.3	Constants	259
7.4	UE variables	259
–	<i>NR-UE-Variables</i>	259
–	<i>VarMeasConfig</i>	259
–	<i>VarMeasReportList</i>	260
–	End of <i>NR-UE-Variables</i>	261
8	Protocol data unit abstract syntax	262
8.1	General	262
8.2	Structure of encoded RRC messages	262
8.3	Basic production	262
8.4	Extension	262
8.5	Padding	263
9	Specified and default radio configurations	263
9.1	Specified configurations	263
9.1.1	Logical channel configurations	263
9.1.2	SRB configurations	263
9.1.2.1	SRB1/SRB1S	263
9.1.2.2	SRB2/SRB2S	264
9.1.2.3	SRB3	264

9.2	Default radio configurations	264
9.2.1	SRB configurations	264
9.2.1.1	SRB1/SRB1S	264
9.2.1.2	SRB2/SRB2S	264
9.2.1.3	SRB3	265
10	Generic error handling	265
10.1	General	265
10.2	ASN.1 violation or encoding error	266
10.3	Field set to a not comprehended value	266
10.4	Mandatory field missing	266
10.5	Not comprehended field	267
11	Radio information related interactions between network nodes	268
11.1	General	268
11.2	Inter-node RRC messages	268
11.2.1	General	268
11.2.2	Message definitions	269
–	<i>HandoverCommand</i>	269
–	<i>HandoverPreparationInformation</i>	269
–	<i>CG-Config</i>	271
–	<i>CG-ConfigInfo</i>	273
–	<i>MeasurementTimingConfiguration</i>	276
11.3	Inter-node RRC information element definitions	277
11.4	Inter-node RRC multiplicity and type constraint values	278
–	Multiplicity and type constraints definitions	278
–	<i>End of NR-InterNodeDefinitions</i>	278
12	Processing delay requirements for RRC procedures	279
Annex A (informative):	Guidelines, mainly on use of ASN.1	279
A.1	Introduction	279
A.2	Procedural specification	280
A.2.1	General principles	280
A.2.2	More detailed aspects	280
A.3	PDU specification	280
A.3.1	General principles	280
A.3.1.1	ASN.1 sections	280
A.3.1.2	ASN.1 identifier naming conventions	281
A.3.1.3	Text references using ASN.1 identifiers	283
A.3.2	High-level message structure	284
A.3.3	Message definition	285
A.3.4	Information elements	287
A.3.5	Fields with optional presence	288
A.3.6	Fields with conditional presence	289
A.3.7	Guidelines on use of lists with elements of SEQUENCE type	290
A.3.8	Guidelines on use of parameterised SetupRelease type	290
A.3.9	Guidelines on use of ToAddModList and ToReleaseList	291
A.4	Extension of the PDU specifications	293
A.4.1	General principles to ensure compatibility	293
A.4.2	Critical extension of messages and fields	293
A.4.3	Non-critical extension of messages	295
A.4.3.1	General principles	295
A.4.3.2	Further guidelines	296
A.4.3.3	Typical example of evolution of IE with local extensions	297
A.4.3.4	Typical examples of non critical extension at the end of a message	298
A.4.3.5	Examples of non-critical extensions not placed at the default extension location	299
–	<i>ParentIE-WithEM</i>	299
–	<i>ChildIE1-WithoutEM</i>	300
–	<i>ChildIE2-WithoutEM</i>	301

A.5 Guidelines regarding inclusion of transaction identifiers in RRC messages..... 301

A.6 Guidelines regarding use of need codes 302

A.7 Guidelines regarding use of conditions 302

Annex B (informative): Change history..... 304

Foreword

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

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- x the first digit:
 - 1 presented to TSG for information;
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 - 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.

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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.

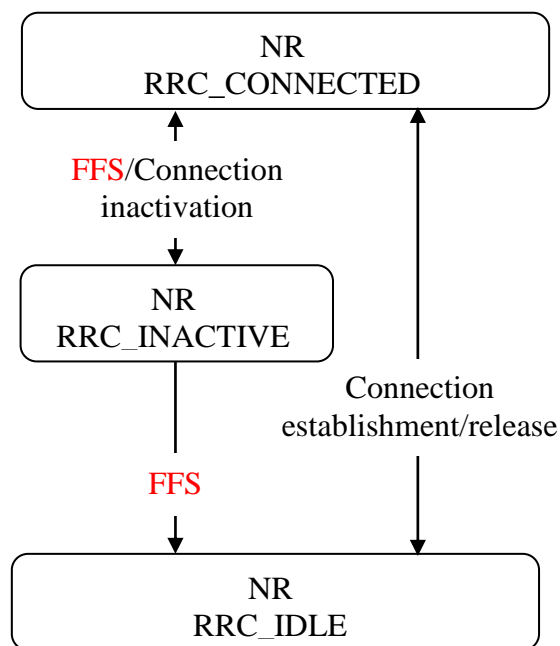


Figure 4.2.1-1: UE state machine and state transitions in NR

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.

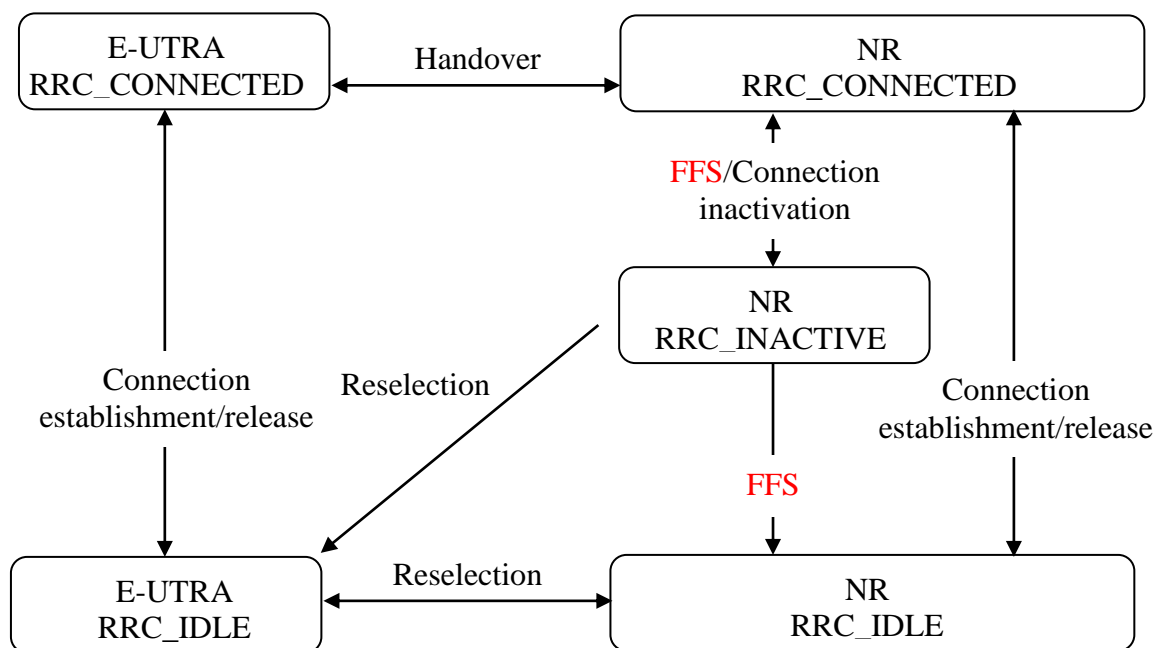


Figure 4.2.1-2: UE state machine and state transitions between NR/NGC and E-UTRAN/EPC

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 September 2018. 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

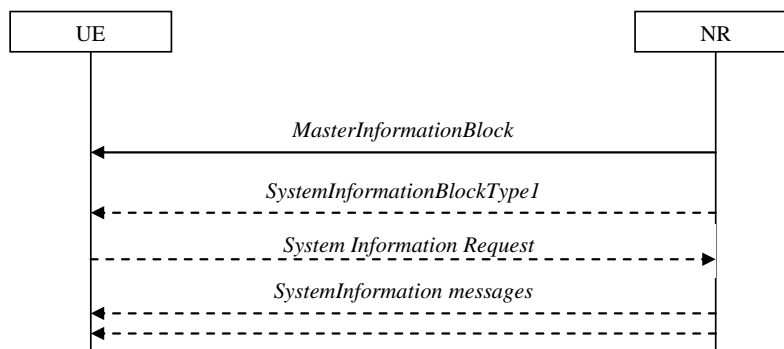


Figure 5.2.2.1-1: System information acquisition

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_Standalone Whether 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

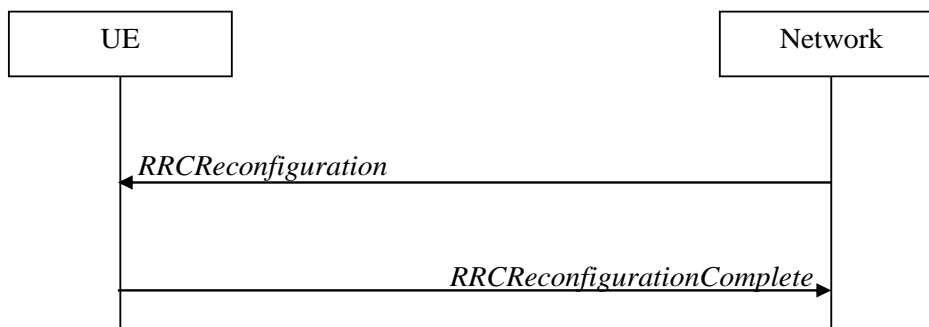


Figure 5.3.5.1-1: RRC reconfiguration, successful

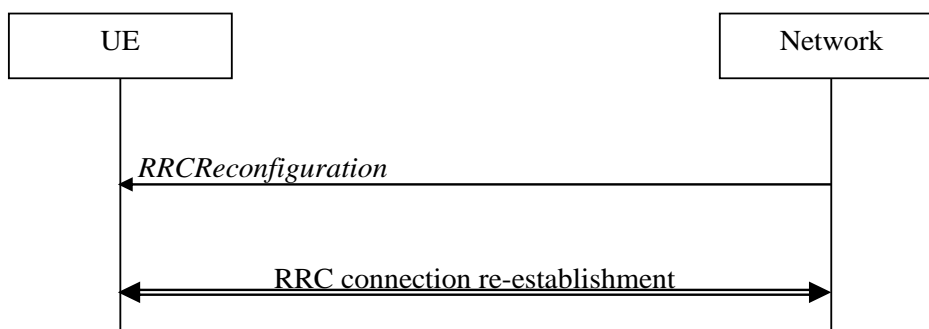


Figure 5.3.5.1-2: RRC reconfiguration, failure

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 reporting to (re-)configure MAC, RLC, physical layer and RLF timers and constants of the SCG configuration, and to reconfigure PDCP for DRBs associated with the S-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;
 - 2> else (*RRCReconfiguration* was received via SRB3):
 - 3> submit the *RRCReconfigurationComplete* message via SRB3 to lower layers for transmission using the new configuration;
- NOTE: The order the UE sends the *RRCConnectionReconfigurationComplete* message and performs the Random Access procedure towards the SCG is left to UE implementation.
- 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 *sCellToReleaseList*:
 - 2> perform SCell release as specified in 5.3.5.5.8;
- 1> if the *CellGroupConfig* contains the *spCellConfig*:
 - 2> configure the SpCell as specified in 5.3.5.5.7;
- 1> if the *CellGroupConfig* contains the *sCellToAddModList*:
 - 2> perform SCell addition/modification as specified in 5.3.5.5.9.

5.3.5.5.2 Reconfiguration with sync

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

- 1> stop timer T310 for the corresponding SpCell, if running;
- 1> start timer T304 for the corresponding SpCell with the timer value set to t_{304} , 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 *spCellConfigCommon*;
- 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 SCell 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 $K_{\text{eNB}}/S-K_{\text{gNB}}$ 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 $K_{\text{eNB}}/S-K_{\text{gNB}}$ 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 $K_{\text{eNB}}/S-K_{\text{gNB}}$ 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 $K_{eNB}/S-K_{gNB}$ as indicated in *keyToUse*, i.e. the ciphering configuration shall be applied to all subsequent PDCP PDUs received and sent by the UE;

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 configured in CSI-ReportConfig;
- 1> release SchedulingRequestResourceConfig instances configured in PUCCH-Config.

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

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

5.4 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*, *nrofCSI-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):

$$\text{SFN mod } T = \text{FLOOR}(\text{gapOffset}/10);$$

$$\text{subframe} = \text{gapOffset mod } 10;$$
 with $T = \text{MGRP}/10$ as defined in TS 38.133 [x];
 - 3> if *mgta* is configured, apply the specified timing advance to the gap occurrences calculated above (i.e. the UE starts the measurement *mgta* ms before the gap subframe occurrences);
- 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:

$$\text{SFN mod } T = \text{FLOOR}((\text{Offset}/10)) \text{ mod } T;$$

if the *Periodicity* is larger than sf5:

$$\text{subframe} = \text{Offset mod } 10;$$

else:

$$\text{subframe} = \text{Offset or } (\text{Offset} + 5);$$

with $T = \text{Periodicity}/10$.

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 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

M_n is the latest received measurement result from the physical layer;

F_n is the updated filtered measurement result, that is used for evaluation of reporting criteria or for measurement reporting;

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

$a = 1/2^{(k/4)}$, 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 *nrofCSI-RS-ResourcesToAverage*;
 - 2> apply layer 3 cell filtering as described in 5.5.3.2.

5.5.3.3a Derivation of layer 3 beam filtered measurement

The UE shall:

- 1> for each layer 3 beam filtered measurement quantity to be derived based on SS/PBCH block;
 - 2> derive each configured beam measurement quantity based on SS/PBCH block as described in TS 38.215[9], and apply layer 3 beam filtering as described in 5.5.3.2;
- 1> for each layer 3 beam filtered measurement quantity to be derived based on CSI-RS;
 - 2> derive each configured beam measurement quantity based on CSI-RS as described in TS 38.215 [9], and apply layer 3 beam filtering as described in 5.5.3.2.

5.5.4 Measurement report triggering

5.5.4.1 General

If security has been activated successfully, the UE shall:

- 1> for each *measId* included in the *measIdList* within *VarMeasConfig*:
 - 2> if the corresponding *reportConfig* includes a *reportType* set to *eventTriggered* or *periodical*;
 - 3> if the corresponding *measObject* concerns NR;
 - 4> if the *eventA1* or *eventA2* is configured in the corresponding *reportConfig*:
 - 5> consider only the serving cell to be applicable;
 - 4> 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 reporting procedure, as specified in 5.5.5, immediately after the quantity to be reported becomes available for the NR SpCell and for the strongest cell among the applicable cells;
- 2> upon expiry of the periodical reporting timer for this *measId*:
 - 3> initiate the measurement reporting procedure, as specified in 5.5.5.

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*, *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.

Mn is the measurement result of the neighbouring cell, not taking into account any offsets.

Ofn is the measurement object specific offset of the neighbour cell (i.e. *offsetMO* as defined within *measObjectNR* corresponding to the neighbour cell).

Ocn is the cell specific offset of the neighbour cell (i.e. *cellIndividualOffset* as defined within *measObjectNR* corresponding to the neighbour cell), and set to zero if not configured for the neighbour cell.

Hys is the hysteresis parameter for this event (i.e. *hysteresis* as defined within *reportConfigNR* for this event).

Thresh1 is the threshold parameter for this event (i.e. *a5-Threshold1* as defined within *reportConfigNR* for this event).

Thresh2 is the threshold parameter for this event (i.e. *a5-Threshold2* as defined within *reportConfigNR* for this event).

Mn*, *Mp are expressed in dBm in case of RSRP, or in dB in case of RSRQ and RS-SINR.

Ofn*, *Ocn*, *Hys are expressed in dB.

Thresh1 is 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 *maxNrofRsIndexesToReportSS/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 at least 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 received.
 - 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

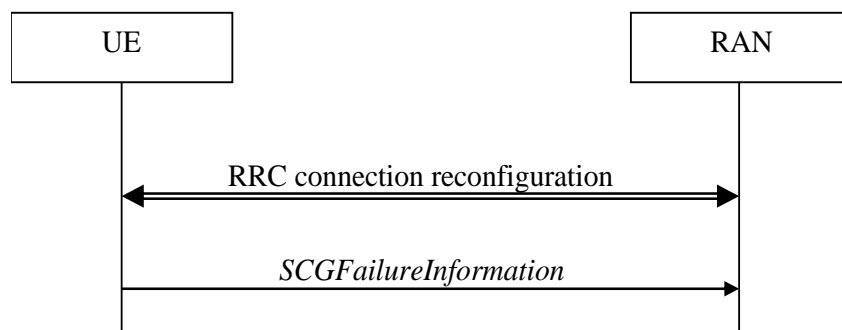


Figure 5.7.3.1-1: SCG failure information

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 *MeasObjectNR* for which a *measId* is configured and measurement results are available;

2> include an entry in *measResultsPerMOList*;

2> if there is a *measId* configured with the *MeasObjectNR* and a *reportConfig* which has *rsType* set to *ssb*:

3> set *ssbFrequency* to the value indicated by *ssbFrequency* as included in the *MeasObjectNR*;

2> if there is a *measId* configured with the *MeasObjectNR* and a *reportConfig* which has *rsType* set to *csi-rs*:

3> set *refFreqCSI-RS* to the value indicated by *refFreqCSI-RS* as included in the associated measurement object;

2> if a serving cell is associated with the *MeasObjectNR*:

3> set *measResultServingCell* to include the available quantities of the concerned cell and in accordance with the performance requirements in [FFS_Ref];

- 2> set the *measResultNeighCellList* to include the best measured cells, ordered such that the best cell is listed first, and based on measurements collected up to the moment the UE detected the failure, and set its fields as follows;
- 3> ordering the cells with sorting as follows:
 - 4> based on SS/PBCH block if SS/PBCH block measurement results are available and otherwise based on CSI-RS,
 - 4> using RSRP if RSRP measurement results are available, otherwise using RSRQ if RSRQ measurement results are available, otherwise using SINR,
- 3> for each neighbour cell included:
 - 4> include the optional fields that are available.

NOTE: The measured quantities are filtered by the L3 filter as configured in the mobility measurement configuration. The measurements are based on the time domain measurement resource restriction, if configured. Blacklisted cells are not required to be reported.

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
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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	<i>Specified</i> 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	<i>Maintain</i> 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	<i>No action</i> (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	<i>Release</i> 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},
  pdccch-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].
pdccch-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 pdccch-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 <i>pdccch-ConfigSIB1</i> 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 <i>scs15or60</i> corresponds to 15 Khz and the value <i>scs30or120</i> corresponds to 30 kHz. If the UE acquires this MIB on a carrier frequency >6GHz, the value <i>scs15or60</i> corresponds to 60 Khz and the value <i>scs30or120</i> 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 ::=
    criticalExtensions      SEQUENCE {
        measurementReport  CHOICE {
            criticalExtensionsFuture  MeasurementReport-IEs,
                                   SEQUENCE {}
        }
    }

MeasurementReport-IEs ::=
    measResults             SEQUENCE {
        MeasResults,

        lateNonCriticalExtension  OCTET STRING
        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 ::=
    rrc-TransactionIdentifier  SEQUENCE {
        RRC-TransactionIdentifier,
        criticalExtensions     CHOICE {
            rrcReconfiguration  RRCReconfiguration-IEs,
            criticalExtensionsFuture  SEQUENCE {}
        }
    }

RRCReconfiguration-IEs ::=
    radioBearerConfig          SEQUENCE {
        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
```

<i>SIB1 field descriptions</i>
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 ::=
    locationAndBandwidth          SEQUENCE {
        INTEGER (0..37949),      INTEGER (0..37949),
        subcarrierSpacing,       SubcarrierSpacing,
        cyclicPrefix              ENUMERATED { extended }      OPTIONAL    -- Need R
    }

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

BWP-UplinkCommon ::=
    genericParameters            SEQUENCE {
        rach-ConfigCommon         BWP,
        pusch-ConfigCommon        SetupRelease { RACH-ConfigCommon } OPTIONAL,    -- Need M
        pucch-ConfigCommon        SetupRelease { PUSCH-ConfigCommon } OPTIONAL,    -- Need M
        ...                      SetupRelease { PUCCH-ConfigCommon } OPTIONAL,    -- Need M
    }

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

```
}

BWP-Downlink ::=
    bwp-Id
    bwp-Common
    bwp-Dedicated
    ...
}

BWP-DownlinkCommon ::=
    genericParameters
    pdcch-ConfigCommon
    pdsch-ConfigCommon
    ...
}

BWP-DownlinkDedicated ::=
    pdcch-Config
    pdsch-Config
    sps-Config
    radioLinkMonitoringConfig
    ...
}

-- 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 $N_{\text{BWP}}^{\text{size}}=275$. 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 $\mu=0$, kHz30 to $\mu=1$, 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 switch 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***pdccch-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***pdccch-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 switch 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)

<i>BWP-UplinkCommon field descriptions</i>
<i>pucch-ConfigCommon</i> Cell specific parameters for the PUCCH
<i>pusch-ConfigCommon</i> Cell specific parameters for the PUSCH
<i>rach-ConfigCommon</i> 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.

<i>BWP-UplinkDedicated field descriptions</i>
<i>beamFailureRecoveryConfig</i> Determines how the UE performs Beam Failure Recovery upon detection of a Beam Failure (see RadioLinkMonitoringConfig)
<i>configuredGrantConfig</i> 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.
<i>pucch-Config</i> 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).
<i>pusch-Config</i> 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)
<i>srs-Config</i> Uplink sounding reference signal configuration

Conditional Presence	Explanation
<i>SetupOnly</i>	The field is optionally present, Need M, upon configuration of a new SCell. It is absent otherwise.
<i>SpCellOnly</i>	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 signalled 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-CSI-RS-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 ::=
    cellGroupId                               SEQUENCE {
        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 ::=
    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 ::=
    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
    }
    ...
}

SCellConfig ::=
    SEQUENCE {
```

```

    sCellIndex          SCellIndex,
    sCellConfigCommon   ServingCellConfigCommon
    sCellConfigDedicated ServingCellConfig
    ...
}

-- TAG-CELL-GROUP-CONFIG-STOP
-- ASN1STOP

```

OPTIONAL, -- Cond SCellAdd
OPTIONAL, -- Cond SCellAddMod

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 secondary serving cells (SCells) to be added or modified.

sCellToReleaseList

List of secondary serving cells (SCells) to be released

spCellConfig

Parameters for the SpCell of this cell group (PCell of MCG or PSCell of SCG).

ReconfigurationWithSync field descriptions

rach-ConfigDedicated

Random access configuration to be used for the reconfiguration with sync (e.g. handover). The UE performs the RA according to these parameters in the firstActiveUplinkBWP (see UplinkConfig).

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
<i>LCH-SetupOnly</i>	The field is mandatory present if the corresponding LCH is being set up; otherwise it is not present.
<i>LCH-Setup</i>	The field is mandatory present if the corresponding LCH is being set up for DRB; otherwise it is optionally present, need M.
<i>ReconfWithSync</i>	The field is mandatory present in case of SpCell change and security key change; otherwise it is optionally present, need M.
<i>SCellAdd</i>	The field is mandatory present, need M, upon SCell addition; otherwise it is not present
<i>SCellAddMod</i>	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
    subType
        typeII
            n1-n2-codebookSubsetRestriction            SEQUENCE {
                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}
        typeII-PortSelectionRI-Restriction  BIT STRING (SIZE (2))
    },
    phaseAlphabetSize      ENUMERATED {n4, n8},
    subbandAmplitude      BOOLEAN,
    numberOfBeams          ENUMERATED {two, three, four}
}
}

-- TAG-CODEBOOKCONFIG-STOP
-- ASN1STOP

```

<i>CodebookConfig</i> 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 $\text{ceil}(\log_2(\text{nchoosek}(O1*O2,4))) + 8*n1*n2$ where $\text{nchoosek}(a,b) = a!/(b!(a-b)!)$
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 ::=
    frequencyHopping
    cg-DMRS-Configuration
    mcs-Table
    mcs-TableTransformPrecoder
    uci-OnPUSCH
    resourceAllocation
    rbg-Size
    powerControlLoopToUse
    p0-PUSCH-Alpha
    transformPrecoder
    nrofHARQ-Processes
    repK
    repK-RV
    periodicity

SEQUENCE {
    ENUMERATED {mode1, mode2} OPTIONAL, -- Need S,
    DMRS-UplinkConfig,
    ENUMERATED {qam256, spare1} OPTIONAL, -- Need S
    ENUMERATED {qam256, spare1} OPTIONAL, -- Need S
    SetupRelease { CG-UCI-OnPUSCH },
    ENUMERATED { resourceAllocationType0, resourceAllocationType1, dynamicSwitch },
    ENUMERATED {config2} OPTIONAL, -- Need S
    ENUMERATED {n0, n1},
    P0-PUSCH-AlphaSetId,
    ENUMERATED {enabled} OPTIONAL, -- Need S
    INTEGER(1..16),
    ENUMERATED {n1, n2, n4, n8},
    ENUMERATED {s1-0231, s2-0303, s3-0000} OPTIONAL, -- Cond RepK
    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),
        ...
    }
    }
    }

CG-UCI-OnPUSCH ::= CHOICE {
    dynamic SEQUENCE(SIZE(1..4)) OF BetaOffsets,
    semiStatic BetaOffsets
}

-- TAG-CONFIGUREDGRANTCONFIG-STOP
-- ASN1STOP

```

ConfiguredGrantConfig field descriptions	
antennaPort	Indicates the antenna port(s) to be used for this configuration, and the maximum bitwidth is 5. See TS 38.214, 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, $n \cdot 14$, where $n=\{1, 2, 4, 5, 8, 10, 16, 20, 32, 40, 64, 80, 128, 160, 320, 640\}$ 30kHz: 2, 7, $n \cdot 14$, 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, $n \cdot 14$, 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, $n \cdot 12$, 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, $n \cdot 14$, 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.

<i>rrc-ConfiguredUplinkGrant</i>
Configuration for "configured grant" transmission with fully RRC-configured UL grant (Type1). If this field is absent the UE uses UL grant configured by DCI addressed to CS-RNTI (Type2). Type 1 configured grant may be configured for UL or SUL, but not for both simultaneously.
<i>timeDomainAllocation</i>
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.
<i>timeDomainOffset</i>
Offset related to SFN=0, see TS 38.321, section 5.8.2.
<i>transformPrecoder</i>
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.
<i>uci-OnPUSCH</i>
Selection between and configuration of dynamic and semi-static beta-offset. For Type 1 UL data transmission without grant, <i>uci-OnPUSCH</i> should be set to <i>semiStatic</i> .

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

– 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 ::=
    controlResourceSetId          SEQUENCE {
        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)
            },
            nonInterleaved         NULL
        },
        precoderGranularity        ENUMERATED {sameAsREG-bundle, allContiguousRBs},
        tci-StatesPDCCH-ToAddList  SEQUENCE (SIZE (1..maxNrofTCI-StatesPDCCH)) OF TCI-StateId
        tci-StatesPDCCH-ToReleaseList SEQUENCE (SIZE (1..maxNrofTCI-StatesPDCCH)) OF TCI-StateId
        tci-PresentInDCI          ENUMERATED {enabled}
        pdcch-DMRS-ScramblingID   INTEGER (0..65535)
        ...
    }
-- Need S
-- Need N
-- Need N
-- Need S
-- Need S
```

```
-- TAG-CONTROLRESOURCESET-STOP
-- ASN1STOP
```

<i>ControlResourceSet field descriptions</i>
cce-REG-MappingType Mapping of Control Channel Elements (CCE) to Resource Element Groups (REG). Corresponds to L1 parameter 'CORESET-CCE-REG-mapping-type' (see 38.211 Section 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 7.3.2.2 FFS_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 initialization. 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 <i>physCellId</i> configured for this serving cell.
precoderGranularity Precoder granularity in frequency domain. Corresponds to L1 parameter 'CORESET-precoder-granularity' (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 <i>physCellId</i> 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, section 10.). The network configures at most <i>maxNrofTCI-StatesPDCCH</i> 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 ::=
  schedulingCellInfo
    own
      cif-Presence
    },
    other
      schedulingCellId
      cif-InSchedulingCell
    }
  },
  ...
}

-- 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 <i>cif-Presence</i> 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 <i>dl-Bandwidth</i> for the concerned SCell is greater than 10 resource blocks, values 2, 3, 4 are applicable when <i>dl-Bandwidth</i> 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
<i>SCellOnly</i>	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-ResourcesforInterference INTEGER (1..maxNrofCSI-IM-ResourceSetsPerConfig) OPTIONAL, -- Cond CSI-IM-forInterference
    nzp-CSI-RS-ResourcesforInterference INTEGER (1..maxNrofNZP-CSI-RS-ResourceSetsPerConfig) OPTIONAL, -- Cond NZP-CSI-RS-forInterference
    ...
}

-- TAG-CSI-APERIODICTRIGGERSTATELIST-STOP
-- ASN1STOP
```

CSI-AssociatedReportConfigInfo field descriptions	
csi-IM-ResourcesforInterference	CSI-IM-ResourceSet for interference measurement. Entry number in csi-IM-ResourceSetList in the CSI-ResourceConfig indicated by csi-IM-ResourcesForInterference in the CSI-ReportConfig indicated by reportConfigId above (1 corresponds to the first entry, 2 to the second entry, and so on). The indicated CSI-IM-ResourceSet should have exactly the same number of resources like the NZP-CSI-RS-ResourceSet indicated in nzp-CSI-RS-ResourcesforChannel.
csi-SSB-ResourceSet	CSI-SSB-ResourceSet for channel measurements. Entry number in csi-SSB-ResourceSetList in the CSI-ResourceConfig indicated by resourcesForChannelMeasurement in the CSI-ReportConfig indicated by reportConfigId above (1 corresponds to the first entry, 2 to the second entry, and so on).
nzp-CSI-RS-ResourcesforInterference	NZP-CSI-RS-ResourceSet for interference measurement. Entry number in nzp-CSI-RS-ResourceSetList in the CSI-ResourceConfig indicated by nzp-CSI-RS-ResourcesForInterference in the CSI-ReportConfig indicated by reportConfigId above (1 corresponds to the first entry, 2 to the second entry, and so on). 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 <i>TCI-StateId</i> refers to the TCI-State which has this value for <i>tcI-StateId</i> and is defined in <i>tcI-StatesToAddModList</i> in the <i>PDSCH-Config</i> included in the <i>BWP-Downlink</i> corresponding to the serving cell and to the DL BWP to which the <i>resourcesForChannelMeasurement</i> (in the <i>CSI-ReportConfig</i> indicated by <i>reportConfigId</i> 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 the second entry, and so on).

Conditional Presence	Explanation
<i>Aperiodic</i>	The field is mandatory present if the <i>NZP-CSI-RS-Resources</i> in the associated <i>resourceSet</i> have the resourceType aperiodic. The field is absent otherwise.
<i>CSI-IM-forInterference</i>	This field is optional need M if the <i>CSI-ReportConfig</i> identified by <i>reportConfigId</i> is configured with <i>csi-IM-ResourcesForInterference</i> ; otherwise it is absent.
<i>NZP-CSI-RS-forInterference</i>	This field is optional need M if the <i>CSI-ReportConfig</i> identified by <i>reportConfigId</i> is configured with <i>nzp-CSI-RS-ResourcesForInterference</i> ; otherwise it is absent.

– CSI-FrequencyOccupation

The IE *CSI-FrequencyOccupation* is used to configure the frequency domain occupation of a channel state information measurement resource (e.g. *NZP-CSI-RS-Resource*, *CSI-IM-Resource*).

CSI-FrequencyOccupation information element

```
-- ASN1START
-- TAG-CSI-FREQUENCYOCCUPATION-START
```

```

CSI-FrequencyOccupation ::= SEQUENCE {
    startingRB          INTEGER (0..maxNrofPhysicalResourceBlocks-1),
    nrofRBs             INTEGER (24..maxNrofPhysicalResourceBlocksPlus1),
    ...
}

-- TAG-CSI-FREQUENCYOCCUPATION-STOP
-- ASN1STOP

```

CSI-FrequencyOccupation field descriptions

nrofRBs

Number of PRBs across which this CSI resource spans. Only multiples of 4 are allowed. The smallest configurable number is the minimum of 24 and the width of the associated BWP. If the configured value is larger than the width of the corresponding BWP, the UE shall assume that the actual CSI-RS bandwidth is equal to the width of the BWP.

startingRB

PRB where this CSI resource starts in relation to common resource block #0 (CRB#0) on the common resource block grid. Only multiples of 4 are allowed (0, 4, ...)

– *CSI-IM-Resource*

The IE *CSI-IM-Resource* is used to configure one CSI Interference Management (IM) resource.

***CSI-IM-Resource* information element**

```

-- ASN1START
-- TAG-CSI-IM-RESOURCE-START

CSI-IM-Resource ::= SEQUENCE {
    csi-IM-ResourceId          CSI-IM-ResourceId,
    csi-IM-ResourceElementPattern CHOICE {
        pattern0              SEQUENCE {
            subcarrierLocation-p0    ENUMERATED { s0, s2, s4, s6, s8, s10 },
            symbolLocation-p0        INTEGER (0..12)
        },
        pattern1              SEQUENCE {
            subcarrierLocation-p1    ENUMERATED { s0, s4, s8 },
            symbolLocation-p1        INTEGER (0..13)
        }
    },
    freqBand                   OPTIONAL, -- Need M
    periodicityAndOffset       OPTIONAL, -- Need M
    ...                       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
<i>PeriodicOrSemiPersistent</i>	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 ::=
    csi-IM-ResourceSetId
    csi-IM-Resources
    ...
}
-- 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-ResourceSets*.

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-ResourceSetToAddModList	Pool of CSI-IM-ResourceSet 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-ResourceSetToAddModList	Pool of NZP-CSI-RS-ResourceSet 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.

```
-- ASN1START
-- TAG-CSI-REPORTCONFIG-START

CSI-ReportConfig ::=
    reportConfigId
    carrier
    resourcesForChannelMeasurement
    csi-IM-ResourcesForInterference
    nzp-CSI-RS-ResourcesForInterference
    reportConfigType
        periodic
            reportSlotConfig
            pucch-CSI-ResourceList
        },
        semiPersistentOnPUCCH
            reportSlotConfig
            pucch-CSI-ResourceList
        },
        semiPersistentOnPUSCH
            reportSlotConfig
            reportSlotOffsetList
            p0alpha
        },
        aperiodic
            reportSlotOffsetList
        }
    },
    reportQuantity
        none
        cri-RI-PMI-CQI
        cri-RI-i1
        cri-RI-i1-CQI
        pdsch-BundleSizeForCSI
    },
    cri-RI-CQI
    cri-RSRP
    ssb-Index-RSRP
    cri-RI-LI-PMI-CQI
    },
    reportFreqConfiguration
        cqi-FormatIndicator
        pmi-FormatIndicator
        csi-ReportingBand
            subbands3
            subbands4
            subbands5
            subbands6
            subbands7
            subbands8
            subbands9
```

```

        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

}
timeRestrictionForChannelMeasurements    ENUMERATED {configured, notConfigured},
timeRestrictionForInterferenceMeasurements    ENUMERATED {configured, notConfigured},
codebookConfig                          CodebookConfig
nrofCQIsPerReport                      ENUMERATED {n1, n2}
groupBasedBeamReporting                 CHOICE {
    enabled                             NULL,
    disabled                           SEQUENCE {
        nrofReportedRS                ENUMERATED {n1, n2, n3, n4}
    }
},
cqi-Table                              ENUMERATED {table1, table2, spare2, spare1}
subbandSize                            ENUMERATED {value1, value2},
non-PMI-PortIndication                 SEQUENCE (SIZE (1..maxNrofNZP-CSI-RS-ResourcesPerConfig)) OF PortIndexFor8Ranks
...
}

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
        rank2-8          SEQUENCE(SIZE(2)) OF PortIndex8
        rank3-8          SEQUENCE(SIZE(3)) OF PortIndex8
    }
}

```

```

OPTIONAL, -- Need R
OPTIONAL, -- Need R
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
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
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-I 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-contiguous subset of subbands in the bandwidth part which CSI shall be reported for. Each bit in the bit-string represents one subband. The right-most bit in the bit string represents the lowest subband in the BWP. (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	<p>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).</p> <p>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.</p>
nrofCQIsPerReport	Maximum number of CQIs per CSI report (cf. 1 for 1-CW, 2 for 2-CW)
nrofReportedRS	<p>The number (N) of measured RS resources to be reported per report setting in a non-group-based report. $N \leq N_{\max}$, 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.</p> <p>FFS: Note: this parameter may not be needed for certain resource and/or report settings</p> <p>FFS_ASN1: Change groupBasedBeamReporting into a CHOICE and include this field into the "no" option?</p> <p>(see 38.214, section FFS_Section) When the field is absent the UE applies the value 1</p>
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)

<i>pdsch-BundleSizeForCSI</i>
PRB bundling size to assume for CQI calculation when reportQuantity is CRI/RI/i1/CQI. Corresponds to L1 parameter 'PDSCH-bundle-size-for-CSI' (see 38.214, section 5.2.1.4)
<i>pmi-FormatIndicator</i>
Indicates whether the UE shall report a single (wideband) or multiple (subband) PMI. (see 38.214, section 5.2.1.4)
<i>pucch-CSI-ResourceList</i>
Indicates which PUCCH resource to use for reporting on PUCCH.
<i>reportConfigType</i>
Time domain behavior of reporting configuration
<i>reportFreqConfiguration</i>
Reporting configuration in the frequency domain. (see 38.214, section 5.2.1.4)
<i>reportQuantity</i>
The CSI related quantities to report. Corresponds to L1 parameter 'ReportQuantity' (see 38.214, section REF)
<i>reportSlotConfig</i>
Periodicity and slot offset. Corresponds to L1 parameter 'ReportPeriodicity' and 'ReportSlotOffset' (see 38.214, section 5.2.1.4) as well as to L1 parameter 'Reportperiodicity-spCSI'. (see 38.214, section 5.2.1.1?FFS_Section)
<i>reportSlotOffsetList</i>
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 <i>pusch-TimeDomainAllocationList</i> in <i>PUSCH-Config</i> . 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 <i>pusch-TimeDomainAllocationList</i> in <i>PUSCH-Config</i> . 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).
<i>resourcesForChannelMeasurement</i>
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.
<i>subbandSize</i>
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)
<i>timeRestrictionForChannelMeasurements</i>
Time domain measurement restriction for the channel (signal) measurements. Corresponds to L1 parameter 'MeasRestrictionConfig-time-channel' (see 38.214, section 5.2.1.1)
<i>timeRestrictionForInterferenceMeasurements</i>
Time domain measurement restriction for interference measurements. Corresponds to L1 parameter 'MeasRestrictionConfig-time-interference' (see 38.214, section 5.2.1.1)

<i>PortIndexFor8Ranks field descriptions</i>
<i>portIndex8</i> Port-Index configuration for up to rank 8. If present, the network configures port indexes for at least one of the ranks.
<i>portIndex4</i> Port-Index configuration for up to rank 4. If present, the network configures port indexes for at least one of the ranks.
<i>portIndex2</i> Port-Index configuration for up to rank 2. If present, the network configures port indexes for at least one of the ranks.
<i>portIndex1</i> Port-Index configuration for rank 1.

<i>PUCCH-CSI-Resource field descriptions</i>
<i>pucch-Resource</i> 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 <i>PUCCH-Config</i> 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
            }
        }
    }

-- TAG-CSI-RESOURCECONFIG-STOP
-- ASN1STOP
```

```

    },
    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

```

<i>CSI-ResourceConfig field descriptions</i>	
<i>bwp-Id</i>	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)
<i>csi-ResourceConfigId</i>	Used in CSI-ReportConfig to refer to an instance of CSI-ResourceConfig
<i>csi-RS-ResourceSetList</i>	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)
<i>csi-SSB-ResourceSetList</i>	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)
<i>resourceType</i>	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,
    isQuasiCollocated BOOLEAN
},
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).

<i>CSI-RS-Resource-Mobility field descriptions</i>
<p>associatedSSB</p> <p>If this field is present, the UE may base the timing of the CSI-RS resource indicated in <i>CSI-RS-Resource-Mobility</i> on the timing of the cell indicated by the <i>cellId</i> in the <i>CSI-RS-CellMobility</i>. 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 <i>associatedSSB</i> and <i>cellId</i>. If this field is absent, the UE shall base the timing of the CSI-RS resource indicated in <i>CSI-RS-Resource-Mobility</i> 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 <i>cellId</i> in the <i>CSI-RS-CellMobility</i> are not detected.</p> <p>CSI-RS resources with and without <i>associatedSSB</i> may be configured in accordance with the rules in 38.214, section 5.1.6.1.3.</p>
<p>csi-RS-Index</p> <p>CSI-RS resource index associated to the CSI-RS resource to be measured (and used for reporting).</p>
<p>firstOFDMSymbolInTimeDomain</p> <p>Time domain allocation within a physical resource block. The field indicates the first OFDM symbol in the PRB used for CSI-RS. Parameter I0 in 38.211, section 7.4.1.5.3. Value 2 is supported only when DL-DMRS-typeA-pos equals 3.</p>
<p>frequencyDomainAllocation</p> <p>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 parameters below and from the number of bits set to 1 in <i>frequencyDomainAllocation</i>.</p>
<p>isQuasiColocated</p> <p>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).</p>
<p>sequenceGenerationConfig</p> <p>Scrambling ID for CSI-RS (see 38.211, section 7.4.1.5.2).</p>
<p>slotConfig</p> <p>Indicates the CSI-RS periodicity (in milliseconds) and for each periodicity the offset (in number of slots). When <i>subcarrierSpacingCSI-RS</i> is set to 15kHz, the maximum offset values for periodicities ms4/ms5/ms10/ms20/ms40 are 3/4/9/19/39 slots. When <i>subcarrierSpacingCSI-RS</i> is set to 30kHz, the maximum offset values for periodicities ms4/ms5/ms10/ms20/ms40 are 7/9/19/39/79 slots. When <i>subcarrierSpacingCSI-RS</i> is set to 60kHz, the maximum offset values for periodicities ms4/ms5/ms10/ms20/ms40 are 15/19/39/79/159 slots. When <i>subcarrierSpacingCSI-RS</i> is set 120kHz, the maximum offset values for periodicities ms4/ms5/ms10/ms20/ms40 are 31/39/79/159/319 slots.</p>

– *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 ::=
    frequencyDomainAllocation SEQUENCE {
        row1 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 I1 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 I0 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 or released, the UE assumes that downlink PTRS are not present. See 38.214 section 5.1.6.3

scramblingID0

DL DMRS scrambling initialization 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 initialization. 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 initialization 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 initialization 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 InterFreqH0AndServCellAdd
        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 ::=
    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
```

<i>DownlinkPreemption field descriptions</i>
<i>dcf-PayloadSize</i> Total length of the DCI payload scrambled with INT-RNTI. Corresponds to L1 parameter 'INT-DCI-payload-length' (see 38.213, section 11.2)
<i>int-ConfigurationPerServingCell</i> 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)
<i>int-RNTI</i> RNTI used for indication pre-emption in DL. Corresponds to L1 parameter 'INT-RNTI', where "INT" stands for "interruption" (see 38.213, section 10)
<i>timeFrequencySet</i> 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.

<i>INT-ConfigurationPerServingCell field descriptions</i>
<i>positionInDCI</i> 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))
}
...
}

-- 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 ::=
    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
```

<i>FrequencyInfoDL</i> field descriptions
<i>absoluteFrequencyPointA</i> 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 <i>scs-SpecificCarrierList</i> . Corresponds to L1 parameter 'offset-ref-low-scs-ref-PRB' (see 38.211, section FFS_Section)
<i>absoluteFrequencySSB</i> 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. <i>ssb-PositionsInBurst</i> , <i>ssb-periodicityServingCell</i> and <i>subcarrierSpacing</i> in <i>ServingCellConfigCommon</i> 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.
<i>frequencyBandList</i> 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 <i>FrequencyInfoDL</i> is provided in dedicated signalling (HO or S(p)Cell addition).
<i>scs-SpecificCarrierList</i> 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
<i>SpCellAdd</i>	The field is mandatory present if this <i>FrequencyInfoDL</i> 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 ::=
    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	
<i>absoluteFrequencyPointA</i>	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)
<i>additionalSpectrumEmission</i>	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)
<i>frequencyBandList</i>	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).
<i>frequencyShift7p5khz</i>	Enable the NR UL transmission with a 7.5KHz shift to the LTE raster. If the field is absent, the frequency shift is disabled.
<i>p-Max</i>	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.
<i>scs-SpecificCarrierList</i>	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
<i>FDD-OrSUL</i>	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)).
<i>FDD-OrSUL-Optional</i>	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 ::=
-- 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 ::=
    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 <i>logicalChannelSR-DelayTimer</i> is not included in <i>BSR-Config</i> .
maxPUSCH-Duration	If present, UL MAC SDUs from this logical channel can only be transmitted using uplink grants that result in a PUSCH duration shorter than or equal to the duration indicated by this field. Otherwise, UL MAC SDUs from this logical channel can be transmitted using an uplink grant resulting in any PUSCH duration. Corresponds to 'maxPUSCH-Duration' in TS 38.321 [3].
priority	Logical channel priority, as specified in TS 38.321 [3].
prioritisedBitRate	Value in kiloBytes/s. 0kBps corresponds to 0, 8kBps corresponds to 8 kiloBytes/s, 16 kBps corresponds to 16 kiloBytes/s, and so on. For SRBs, the value can only be set to infinity.
schedulingRequestId	If present, it indicates the scheduling request configuration applicable for this logical channel, as specified in TS 38.321 [3].

Conditional Presence	Explanation
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 ::=
    drx-Config
    schedulingRequestConfig
    bsr-Config
    tag-Config
    phr-Config
    skipUplinkTxDynamic
    ...
}

DRX-Config ::=
    drx-onDurationTimer
    drx-InactivityTimer
    drx-HARQ-RTT-TimerDL
    drx-HARQ-RTT-TimerUL
    drx-RetransmissionTimerDL
    drx-RetransmissionTimerUL
    drx-LongCycleStartOffset
    ms10
    ms20
    ms32
    ms40

SEQUENCE {
    SetupRelease { DRX-Config }
    SchedulingRequestConfig
    BSR-Config
    TAG-Config
    SetupRelease { PHR-Config }
    BOOLEAN,
    ...
}

SEQUENCE {
    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 }
    },
    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},
    INTEGER (0..56),
    INTEGER (0..56),
    ENUMERATED {
        s10, s11, s12, s14, s16, s18, s116, s124, s133, s140, s164, s180, s196, s1112, s1128,
        s1160, s1320, spare15, spare14, spare13, spare12, spare11, spare10, spare9,
        spare8, spare7, spare6, spare5, spare4, spare3, spare2, spare1},
    ENUMERATED {
        s10, s11, s12, s14, s16, s18, s116, s124, s133, s140, s164, s180, s196, s1112, s1128,
        s1160, s1320, spare15, spare14, spare13, spare12, spare11, spare10, spare9,
        spare8, spare7, spare6, spare5, spare4, spare3, spare2, spare1 },
    CHOICE {
        INTEGER(0..9),
        INTEGER(0..19),
        INTEGER(0..31),
        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)
}
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
        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}
    ...
}

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

OPTIONAL, -- Need R

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. <i>real</i> or <i>virtual</i>) 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 corresponds to 20 subframes, and so on.
phr-ProhibitTimer Value in number of subframes for PHR reporting as specified in TS 38.321 [3]. sf0 corresponds to 0 subframe, sf10 corresponds to 10 subframes, sf20 corresponds to 20 subframes, and so on.
phr-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 <i>timeAlignmentTimer</i> for TAG with ID <i>tag-Id</i> , 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 ::=
    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 <i>ssb-RSRP</i> corresponds to cell RSRP based on SS/PBCH block and choice of <i>csi-RSRP</i> 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 ::=
    gapFR2
    ...
}

GapConfig ::=
    gapOffset
    mgl
    mgrp
    mgta
    ...
}

-- 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 <i>gapOffset</i> is the gap offset of the gap pattern with MGRP indicated in the field <i>mgrp</i> . The value range should be from 0 to <i>mgrp</i> -1.
mgl Value <i>mgl</i> 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 <i>ms1dot5</i> corresponds to 1.5ms, <i>ms3</i> corresponds to 3ms and so on.
mgrp Value <i>mgrp</i> 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 <i>mgta</i> 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 <i>ms0</i> corresponds to 0 ms, <i>ms0dot25</i> corresponds to 0.25ms and <i>ms0dot5</i> 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 ::=
    gapSharingFR2
    ...
}

```

```

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 ::=
  ssb-ConfigMobility                    SSB-ConfigMobility                                OPTIONAL,    -- Need M
  csi-rs-ResourceConfigMobility          SetupRelease { CSI-RS-ResourceConfigMobility }  OPTIONAL,    -- Need M
}

SSB-ConfigMobility ::=
  ssb-ToMeasure                          SetupRelease { SSB-ToMeasure }                OPTIONAL,    -- Need M
  useServingCellTimingForSync            BOOLEAN,
  ss-RSSI-Measurement                    SS-RSSI-Measurement                        OPTIONAL,    -- Need M
  ...
}

Q-OffsetRangeList ::=
  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 ::=
  shortBitmap                            BIT STRING (SIZE (4)),
  mediumBitmap                           BIT STRING (SIZE (8)),
  longBitmap                             BIT STRING (SIZE (64))
}

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

CellsToAddModList ::=
  SEQUENCE (SIZE (1..maxNrofCellMeas)) OF CellsToAddMod

CellsToAddMod ::=
  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.

<i>MeasObjectNR</i> field descriptions
<i>absThreshCSI-RS-Consolidation</i> 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.
<i>absThreshSS-BlocksConsolidation</i> 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 5.5.3.3 and the L3 filter(s) per SS/PBCH block index as described in 5.5.3.2.
<i>blackCellsToAddModList</i> List of cells to add/modify in the black list of cells.
<i>blackCellsToRemoveList</i> List of cells to remove from the black list of cells.
<i>cellsToAddModList</i> List of cells to add/modify in the cell list.
<i>cellsToRemoveList</i> List of cells to remove from the cell list.
<i>nrofCSI-RS-ResourcesToAverage</i> 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 <i>MeasObjectNR</i> .
<i>nrofSS-BlocksToAverage</i> 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 <i>MeasObject</i> .
<i>offsetMO</i> Offset values applicable to all measured cells with reference signal(s) indicated in this <i>MeasObjectNR</i> .
<i>quantityConfigIndex</i> Indicates the <i>n</i> -th element of <i>quantityConfigNR-List</i> provided in <i>MeasConfig</i> .
<i>referenceSignalConfig</i> RS configuration (e.g. SMTC window, CSI-RS resource, etc.)
<i>refFreqCSI-RS</i> Point A which is used for mapping of CSI-RS to physical resources according to TS 38.211 section 7.4.1.5.3.
<i>smtc1</i> Primary measurement timing configuration. Applicable for intra- and inter-frequency measurements.
<i>smtc2</i> Secondary measurement timing configuration for SS corresponding to this <i>MeasObjectNR</i> with PCI listed in <i>pci-List</i> . For these SS, the periodicity is indicated by periodicity in <i>smtc2</i> and the timing offset is equal to the offset indicated in periodicityAndOffset modulo periodicity. periodicity in <i>smtc2</i> can only be set to a value strictly shorter than the periodicity indicated by periodicityAndOffset in <i>smtc1</i> (e.g. if periodicityAndOffset indicates sf10, periodicity can only be set of sf5, if periodicityAndOffset indicates sf5, <i>smtc2</i> cannot be configured).
<i>ssbFrequency</i> Indicates the frequency of the SS associated to this <i>MeasObjectNR</i> .
<i>ssbSubcarrierSpacing</i> Subcarrier spacing of SSB. Only the values 15 or 30 (<6GHz), 120 kHz or 240 kHz (>6GHz) are applicable.
<i>whiteCellsToAddModList</i> List of cells to add/modify in the white list of cells.
<i>whiteCellsToRemoveList</i> 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 <i>measurementSlots</i>) the UE measures the RSSI from symbol 0 to symbol <i>endSymbol</i> . 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 <i>duration</i> and by the <i>subcarrierSpacing</i>). 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
<i>SSBorAssociatedSSB</i>	This field is mandatory present if <i>ssb-ConfigMobility</i> is configured or <i>associatedSSB</i> is configured in at least one cell, otherwise, it is absent.
<i>IntraFreqConnected</i>	This field is optionally present in an intra-frequency measurement object and only if <i>ssb-ConfigMobility</i> is configured or <i>associatedSSB</i> 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
        measObject
        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
        measResultServingMOList
        measResultNeighCells
        measResultListNR
        ...
    }
    OPTIONAL,
    ...
}
```



```

MeasResultServMOList ::=
    SEQUENCE (SIZE (1..maxNrofServingCells)) OF MeasResultServMO

MeasResultServMO ::=
    SEQUENCE {
        servCellId
        measResultServingCell
        measResultBestNeighCell
        ...
    }
    OPTIONAL,

MeasResultListNR ::=
    SEQUENCE (SIZE (1..maxCellReport)) OF MeasResultNR

MeasResultNR ::=
    SEQUENCE {
        physCellId
        --FFS: Details of cgi info
        measResult
            cellResults
                resultsSSB-Cell
                resultsCSI-RS-Cell
            },
            rsIndexResults
                resultsSSB-Indexes
                resultsCSI-RS-Indexes
            }
        },
        ...
    }

MeasQuantityResults ::=
    SEQUENCE {
        rsrp
        rsrq
        sinr
    }
    OPTIONAL,
    OPTIONAL,
    OPTIONAL

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

ResultsPerSSB-Index ::=
    SEQUENCE {
        ssb-Index
        ssb-Results
    }
    OPTIONAL

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

ResultsPerCSI-RS-Index ::=
    SEQUENCE {
        csi-RS-Index
        csi-RS-Results
    }
    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 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.
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

```

– **MeasResultCellListSFTD**

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

```

<i>MeasResultSFTD</i> field descriptions
<i>sfn-OffsetResult</i> Indicates the SFN difference between the PCell and the NR cell as an integer value according to TS 38.215 [9].
<i>frameBoundaryOffsetResult</i> 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-RS transmitted 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
```

<i>NZP-CSI-RS-Resource field descriptions</i>	
<i>periodicityAndOffset</i>	Periodicity and slot offset <i>s/1</i> corresponds to a periodicity of 1 slot, <i>s/2</i> 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)
<i>powerControlOffset</i>	Power offset of NZP CSI-RS RE to PDSCH RE. Value in dB. Corresponds to L1 parameter <i>Pc</i> (see 38.214, sections 5.2.2.3.1 and 4.1)
<i>powerControlOffsetSS</i>	Power offset of NZP CSI-RS RE to SS RE. Value in dB. Corresponds to L1 parameter ' <i>Pc_SS</i> ' (see 38.214, section 5.2.2.3.1)
<i>qcl-InfoPeriodicCSI-RS</i>	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 <i>tcid-StateId</i> and is defined in <i>tcid-StatesToAddModList</i> in the <i>PD-SCH-Config</i> included in the <i>BWP-Downlink</i> 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)
<i>resourceMapping</i>	OFDM symbol location(s) in a slot and subcarrier occupancy in a PRB of the CSI-RS resource
<i>scramblingID</i>	Scrambling ID (see 38.214, section 5.2.2.3.1)

Conditional Presence	Explanation
<i>Periodic</i>	The field is optionally present, Need M, for periodic NZP-CSI-RS-Resources (as indicated in CSI-ResourceConfig). The field is absent otherwise
<i>PeriodicOrSemiPersistent</i>	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 associated 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 '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 }
    }

-- TAG-PCI-RANGE-STOP
```

OPTIONAL -- Need S

-- ASN1STOP

PCI-Range field descriptions
range Indicates the number of physical cell identities in the range (including <i>start</i>). 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 <i>start</i> 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 ::=
    pci-RangeIndex          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
```

<i>PDCCH-Config field descriptions</i>	
<i>controlResourceSetToAddModList</i>	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).
<i>downlinkPreemption</i>	Configuration of downlink preemption 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.
<i>searchSpacesToAddModList</i>	List of UE specifically configured Search Spaces. The network configures at most 10 Search Spaces per BWP per cell (including the initial Search Space).
<i>tpc-PUCCH</i>	Enable and configure reception of group TPC commands for PUCCH
<i>tpc-PUSCH</i>	Enable and configure reception of group TPC commands for PUSCH
<i>tpc-SRS</i>	Enable and configure reception of group TPC commands for SRS

Conditional Presence	Explanation
<i>PUCCH-CellOnly</i>	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
```

<i>PDCCH-ConfigCommon field descriptions</i>	
<i>commonControlResourceSet</i>	An additional common control resource set which 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.
<i>commonSearchSpace</i>	An additional common search space.
<i>controlResourceSetZero</i>	Parameters of the common CORESET#0. The values are interpreted like the corresponding bits in MIB pdccch-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).
<i>pagingSearchSpace</i>	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.
<i>ra-SearchSpace</i>	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.
<i>searchSpaceOtherSystemInformation</i>	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.
<i>searchSpaceSIB1</i>	ID of the search space for SIB1 message. Corresponds to L1 parameter 'rmsi-SearchSpace' (see 38.213, section 10)
<i>searchSpaceZero</i>	Parameters of the common SearchSpace#0. The values are interpreted like the corresponding bits in MIB pdccch-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
<i>InitialBWP-Only</i>	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	
<i>discardTimer</i>	Value in ms of <i>discardTimer</i> specified in TS 38.323 [5]. Value ms50 corresponds to 50 ms, ms100 corresponds to 100 ms and so on.
<i>drb-ContinueROHC</i>	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.
<i>headerCompression</i>	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.
<i>integrityProtection</i>	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.
<i>maxCID</i>	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.
<i>moreThanOneRLC</i>	FFS / TODO: Handle more than two secondary cell groups
<i>outOfOrderDelivery</i>	Indicates whether or not <i>outOfOrderDelivery</i> specified in TS 38.323 [5] is configured. Out-of-order delivery is configured only when the radio bearer is established
<i>pdcp-Duplication</i>	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.
<i>pdcp-SN-Size</i>	PDCP sequence number size, 12 or 18 bits.
<i>primaryPath</i>	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 transmission when more than one RLC entity is associated with the PDCP entity. In this version of the specification, only cell group ID corresponding to MCG is supported for SRBs.
<i>pdcp-SN-Size</i>	PDCP sequence number size, 12 or 18 bits.
<i>statusReportRequired</i>	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.
<i>t-Reordering</i>	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 <i>infinity</i> .
<i>ul-DataSplitThreshold</i>	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
<i>DRB</i>	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.
<i>MoreThanOneRLC</i>	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.
<i>RLC-AM</i>	For RLC AM, the field is optionally present, need R. Otherwise, the field is not present.
<i>Setup</i>	The field is mandatory present in case of radio bearer setup. Otherwise the field is optionally present, need M.
<i>SplitBearer</i>	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 <i>infinity</i> is applied.
<i>ConnectedTo5GC</i>	The field is optionally present, need R, if EN-DC is not configured, and absent if EN-DC is configured.
<i>Setup2</i>	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 ::=
    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
        bundleSizeSet1
        bundleSizeSet2
    },
    zp-CSI-RS-ResourceToAddModList
    zp-CSI-RS-ResourceToReleaseList
    aperiodic-ZP-CSI-RS-ResourceSetsToAddModList
    aperiodic-ZP-CSI-RS-ResourceSetsToReleaseList
    sp-ZP-CSI-RS-ResourceSetsToAddModList
    sp-ZP-CSI-RS-ResourceSetsToReleaseList
    p-ZP-CSI-RS-ResourceSet
    ...
}
RateMatchPatternGroup ::=
    RateMatchPatternId,
    bwpLevel
}

-- TAG-PDSCH-CONFIG-STOP
-- ASN1STOP

```

SEQUENCE {

ENUMERATED { n4, wideband, n2-wideband, n4-wideband } OPTIONAL, -- Need S

ENUMERATED { n4, wideband } OPTIONAL -- Need S

SEQUENCE (SIZE (1..maxNrofZP-CSI-RS-Resources)) OF ZP-CSI-RS-Resource OPTIONAL, -- Need N

SEQUENCE (SIZE (1..maxNrofZP-CSI-RS-Resources)) OF ZP-CSI-RS-ResourceId OPTIONAL, -- Need N

SEQUENCE (SIZE (1..maxNrofZP-CSI-RS-ResourceSets)) OF ZP-CSI-RS-ResourceSet OPTIONAL, -- Need N

SEQUENCE (SIZE (1..maxNrofZP-CSI-RS-ResourceSets)) OF ZP-CSI-RS-ResourceSetId OPTIONAL, -- Need N

SEQUENCE (SIZE (1..maxNrofZP-CSI-RS-ResourceSets)) OF ZP-CSI-RS-ResourceSet OPTIONAL, -- Need N

SEQUENCE (SIZE (1..maxNrofZP-CSI-RS-ResourceSets)) OF ZP-CSI-RS-ResourceSetId OPTIONAL, -- Need N

SetupRelease { ZP-CSI-RS-ResourceSet } OPTIONAL, -- Need M

SEQUENCE (SIZE (1..maxNrofRateMatchPatternsPerGroup)) OF CHOICE { cellLevel

<i>PDSCH-Config field descriptions</i>
<p><i>aperiodic-ZP-CSI-RS-ResourceSetsToAddModList</i> 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)</p>
<p><i>dataScramblingIdentityPDSCH</i> Identifier used to initialize data scrambling (c_init) for PDSCH. Corresponds to L1 parameter 'Data-scrambling-Identity' (see 38.211, section 7.3.1.1).</p>
<p><i>dmrs-DownlinkForPDSCH-MappingTypeA</i> DMRS configuration for PDSCH transmissions using PDSCH mapping type A (chosen dynamically via PDSCH-TimeDomainResourceAllocation).</p>
<p><i>dmrs-DownlinkForPDSCH-MappingTypeB</i> DMRS configuration for PDSCH transmissions using PDSCH mapping type B (chosen dynamically via PDSCH-TimeDomainResourceAllocation).</p>
<p><i>maxNrofCodeWordsScheduledByDCI</i> 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.</p>
<p><i>mcs-Table</i> 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.</p>
<p><i>pdsch-AggregationFactor</i> 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</p>
<p><i>pdsch-AllocationList</i> 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.</p>
<p><i>prb-BundlingType</i> Indicates the PRB bundle type and bundle size(s). Corresponds to L1 parameter 'PRB_bundling' (see 38.214, section 5.1.2.3). If <i>dynamic</i> is chosen, the actual <i>bundleSizeSet1</i> or <i>bundleSizeSet2</i> to use is indicated via DCI. Constraints on <i>bundleSize(Set)</i> setting depending on <i>vrbs-ToPRB-Interleaver</i> and <i>rbg-Size</i> settings are described in TS 38.214 ([19], section 5.1.2.3). If a <i>bundleSize(Set)</i> value is absent, the UE applies the value <i>n2</i>.</p>
<p><i>p-ZP-CSI-RS-ResourceSet</i> 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.</p>
<p><i>rateMatchPatternGroup1</i> 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)</p>
<p><i>rateMatchPatternGroup2</i> 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)</p>
<p><i>rateMatchPatternToAddModList</i> 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.</p>
<p><i>rbg-Size</i> 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)</p>
<p><i>resourceAllocation</i> Configuration of resource allocation type 0 and resource allocation type 1 for non-fallback DCI Corresponds to L1 parameter 'Resource-allocation-config' (see 38.214, section</p>

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 <i>ZP-CSI-RS-ResourceSetId</i> and the IDs of one or more <i>ZP-CSI-RS-Resources</i> (the actual resources are defined in the <i>zp-CSI-RS-ResourceToAddModList</i>). 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 <i>ZP-CSI-RS-ResourceSetId</i> in the DCI payload. The DCI codepoint '01' triggers the resource set with <i>ZP-CSI-RS-ResourceSetId</i> 1, the DCI codepoint '10' triggers the resource set with <i>ZP-CSI-RS-ResourceSetId</i> 2, and the DCI codepoint '11' triggers the resource set with <i>ZP-CSI-RS-ResourceSetId</i> 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)
vrbs-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 ::=
    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
<i>SCellAddOnly</i>	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 configured time domain allocations the UE shall apply for that DL assignment. The UE determines the bit width of the DCI field based on the number of entries in the *PDSCH-TimeDomainResourceAllocationList*. Value 0 in the DCI field refers to the first element in this list, value 1 in the DCI field refers to the second element in this list, and so on.

***PDSCH-TimeDomainResourceAllocationList* information element**

```
-- ASN1START
-- TAG-PDSCH-TIMEDOMAINRESOURCEALLOCATIONLIST-START

PDSCH-TimeDomainResourceAllocationList ::= SEQUENCE (SIZE(1..maxNrofDL-Allocations)) OF PDSCH-TimeDomainResourceAllocation

PDSCH-TimeDomainResourceAllocation ::= SEQUENCE {
    k0                                INTEGER(0..32)                                OPTIONAL,    -- Need S
    mappingType                       ENUMERATED {typeA, typeB},
    startSymbolAndLength              INTEGER (0..127)
}

-- TAG-PDSCH-TIMEDOMAINRESOURCEALLOCATIONLIST-STOP
-- ASN1STOP
```

<i>PDSCH-TimeDomainResourceAllocation</i> field descriptions	
<i>k0</i>	The <i>n1</i> corresponds to the value 1, <i>n2</i> corresponds 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.
<i>mappingType</i>	PDSCH mapping type. Corresponds to L1 parameter 'Mapping-type' (see 38.214, section FFS_Section)
<i>startSymbolAndLength</i>	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
```

<i>PhysicalCellGroupConfig</i> field descriptions	
cs-RNTI	RNTI value for downlink SPS (see SPS-config) and uplink configured grant (see ConfiguredGrantConfig).
harq-ACK-SpatialBundlingPUCCH	Enables spatial bundling of HARQ ACKs. It is configured per cell group (i.e. for all the cells within the cell group) for PUCCH reporting of HARQ-ACK. It is only applicable when more than 4 layers are possible to schedule. When the field is absent, the spatial bundling is disabled. 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 field 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 non-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
<i>SP-CSI-Report</i>	The field is mandatory present, Need M, when at least one <i>CSI-ReportConfig</i> with <i>reportConfigType</i> set to <i>semiPersistentOnPUSCH</i> is configured; otherwise it is optionally present, need M.

— **PRB-Id**

The *PRB-Id* identifies a Physical Resource Block (PRB) position within a carrier.

PRB-Id information element

```
-- ASN1START
-- TAG-PRB-ID-START

PRB-Id ::= INTEGER (0..maxNrofPhysicalResourceBlocks-1)

-- TAG-PRB-ID-STOP
-- ASN1STOP
```

– PTRS-DownlinkConfig

The IE *PTRS-DownlinkConfig* is used to configure downlink phase tracking reference signals (PTRS) (see 38.214 section 5.1.6.3)

PTRS-DownlinkConfig information element

```
-- ASN1START
-- TAG-PTRS-DOWNLINKCONFIG-START

PTRS-DownlinkConfig ::=
    frequencyDensity
    timeDensity
    epre-Ratio
    resourceElementOffset
    ...
}

SEQUENCE {
    SEQUENCE (SIZE (2)) OF INTEGER (1..276)
    SEQUENCE (SIZE (3)) OF INTEGER (0..29)
    INTEGER (0..3)
    ENUMERATED { offset01, offset10, offset11 }
}

OPTIONAL, -- Need S
OPTIONAL, -- Need S
OPTIONAL, -- Need S
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 ::=
modeSpecificParameters
  cp-OFDM
    frequencyDensity
    timeDensity
    maxNrofPorts
    resourceElementOffset
    ptrs-Power
  },
  dft-S-OFDM
    sampleDensity
    timeDensityTransformPrecoding
  }
  ...
}

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

```

SEQUENCE {
CHOICE {
SEQUENCE {
SEQUENCE (SIZE (2)) OF INTEGER (1..276) OPTIONAL, -- Need S
SEQUENCE (SIZE (3)) OF INTEGER (0..29) OPTIONAL, -- Need S
ENUMERATED {n1, n2},
ENUMERATED {offset01, offset10, offset11 } OPTIONAL, -- Need S
ENUMERATED {p00, p01, p10, p11}
SEQUENCE {
SEQUENCE (SIZE (5)) OF INTEGER (1..276),
ENUMERATED {d2} OPTIONAL -- Need S
OPTIONAL, -- Need M
...
}

<i>PTRS-UplinkConfig field descriptions</i>	
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 $T=\{NRB_n, n=0,1,2,3,4\}$, 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,
            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 }
    secondHopPRB                           PRB-Id
    format                                 CHOICE {
        format0                            PUCCH-format0,
        format1                            PUCCH-format1,
        format2                            PUCCH-format2,
        format3                            PUCCH-format3,
        format4                            PUCCH-format4
    }
}                                           OPTIONAL, -- Need R
                                           OPTIONAL, -- Need R
                                           -- Cond InFirstSetOnly
                                           -- Cond InFirstSetOnly
                                           -- Cond NotInFirstSet
                                           -- Cond NotInFirstSet
                                           -- 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).

<i>PUCCH-format3 field descriptions</i>
<i>nrofPRBs</i> The supported values are 1,2,3,4,5,6,8,9,10,12,15 and 16.

<i>PUCCH-FormatConfig field descriptions</i>
<i>additionalDMRS</i> 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 symbols for a PUCCH Format 3 or 4 with more than 2X+1 symbols when FH is disabled (X=4). The field is not applicable for format 1 and 2. See TS 38.213, section 9.2.2.
<i>interslotFrequencyHopping</i> Enabling inter-slot frequency hopping when PUCCH Format 1, 3 or 4 is repeated over multiple slots. The field is not applicable for format 2. See TS 38.213, section 9.2.6.
<i>maxCodeRate</i> 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.
<i>nrofSlots</i> 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.
<i>pi2BPSK</i> 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.
<i>simultaneousHARQ-ACK-CSI</i> 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.

<i>PUCCH-Resource field descriptions</i>
<i>format</i> Selection of the PUCCH format (format 0 - 4) and format-specific parameters, see TS 38.213, section 9.2.
<i>intraSlotFrequencyHopping</i> See TS 38.213, section 9.2.1.
<i>secondHopPRB</i> Index of starting PRB for second hop of PUCCH in case of FH. This value is applicable for intra-slot frequency hopping. See TS 38.213, section 9.2.1.

<i>PUCCH-ResourceSet field descriptions</i>
<i>maxPayloadMinus1</i> 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).
<i>resourceList</i> PUCCH resources of format0 and format1 are only allowed in the first PUCCH resource set, i.e., in a PUCCH-ResourceSet with pucch-ResourceSetId = 0. This set may contain between 1 and 32 resources. PUCCH resources of format2, format3 and format4 are only allowed in a PUCCH-ResourceSet with pucch-ResourceSetId > 0. If present, these sets contain between 1 and 8 resources each. The UE chooses a PUCCH-Resource from this list as specified in TS 38.213, 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 ::=
    pucch-ResourceCommon          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 hopping 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 reference 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-PATHLOSSREFERENCE-RS-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 PDCCCH-OfSpCell
        tpc-IndexPUCCH-SCell    INTEGER (1..15)                OPTIONAL,  -- Cond PDCCCH-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
<i>PDCCH-OfSpCell</i>	The field is mandatory present, need R, if the <i>PUCCH-TPC-CommandConfig</i> is provided in the <i>PDCCH-Config</i> for the SpCell. Otherwise, the field is absent.
<i>PDCCH-ofSpCellOrPUCCH-SCell</i>	The field is mandatory present, need R, if the <i>PUCCH-TPC-CommandConfig</i> is provided in the <i>PDCCH-Config</i> 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 <i>PUCCH-TPC-CommandConfig</i> is provided in the <i>PDCCH-Config</i> 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 ::=
    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 ::=
  betaOffsets
    dynamic
    semiStatic
  }
  scaling          ENUMERATED { f0p5, f0p65, f0p8, f1 }    OPTIONAL, -- Need M

-- TAG-PUSCH-CONFIG-STOP
-- ASN1STOP
```

<i>PUSCH-Config field descriptions</i>	
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	Identifier used to initialize 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 'Resource-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 <i>txConfig</i> 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}
        pusch-TimeDomainAllocationList            PUSCH-TimeDomainResourceAllocationList OPTIONAL, -- Need R
        msg3-DeltaPreamble                        INTEGER (-1..6)
        p0-NominalWithGrant                       INTEGER (-202..24)
        ...
    }

-- TAG-PUSCH-CONFIGCOMMON-STOP
-- ASN1STOP
```

<i>PUSCH-ConfigCommon field descriptions</i>
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)

<i>PUSCH-PowerControl field descriptions</i>
<i>deltaMCS</i> Indicates whether to apply delta MCS. When the field is absent, the UE applies $K_s = 0$ in delta_TFC formula for PUSCH. Corresponds to L1 parameter 'deltaMCS-Enabled' (see 38.213, section 7.1)
<i>msg3-Alpha</i> 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.
<i>p0-AlphaSets</i> 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)
<i>p0-NominalWithoutGrant</i> 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)
<i>pathlossReferenceRSToAddModList</i> A set of Reference Signals (e.g. a CSI-RS config or a SSB) 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)
<i>sri-PUSCH-MappingToAddModList</i> 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)
<i>tpc-Accumulation</i> 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)
<i>twoPUSCH-PC-AdjustmentStates</i> Number of PUSCH power control adjustment states maintained by the UE (i.e., $fc(i)$). If the field is present (n_2) 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)

<i>SRI-PUSCH-PowerControl field descriptions</i>
<i>sri-P0-PUSCH-AlphaSetId</i> The ID of a P0-PUSCH-AlphaSet as configured in p0-AlphaSets in PUSCH-PowerControl.
<i>sri-PUSCH-ClosedLoopIndex</i> The index of the closed power control loop associated with this SRI-PUSCH-PowerControl
<i>sri-PUSCH-PathlossReferenceRS-Id</i> The ID of PUSCH-PathlossReferenceRS as configured in the pathlossReferenceRSToAddModList in PUSCH-PowerControl.
<i>sri-PUSCH-PowerControlId</i> 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 configured time domain allocations the UE shall apply for that UL grant. The UE determines the bit width of the DCI field based on the number of entries in the *PUSCH-TimeDomainResourceAllocationList*. Value 0 in the DCI field refers to the first element in this list, value 1 in the DCI field refers to the second element in this list, and so on.

***PUSCH-TimeDomainResourceAllocation* information element**

```

-- ASN1START
-- TAG-PUSCH-TIMEDOMAINRESOURCEALLOCATIONLIST-START

PUSCH-TimeDomainResourceAllocationList ::= SEQUENCE (SIZE(1..maxNrofUL-Allocations)) OF PUSCH-TimeDomainResourceAllocation

```



```
PUSCH-TimeDomainResourceAllocation ::= SEQUENCE {
    k2                                INTEGER(0..32)          OPTIONAL,    -- Need S
    mappingType                      ENUMERATED {typeA, typeB},
    startSymbolAndLength             INTEGER (0..127)
}

-- TAG-PUSCH-TIMEDOMAINRESOURCEALLOCATIONLIST-STOP
-- ASN1STOP
```

PUSCH-TimeDomainResourceAllocationList field descriptions	
k2	Corresponds to L1 parameter 'K2' (see 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 ::=
    quantityConfigNR-List
    ...
}

QuantityConfigNR ::=
    quantityConfigCell
    quantityConfigRS-Index
}

QuantityConfigRS ::=
    ssb-FilterConfig
    cs-RS-FilterConfig
}

FilterConfig ::=
    filterCoefficientRSRP
    filterCoefficientRSRQ
    filterCoefficientRS-SINR
}

SEQUENCE {
    SEQUENCE (SIZE (1..maxNrofQuantityConfig)) OF QuantityConfigNR OPTIONAL, -- Need M

    SEQUENCE {
        QuantityConfigRS,
        QuantityConfigRS OPTIONAL -- Need M

    SEQUENCE {
        FilterConfig,
        FilterConfig

    SEQUENCE {
        FilterCoefficient
        FilterCoefficient
        FilterCoefficient
        DEFAULT fc4,
        DEFAULT fc4,
        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 based L3 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 {
            1839                      INTEGER (0..837),
            1139                      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

```

<i>RACH-ConfigCommon</i> field descriptions	
<i>messagePowerOffsetGroupB</i>	Threshold for preamble selection. Value in dB. Value minus infinity corresponds to –infinity. Value dB0 corresponds to 0 dB, dB5 corresponds to 5 dB and so on. (see FFS_Spec, section FFS_Section)
<i>msg1-SubcarrierSpacing</i>	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 <i>prach-ConfigurationIndex</i> in <i>RACH-ConfigGeneric</i> (see 38.211, section XXX).
<i>msg3-transformPrecoding</i>	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)
<i>numberOfRA-PreamblesGroupA</i>	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 <i>ssb-perRACH-OccasionAndCB-PreamblesPerSSB</i> .
<i>prach-RootSequenceIndex</i>	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
<i>ra-ContentionResolutionTimer</i>	The initial value for the contention resolution timer (see 38.321, section 5.1.5). Value <i>ms8</i> corresponds to 8 ms, value <i>ms16</i> corresponds to 16 ms, and so on.
<i>ra-Msg3SizeGroupA</i>	Transport Blocks size threshold in bit below which the UE shall use a contention based RA preamble of group A. (see 38.321, section 5.1.2)
<i>rach-ConfigGeneric</i>	Generic RACH parameters
<i>restrictedSetConfig</i>	Configuration of an unrestricted set or one of two types of restricted sets, see 38.211 6.3.3.1
<i>rsrp-ThresholdSSB</i>	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)
<i>rsrp-ThresholdSSB-SUL</i>	The UE selects SUL carrier to perform random access based on this threshold (see TS 38.321, section 5.1.1).
<i>ssb-perRACH-OccasionAndCB-PreamblesPerSSB</i>	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).
<i>totalNumberOfRA-Preambles</i>	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
<i>SUL</i>	The field is mandatory present in <i>initialUplinkBWP</i> in <i>supplementaryUplink</i> ; 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 {s11, s12, s14, s18, s110, s120, s140, s180},
        ...
    }

-- 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 respect 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 performed 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 equal 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
    }
    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 associated 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}
    ...
}
-- TAG-RA-PRIORITIZATION-STOP
-- ASN1STOP
OPTIONAL, -- Need R

```

RA-Prioritization field descriptions

powerRampingStepHighPriority

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
    }
    drb-Identity                 OPTIONAL, -- Cond DRBSetup
    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
<i>RBTermChange</i>	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.
<i>PDCP</i>	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.
<i>DRBSetup</i>	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 ::=
    rateMatchPatternId          SEQUENCE {
        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))
                }
            },
            ...
        },
        controlResourceSet      ControlResourceSetId
    },
    subcarrierSpacing           SubcarrierSpacing
mode                           ENUMERATED { dynamic, semiStatic },
    ...
}

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

OPTIONAL, -- Need S

OPTIONAL, -- Cond CellLevel

RateMatchPattern field descriptions	
controlResourceSet	This ControlResourceSet is 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 $\mu=0$, kHz30 to $\mu=1$, 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
<i>CellLevel</i>	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 RateMatchPattern. 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 ::=
    reportType
    periodical
    eventTriggered
-- reportCGI is to be completed before the end of Rel-15.
    ...
}

-- FFS / TODO: Consider separating trigger configuration (trigger, periodic, ...) from report configuration.
-- Current structure allows easier definition of new events and new report types e.g. CGI, etc.
EventTriggerConfig ::=
    eventId
    eventA1
        a1-Threshold
        reportOnLeave
        hysteresis
        timeToTrigger
    },
    eventA2
        a2-Threshold
        reportOnLeave
        hysteresis
        timeToTrigger
    },
    eventA3
        a3-Offset
        ...
    }
```



```

        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
maxNrofRSIndexesToReport      INTEGER (1..maxNrofIndexesToReport)
includeBeamMeasurements       BOOLEAN
reportAddNeighMeas            ENUMERATED {setup}
...
}

PeriodicalReportConfig ::=
    rsType                        NR-RS-Type,

    reportInterval                ReportInterval,
    reportAmount                  ENUMERATED {r1, r2, r4, r8, r16, r32, r64, infinity},

```

OPTIONAL, -- Need R
 OPTIONAL, -- Need R
 OPTIONAL, -- Need R

```

    reportQuantityCell          MeasReportQuantity,
    maxReportCells              INTEGER (1..maxCellReport),

    reportQuantityRsIndexes     MeasReportQuantity
    maxNrofRsIndexesToReport    INTEGER (1..maxNrofIndexesToReport)
    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

```

OPTIONAL, -- Need R
OPTIONAL, -- Need R

<i>EventTriggerConfig field descriptions</i>
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 include the best neighbour cells per serving frequency.
reportAmount Number of measurement reports applicable for <i>eventTriggered</i> as well as for <i>periodical</i> 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 <i>cellsTriggeredList</i> , 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 <i>measObject</i> are applicable as specified in 5.5.4.1.

<i>PeriodicalReportConfig field descriptions</i>
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 <i>eventTriggered</i> as well as for <i>periodical</i> 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 <i>measObject</i> 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
        ...
    }
}

-- 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 ::=
    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
    },
    ...
}

UL-AM-RLC ::=
    sn-FieldLength
    t-PollRetransmit
    pollPDU
    pollByte
    maxRetxThreshold

DL-AM-RLC ::=
    sn-FieldLength
    t-Reassembly
    t-StatusProhibit

UL-UM-RLC ::=
    sn-FieldLength

DL-UM-RLC ::=
    sn-FieldLength
    t-Reassembly

T-PollRetransmit ::=

PollPDU ::=

PollByte ::=

```

```

DL-UM-RLC

SEQUENCE {
    SN-FieldLengthAM
    T-PollRetransmit,
    PollPDU,
    PollByte,
    ENUMERATED { t1, t2, t3, t4, t6, t8, t16, t32 }

SEQUENCE {
    SN-FieldLengthAM
    T-Reassembly,
    T-StatusProhibit

SEQUENCE {
    SN-FieldLengthUM

SEQUENCE {
    SN-FieldLengthUM
    T-Reassembly

OPTIONAL, -- Cond Reestab

OPTIONAL, -- Cond Reestab

OPTIONAL, -- Cond Reestab

OPTIONAL, -- Cond Reestab

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}

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}

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-Configfield 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
```


<i>RLF-TimersAndConstants</i> field descriptions
<i>n3xy</i> Constants are described in section 7.3. n1 corresponds with 1, n2 corresponds to 2 and so on.
<i>t3xy</i> 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
```

<i>SchedulingRequestConfig</i> field descriptions
<i>schedulingRequestToAddModList</i> List of Scheduling Request configurations to add or modify.
<i>schedulingRequestToReleaseList</i> List of Scheduling Request configurations to release
<i>sr-ConfigIndex</i> Used to modify a SR configuration and to indicate, in LogicalChannelConfig, the SR configuration to which a logical channel is mapped.
<i>sr-ProhibitTimer</i> 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.
<i>sr-TransMax</i> 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,
    schedulingRequestID,
    periodicityAndOffset
    sym2
    sym6or7
    sl1
    sl2
    CHOICE {
        NULL,
        NULL,
        NULL,
        INTEGER (0..1),
    }
}

-- Recurs in every slot
```

```

s14          INTEGER (0..3),
s15          INTEGER (0..4),
s18          INTEGER (0..7),
s110         INTEGER (0..9),
s116         INTEGER (0..15),
s120         INTEGER (0..19),
s140         INTEGER (0..39),
s180         INTEGER (0..79),
s1160        INTEGER (0..159),
s1320        INTEGER (0..319),
s1640        INTEGER (0..639)
}
resource          PUCCH-ResourceId
}

-- TAG-SCHEDULING-REQUEST-RESOURCE-CONFIG-STOP
-- ASN1STOP
OPTIONAL, -- Need M
OPTIONAL  -- Need M

```

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
<i>OnePerServCell</i>	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 ::=
    pdu-Session
    sdap-HeaderDL
    sdap-HeaderUL
    defaultDRB
    mappedQoS-FlowsToAdd
    mappedQoS-FlowsToRelease
    ...
}

SEQUENCE {
    PDU-SessionID,
    ENUMERATED {present, absent},
    ENUMERATED {present, absent},
    BOOLEAN,
    SEQUENCE (SIZE (1..maxNrofQFIs)) OF QFI
    SEQUENCE (SIZE (1..maxNrofQFIs)) OF QFI
}

QFI ::=
    INTEGER (0..maxQFI)

PDU-SessionID ::=
    INTEGER (0..255)

-- TAG-SDAP-CONFIG-STOP
-- ASN1STOP
```

<i>SDAP-Config field descriptions</i>
defaultDRB Indicates whether or not this is the default DRB for this PDU session. Among all configured instances of <i>SDAP-Config</i> with the same value of <i>pdu-Session</i> , this field shall be set to TRUE in at most one instance of <i>SDAP-Config</i> 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 <i>SDAP-Config</i> with the same value of <i>pdu-Session</i> .
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 ::=
    searchSpaceId          SEQUENCE {
        searchSpaceId,
        controlResourceSetId
        monitoringSlotPeriodicityAndOffset
        CHOICE {
            s11          NULL,
            s12          INTEGER (0..1),
            s14          INTEGER (0..3),
            s15          INTEGER (0..4),
            s18          INTEGER (0..7),
            s110         INTEGER (0..9),
            s116         INTEGER (0..15),
            s120         INTEGER (0..19),
            s140         INTEGER (0..39),
            s180         INTEGER (0..79),
            s1160        INTEGER (0..159),
            s1320        INTEGER (0..319),
            s1640        INTEGER (0..639),
            s11280       INTEGER (0..1279),
            s12560       INTEGER (0..2559)
        }
        duration           INTEGER (2..2559)
        monitoringSymbolsWithinSlot
    }
    OPTIONAL, -- Cond SetupOnly
    OPTIONAL, -- Cond Setup
    OPTIONAL, -- Need R
    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}
    }
    searchSpaceType          CHOICE {
        common               SEQUENCE {
            dci-Format0-0-AndFormat1-0
            ...
        }
        dci-Format2-0        SEQUENCE {
            nrofCandidates-SFI
            aggregationLevel1   ENUMERATED {n1, n2}
            aggregationLevel2   ENUMERATED {n1, n2}
            aggregationLevel4   ENUMERATED {n1, n2}
            aggregationLevel8   ENUMERATED {n1, n2}
            aggregationLevel16  ENUMERATED {n1, n2}
        },
        ...
    }
    dci-Format2-1            SEQUENCE {
        ...
    }
    dci-Format2-2            SEQUENCE {
        ...
    }
    dci-Format2-3            SEQUENCE {
        monitoringPeriodicity   ENUMERATED {n1, n2, n4, n5, n8, n10, n16, n20 }
        nrofPDCCH-Candidates    ENUMERATED {n1, n2},
        ...
    }
    },
    ue-Specific              SEQUENCE {
        dci-Formats            ENUMERATED {formats0-0-And-1-0, formats0-1-And-1-1},
        ...
    }
}
-- TAG-SEARCHSPACE-STOP
-- ASN1STOP

```

OPTIONAL, -- Cond Setup

OPTIONAL, -- Need R

OPTIONAL, -- Need R

OPTIONAL, -- Need R

OPTIONAL, -- Need R

OPTIONAL, -- Need R

OPTIONAL, -- Need R

OPTIONAL, -- Need R

OPTIONAL, -- Cond Setup

OPTIONAL -- Need R

OPTIONAL -- Cond Setup

<i>SearchSpace field descriptions</i>
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 'Monitoring-periodicity-PDCCH-slot' and 'Monitoring-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 'Monitoring-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
<i>Setup</i>	This field is mandatory present upon creation of a new SearchSpace. It is optionally present, Need M, otherwise.
<i>SetupOnly</i>	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
    }
-- ASN1STOP
```

```

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
tag-Id                        TAG-Id,
ue-BeamLockFunction           ENUMERATED {enabled}
pathlossReferenceLinking      ENUMERATED {pCell, sCell}
servingCellMO                 MeasObjectId
...
}

UplinkConfig ::=
  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

```

<i>ServingCellConfig</i> field descriptions	
<i>bwp-InactivityTimer</i>	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 swithcing to the default BWP.
<i>crossCarrierSchedulingConfig</i>	Indicates whether this SCell is cross-carrier scheduled by another serving cell.
<i>defaultDownlinkBWP-Id</i>	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)
<i>downlinkBWP-ToAddModList</i>	List of additional downlink bandwidth parts to be added or modified. (see 38.211, 38.213, section 12).
<i>downlinkBWP-ToReleaseList</i>	List of additional downlink bandwidth parts to be released. (see 38.211, 38.213, section 12).
<i>firstActiveDownlinkBWP-Id</i>	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.
<i>initialDownlinkBWP</i>	The dedicated (UE-specific) configuration for the initial downlink bandwidth-part.
<i>pathlossReferenceLinking</i>	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)
<i>pdsch-ServingCellConfig</i>	PDSCH releated parameters that are not BWP-specific.
<i>sCellDeactivationTimer</i>	SCell deactivation timer in TS 38.321 [3]. If the field is absent, the UE applies the value infinity.
<i>servingCellMO</i>	<i>measObjectId</i> of the <i>MeasObjectNR</i> in <i>MeasConfig</i> which is associated to the serving cell. For this <i>MeasObjectNR</i> , the following relationship applies between this <i>MeasObjectNR</i> and <i>frequencyInfoDL</i> in <i>ServingCellConfigCommon</i> of the serving cell: if <i>ssbFrequency</i> is configured, its value is the same aslike the <i>absoluteFrequencySSB</i> and if <i>csi-rs-ResourceConfigMobility</i> is configured, the value of its <i>subcarrierSpacing</i> is present in one entry of the <i>scs-SpecificCarrierList</i> , <i>csi-RS-CellList-Mobility</i> includes an entry corresponding to the serving cell (with <i>cellId</i> equal to <i>physCellId</i> in <i>ServingCellConfigCommon</i>) and the frequency range indicated by the <i>csi-rs-MeasurementBW</i> of the entry in <i>csi-RS-CellList-Mobility</i> is included in the frequency range indicated by in the entry of the <i>scs-SpecificCarrierList</i> .
<i>tag-Id</i>	Timing Advance Group ID, as specified in TS 38.321 [3], which this cell belongs to.
<i>ue-BeamLockFunction</i>	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 <i>ServingCellConfigCommon</i> or in a <i>BeamManagement</i> IE??)

<i>UplinkConfig field descriptions</i>	
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 BandwidthPartId = 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
<i>MeasObject</i>	This field is mandatory present for the SpCell, it is optionally present, Need R, for SCells.
<i>SCellOnly</i>	This field is optionally present, Need R, for SCells. It is absent otherwise.
<i>ServCellAdd</i>	This field is mandatory present upon serving cell addition (for PSCell and SCell). It is optionally present, Need M otherwise.
<i>ServCellAdd-UL</i>	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.
<i>ServCellAdd-SUL</i>	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.
<i>ServingCellWithoutPUCCH</i>	This field is optionally present, Need S, for SCells except PUCCH SCells. It is absent otherwise.
<i>SyncAndCellAdd</i>	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.
<i>TDD</i>	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
ssb-PositionsInBurst        CHOICE {
    shortBitmap              BIT STRING (SIZE (4)),
    mediumBitmap             BIT STRING (SIZE (8)),
    longBitmap               BIT STRING (SIZE (64))
}
ssb-periodicityServingCell   ENUMERATED { ms5, ms10, ms20, ms40, ms80, ms160, spare2, spare1 } OPTIONAL, -- Cond AbsFreqSSB
dmrs-TypeA-Position          ENUMERATED {pos2, pos3},          OPTIONAL, -- Need S
lte-CRS-ToMatchAround        SetupRelease { RateMatchPatternLTE-CRS }
rateMatchPatternToAddModList SEQUENCE (SIZE (1..maxNrofRateMatchPatterns)) OF RateMatchPattern OPTIONAL, -- Need M
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

```

<i>ServingCellConfigCommon field descriptions</i>	
<i>dmrs-TypeA-Position</i>	Position of (first) DL DM-RS (see 38.211, section 7.4.1.1.1)
<i>initialDownlinkBWP</i>	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.
<i>longBitmap</i>	bitmap for above 6 GHz
<i>lte-CRS-ToMatchAround</i>	Parameters to determine an LTE CRS pattern that the UE shall rate match around.
<i>mediumBitmap</i>	bitmap for 3-6 GHz
<i>n-TimingAdvanceOffset</i>	The N_TA-Offset to be applied for random access on this serving cell. If the field is absent, the UE applies the value defined for the duplex mode and frequency range of this serving cell. See 38.133, table 7.1.2-2.
<i>rateMatchPatternToAddModList</i>	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-cek' (see 38.214, section 5.1.2.2.3)
<i>shortBitmap</i>	bitmap for sub 3 GHz
<i>ss-PBCH-BlockPower</i>	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)
<i>ssb-periodicityServingCell</i>	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])
<i>ssb-PositionsInBurst</i>	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)
<i>subcarrierSpacing</i>	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.
<i>tdd-UL-DL-ConfigurationCommon</i>	A cell-specific TDD UL/DL configuration, see 38.213, section 11.1.

Conditional Presence	Explanation
<i>AbsFreqSSB</i>	The field is absent when absoluteFrequencySSB in frequencyInfoDL is absent, otherwise the field is mandatory present.
<i>HOAndServCellAdd</i>	This field is mandatory present for inter-cell handover and upon serving cell (PSCell/SCell) addition. Otherwise, the field is absent, Need M.
<i>InterFreqHOAndServCellAdd</i>	This field is mandatory present for inter-frequency handover and upon serving cell (PSCell/SCell) addition. Otherwise, the field is optionally present, Need M.
<i>ServCellAdd</i>	This field is mandatory present upon serving cell addition (for PSCell and SCell). It is optionally present, Need M otherwise.
<i>ServCellAdd-UL</i>	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.
<i>ServCellAdd-SUL</i>	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.
<i>TDD</i>	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 ::=
    slotFormatCombinationId
    slotFormats
}

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 measurements based on synchronization reference signals.

SS-RSSI-Measurement information element

```

-- ASN1START
-- TAG-SS-RSSI-MEASUREMENT-START

SS-RSSI-Measurement ::= SEQUENCE {
    measurementSlots        BIT STRING (SIZE (1..80)),
    endSymbol               INTEGER (0..3)
}

-- TAG-SS-RSSI-MEASUREMENT-STOP
-- ASN1STOP

```

– 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 ::=
    periodicity          SEQUENCE {
                        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
    }
-- 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 ::=
    srs-ResourceSetToReleaseList      SEQUENCE {
    srs-ResourceSetToAddModList        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-ResourceToReleaseList          SEQUENCE (SIZE(1..maxNrofSRS-Resources)) OF SRS-Resource          OPTIONAL, -- Need N

    tpc-Accumulation                   ENUMERATED {disabled}                                          OPTIONAL, -- Need S
    ...
}

SRS-ResourceSet ::=
    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
```

```

    }
    srs-PowerControlAdjustmentStates    ENUMERATED { sameAsFci2, separateClosedLoop}
    ...
}

SRS-ResourceSetId ::=
    INTEGER (0..maxNrofSRS-ResourceSets-1)

SRS-Resource ::=
    srs-ResourceId
    nrofSRS-Ports
    ptrs-PortIndex
    transmissionComb
        n2
            combOffset-n2
            cyclicShift-n2
        },
        n4
            combOffset-n4
            cyclicShift-n4
    },
    resourceMapping
        startPosition
        nrofSymbols
        repetitionFactor
    },
    freqDomainPosition
    freqDomainShift
    freqHopping
        c-SRS
        b-SRS
        b-hop
    },
    groupOrSequenceHopping
    resourceType
        aperiodic
            ...
        },
        semi-persistent
            periodicityAndOffset-sp
            ...
        },
        periodic
            periodicityAndOffset-p
            ...
    },
    sequenceId
    spatialRelationInfo
    ...
}

```

OPTIONAL, -- Need M
OPTIONAL, -- Need S

OPTIONAL, -- Need R

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 {
    s11          NULL,
    s12          INTEGER(0..1),
    s14          INTEGER(0..3),
    s15          INTEGER(0..4),
    s18          INTEGER(0..7),
    s110         INTEGER(0..9),
    s116         INTEGER(0..15),
    s120         INTEGER(0..19),
    s132         INTEGER(0..31),
    s140         INTEGER(0..39),
    s164         INTEGER(0..63),
    s180         INTEGER(0..79),
    s1160        INTEGER(0..159),
    s1320        INTEGER(0..319),
    s1640        INTEGER(0..639),
    s11280       INTEGER(0..1279),
    s12560       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)

<i>SRS-Resource field descriptions</i>
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 maxNrrofPorts 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 pseudo 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 $h_{srs,c(i)} = f_c(i,1)$ or $h_{srs,c(i)} = f_c(i,2)$ (if twoPUSCH-PC-AdjustmentStates are configured) or separate 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
<i>Setup</i>	This field is mandatory present upon configuration of SRS-ResourceSet or SRS-Resource and optional (Need M) otherwise
<i>NonCodebook</i>	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
-- ASN1END
```

```

    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
    }
    monitoringCells            SEQUENCE (SIZE (1..maxNrofServingCells)) OF ServCellIndex
    ...
}

-- 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
}

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

-- TAG-SRS-CARRIERSWITCHING-STOP
-- ASN1STOP

```

OPTIONAL, -- Cond Setup
OPTIONAL, -- Cond Setup
OPTIONAL -- Cond Setup
OPTIONAL -- Cond Setup

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 ::=
    periodicityAndOffset
        sf5
        sf10
        sf20
        sf40
        sf80
        sf160
    },
    duration
        ENUMERATED { sf1, sf2, sf3, sf4, sf5 }
}

SSB-MTC2 ::=
    pci-List
    periodicity
}

-- 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
        qcl-Type1
        qcl-Type2
        ...
    }

QCL-Info ::=
    SEQUENCE {
        cell
        bwp-Id
        referenceSignal
            CHOICE {
                csi-rs
                ssb
            },
        qcl-Type
        ...
    }

-- TAG-TCI-STATE-STOP
-- ASN1STOP
```

OPTIONAL, -- Need R

OPTIONAL, -- Need R

OPTIONAL, -- Cond CSI-RS-Indicated

ENUMERATED {typeA, typeB, typeC, typeD},

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 <i>csi-rs</i> or <i>csi-RS-for-tracking</i> 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 ::=
    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 ::=
    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 ::=
    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)

<i>TDD-UL-DL-Pattern field descriptions</i>
<i>dl-UL-TransmissionPeriodicity</i> Periodicity of the DL-UL pattern, see 38.211, section FFS_Section.
<i>nrofDownlinkSlots</i> 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.
<i>nrofDownlinkSymbols</i> 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).
<i>nrofUplinkSlots</i> 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.
<i>nrofUplinkSymbols</i> 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)

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

<i>TDD-UL-DL-SlotConfig field descriptions</i>
<i>nrofDownlinkSymbols</i> 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)
<i>nrofUplinkSymbols</i> 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)
<i>slotIndex</i> Identifies a slot within a dl-UL-TransmissionPeriodicity (given in tdd-UL-DL-configurationCommon)
<i>symbols</i> 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 ::=
    frequencyInfoUL          SEQUENCE {
        frequencyInfoUL      FrequencyInfoUL          OPTIONAL,  -- Cond InterFreqHOAndServCellAddAndSIB1
        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 is optionally 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 ::=
    zp-CSI-RS-ResourceId          ZP-CSI-RS-ResourceId,
    resourceMapping               CSI-RS-ResourceMapping,
    periodicityAndOffset          CSI-ResourcePeriodicityAndOffset
    ...
}

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-ResourceIds*. 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 ::=
    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,
    featureSetCombinationId 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* 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 combination parameters are defined in TS 36.331 [10], which are supported for MR-DC, they will be defined here as well.

```
-- ASN1START
-- TAG-CA-PARAMETERSEUTRA-START

CA-ParametersEUTRA ::= SEQUENCE {
    multipleTimingAdvance          ENUMERATED {supported}          OPTIONAL,
    simultaneousRx-Tx              ENUMERATED {supported}          OPTIONAL,
    supportedNAICS-2CRS-AP         BIT STRING (SIZE (1..8))        OPTIONAL,
    additionalRx-Tx-PerformanceReq ENUMERATED {supported}          OPTIONAL,
    ue-CA-PowerClass-N             ENUMERATED {class2}              OPTIONAL,
    ...
}

-- 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,
            }
        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,
    }
    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 {model1, modelAndMode2},
    maxNumberCSI-RS-PerResourceSet INTEGER (1..8)
}

TypeI-MultiPanelCodebook ::= SEQUENCE {
    maxNumberTxPortsPerResource    ENUMERATED {p8, p16, p32},
    maxNumberResources             INTEGER (1..64),
    totalNumberTxPorts            INTEGER (2..256),
    supportedCodebookMode         ENUMERATED {model1, 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 ::=
    featureSetListPerUplinkCC          SEQUENCE {
        scalingFactor                  SEQUENCE (SIZE (1.. maxNrofServingCells)) OF FeatureSetUplinkPerCC-Id,
        crossCarrierSchedulingUL-OtherSCS  ENUMERATED {f0p4, f0p75, f0p8} OPTIONAL,
        intraBandFreqSeparationUL         ENUMERATED {supported} OPTIONAL,
        searchSpaceSharingCA-UL           FreqSeparationClass OPTIONAL,
        srs-TxSwitch                     ENUMERATED {supported} OPTIONAL,
        supportedSRS-Resources            SRS-TxSwitch OPTIONAL,
        twoPUCCH-Group                   SRS-Resources OPTIONAL,
        dynamicSwitchSUL                  ENUMERATED {supported} OPTIONAL,
        pusched-DifferentTB-PerSlot       ENUMERATED {supported} OPTIONAL,
        scs-15kHz                        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
        }
       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
```

```
-- 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 for 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 AggregatedBandwidth OPTIONAL, -- Need N
    maxBandwidthRequestedUL AggregatedBandwidth OPTIONAL, -- Need N
    maxCarriersRequestedDL  INTEGER (1.. maxNrofServingCells) OPTIONAL, -- Need N
    maxCarriersRequestedUL  INTEGER (1.. maxNrofServingCells) OPTIONAL, -- Need N
}

AggregatedBandwidth ::= ENUMERATED {mhz50, mhz100, mhz150, mhz200, mhz250, mhz300, mhz350,
                                     mhz400, mhz450, mhz500, mhz550, mhz600, mhz650, mhz700, mhz750, mhz800}

-- TAG-FREQBANDLIST-STOP
-- ASN1STOP
```

– *FreqSeparationClass*

The IE *FreqSeparationClass* is used for an intra-band non-contiguous CA band combination to indicate frequency separation between lower edge of lowest CC and upper edge of highest CC in a frequency band.

FreqSeparationClass information element

```
-- ASN1START
-- TAG-FREQSEPARATIONCLASS-START

FreqSeparationClass ::= ENUMERATED {c1, c2, c3, ...}

-- TAG-FREQSEPARATIONCLASS-STOP
-- ASN1STOP
```

– *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
```

<i>UE-CapabilityRAT-ContainerList</i> field descriptions
<i>ue-CapabilityRAT-Container</i> 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 <i>FeatureSetCombinationIds</i> in this list refer to the <i>FeatureSetCombination</i> entries in the <i>featureSetCombinations</i> list in the <i>UE-MRDC-Capability</i> 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-StatePD SCH          SEQUENCE {
        maxNumberConfiguredTCIstatesPerCC  ENUMERATED {n4, n8, n16, n32, n64}  OPTIONAL,
        maxNumberActiveTCI-PerBWP          ENUMERATED {n1, n2, n4, n8}      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,
    }
    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)
    }
    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}
    supportedSRS-Resources    SRS-Resources
    srs-TxSwitch              SRS-TxSwitch
    maxNumberSimultaneousSRS-PerCC INTEGER (1..4)
    beamReportTiming          SEQUENCE {
        scs-15kHz             ENUMERATED {sym2, sym4, sym8}
        scs-30kHz             ENUMERATED {sym4, sym8, sym14}
        scs-60kHz             ENUMERATED {sym8, sym14, sym28}
        scs-120kHz            ENUMERATED {sym14, sym28, sym56}
    }
    ptrs-DensityRecommendationSetDL SEQUENCE {
        scs-15kHz             PTRS-DensityRecommendationDL
        scs-30kHz             PTRS-DensityRecommendationDL
        scs-60kHz             PTRS-DensityRecommendationDL
        scs-120kHz            PTRS-DensityRecommendationDL
    }
    ptrs-DensityRecommendationSetUL SEQUENCE {
        scs-15kHz             PTRS-DensityRecommendationUL
        scs-30kHz             PTRS-DensityRecommendationUL
        scs-60kHz             PTRS-DensityRecommendationUL
        scs-120kHz            PTRS-DensityRecommendationUL
    }
    csi-RS-ForTracking         CSI-RS-ForTracking
    aperiodicTRS               ENUMERATED {supported}
    ...
}

BeamManagementSSB-CSIRSR ::= SEQUENCE {
    maxNumberSSB-CSIRSR-ResourceOneTx ENUMERATED {n8, n16, n32, n64},
    maxNumberSSB-CSIRSR-ResourceTwoTx  ENUMERATED {n0, n4, n8, n16, n32, n64},
    supportedCSIRSR-Density             ENUMERATED {one, three, oneAndThree}
}

CSIRSR-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),
    maxNumberSemiPersistentSRS-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}
}

-- 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
maxSCS                     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 supported 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 <i>RRCReconfiguration</i> message including <i>reconfigurationWithSync</i>	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 <i>RRCReconfigurationWithSync</i> 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 ::=
    -- 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.

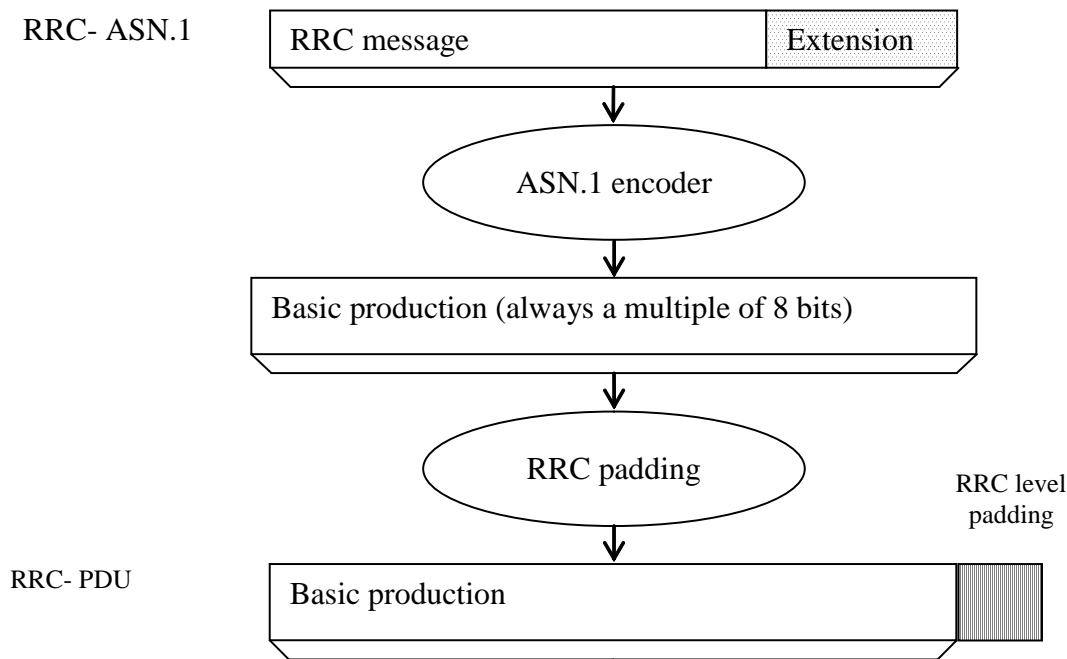


Figure 8.5-1: RRC level padding

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			
<i>logicalChannelIdentity</i>	1		

9.1.2.2 SRB2/SRB2S

Parameters

Name	Value	Semantics description	Ver
RLC configuration			
<i>logicalChannelIdentity</i>	2		

9.1.2.3 SRB3

Parameters

Name	Value	Semantics description	Ver
RLC configuration			
<i>logicalChannelIdentity</i>	3		

9.2 Default radio configurations

9.2.1 SRB configurations

9.2.1.1 SRB1/SRB1S

Parameters (FFS)

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

9.2.1.2 SRB2/SRB2S

Parameters (FFS)

Name	Value	Semantics description	Ver
------	-------	-----------------------	-----

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

9.2.1.3 SRB3

Parameters (FFS)

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

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,
        field2
            OPTIONAL,
        ...
        [[ field3-r9
            Field3-r9
            OPTIONAL,
        field4-r9
            Field4-r9
            OPTIONAL
        ]]
    }
-- Need N
-- Cond Cond1
-- Need N

-- Example with traditional non-critical extension (empty sequence)

BroadcastInfoBlock1 ::=
    SEQUENCE {
        itemIdentity
            INTEGER (1..max),
        field1,
        field2
            OPTIONAL,
        nonCriticalExtension
            BroadcastInfoBlock1-v940-IEs
            OPTIONAL
    }
-- Need N

BroadcastInfoBlock1-v940-IEs ::= SEQUENCE {
        field3-r9
            Field3-r9
            OPTIONAL,
        field4-r9
            Field4-r9
            OPTIONAL,
        nonCriticalExtension
            SEQUENCE {}
            OPTIONAL
    }
-- Cond Cond1
-- Need N
-- Need S

-- ASN1STOP
```

The UE shall, apply the following principles regarding the levels applicable in case of nested error handling:

- an extension addition 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 ::=
    criticalExtensions
        c1
            handoverCommand
            spare3 NULL, spare2 NULL, spare1 NULL
        },
        criticalExtensionsFuture
            SEQUENCE {}
    }

HandoverCommand-IEs ::=
    handoverCommandMessage
    nonCriticalExtension
        SEQUENCE {
            OCTET STRING (CONTAINING RRCReconfiguration),
            SEQUENCE {} OPTIONAL
        }

-- TAG-HANDOVER-COMMAND-STOP
-- ASN1STOP
```

HandoverCommand field descriptions
handoverCommandMessage Contains the <i>RRCReconfiguration</i> 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 {
        cl                     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,
    }
    -- 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

```


<i>CG-Config</i> field descriptions
<i>candidateCellInfoListSN</i> Contains information regarding cells that the source secondary node suggests the target secondary gNB to consider configuring.
<i>fr-InfoListSCG</i> Contains information of FR information of serving cells.
<i>measuredFrequenciesSN</i> Used by SN to indicate a list of frequencies measured by the UE.
<i>requestedP-MaxFR1</i> Requested value for the maximum power for FR1 (see TS 38.104 [12]) the UE can use in NR SCG.
<i>requestedBC-MRDC</i> 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.
<i>scg-CellGroupConfig</i> Contains the RRCReconfiguration message, used to (re-)configure the SCG configuration upon SCG establishment or modification, as generated (entirely) by the (target) SgNB
<i>scg-RB-Config</i> 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
<i>selectedBandCombinationNR</i> Indicates the band combination selected by SN for the EN-DC.
<i>configRestrictModReq</i> 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 ::=
    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)
    }
    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,
    }
    servCellIndexRangeSCG      SEQUENCE {
        lowBound                ServCellIndex,
        upBound                  ServCellIndex
    }
    maxMeasFreqsSCG-NR         INTEGER(1..maxMeasFreqsMN) OPTIONAL, -- Cond SN-Addition
    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
  drx-ShortCycle
    SEQUENCE {
      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 },
      INTEGER (1..16)
    }
  }
}
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	
<i>allowedBandCombinationListMRDC</i>	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.
<i>candidateCellInfoListMN, candidateCellInfoListSN</i>	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.
<i>maxMeasFreqsSCG-NR</i>	Indicates the maximum number of NR inter-frequency carriers the SN is allowed to configure with PSCell for measurements.
<i>maxMeasIdentitiesSCG-NR</i>	Indicates the maximum number of allowed measurement identities that the SCG is allowed to configure.
<i>measuredFrequenciesMN</i>	Used by MN to indicate a list of frequencies measured by the UE.
<i>measGapConfig</i>	Indicates the measurement gap configuration configured by MN.
<i>mcg-RB-Config</i>	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.
<i>p-maxEUTRA</i>	Indicates the maximum power for EUTRA (see TS 36.104 [XX]) the UE can use in LTE MCG.
<i>p-maxNR</i>	Indicates the maximum power for NR (see TS 38.104 [12]) the UE can use in NR SCG.
<i>powerCoordination-FR1</i>	Indicates the maximum power that the UE can use in FR1.
<i>scg-RB-Config</i>	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.
<i>sourceConfigSCG</i>	Includes the current dedicated SCG configuration in the same format as the <i>RRCReconfiguration</i> message, i.e. not only CellGroupConfig but also e.g. measConfig. This field is absent when master eNB uses full configuration option.
<i>ConfigRestrictInfo</i>	Includes fields for which SgNB is explicitly indicated to observe a configuration restriction.
<i>servCellIndexRangeSCG</i>	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 between 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 {
        cl 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).

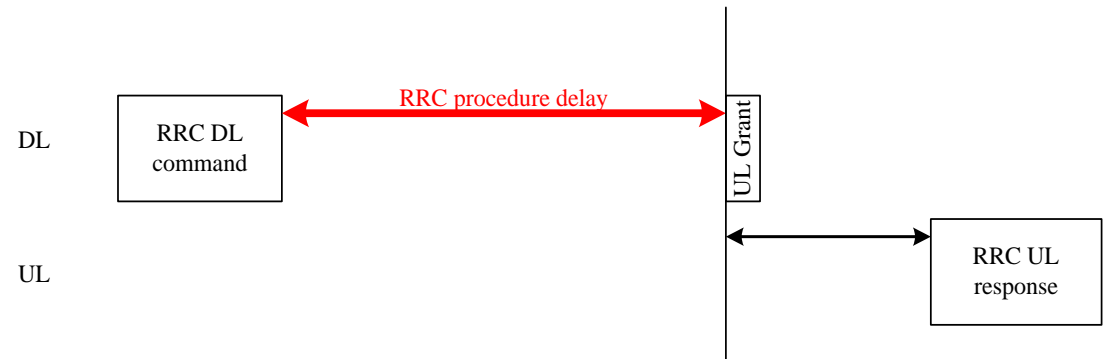


Figure 11.2-1: Illustration of RRC procedure delay

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	<i>RRCReconfiguration</i>	<i>RRCReconfigurationComplete</i>	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 the start and stop tags should not contain any ASN.1 code significant for the complete description of the RRC PDU contents. The complete ASN.1 code may be extracted by copying all the text paragraphs between an ASN.1 start tag and the following ASN.1 stop tag in the order they appear, throughout the specification.

NOTE: A typical procedure for extraction of the complete ASN.1 code consists of a first step where the entire RRC PDU contents description (ultimately the entire specification) is saved into a plain text (ASCII) file format, followed by a second step where the actual extraction takes place, based on the occurrence of the ASN.1 start and stop tags.

A.3.1.2 ASN.1 identifier naming conventions

The naming of identifiers (i.e., the ASN.1 field and type identifiers) should be based on the following guidelines:

- Message (PDU) identifiers should be ordinary mixed case without hyphenation. These identifiers, *e.g.*, the *RRCCConnectionModificationCommand*, 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

RRConnectionReconfiguration ::= SEQUENCE {
    rrc-TransactionIdentifier    RRC-TransactionIdentifier,
    criticalExtensions           CHOICE {
        c1                      CHOICE {
            rrcConnectionReconfiguration-r8    RRCConnectionReconfiguration-r8-IEs,
            spare3 NULL, spare2 NULL, spare1 NULL
        },
        criticalExtensionsFuture SEQUENCE {}
    }
}

RRConnectionReconfiguration-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 ::=
    rootSequenceIndex
    prach-ConfigInfo
}

PRACH-Config ::=
    rootSequenceIndex
    prach-ConfigInfo
}

PRACH-ConfigInfo ::=
    prach-ConfigIndex
    highSpeedFlag
    zeroCorrelationZoneConfig
}

SEQUENCE {
    INTEGER (0..1023),
    PRACH-ConfigInfo
}

SEQUENCE {
    INTEGER (0..1023),
    PRACH-ConfigInfo
} OPTIONAL -- Need N

SEQUENCE {
    ENUMERATED {ffs},
    ENUMERATED {ffs},
    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 ::=
    numberOfRA-Preambles      SEQUENCE {
        ...                   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 ::=
    rootSequenceIndex          SEQUENCE {
        prach-ConfigInfo       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 ::=
    ul-SpecificParameters
        priority
        ...
    } 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 likelihood may be based on the number, size and changeability of the fields included in the message.

- In messages where an inner branch extension mechanism is available, all spare values of the inner branch should be used before any critical extensions are added using the outer branch.

The following example illustrates the use of the critical extension mechanism by showing the ASN.1 of the original and of a later release

```
-- /example/ ASN1START          -- Original release

RRCMessage ::=
  rrc-TransactionIdentifier
  criticalExtensions
    c1
      rrcMessage-r8
      spare3 NULL, spare2 NULL, spare1 NULL
    },
  criticalExtensionsFuture
    SEQUENCE {}
}

-- ASN1STOP
```

```
-- /example/ ASN1START          -- Later release

RRCMessage ::=
  rrc-TransactionIdentifier
  criticalExtensions
    c1
      rrcMessage-r8
      rrcMessage-r10
      rrcMessage-r11
      rrcMessage-r14
    },
  later
    c2
      rrcMessage-r16
      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

RRCTestCase ::=
  rrc-TransactionIdentifier
  criticalExtensions
    c1
      rrcMessage-r8
      spare3 NULL, spare2 NULL, spare1 NULL
    },
  criticalExtensionsFuture
}

RRCTestCase-rN-IEs ::= SEQUENCE {
  field1-rN
  field2-rN
  nonCriticalExtension
}

RRCTestCaseReconfiguration-vMxy-IEs ::= SEQUENCE {
  field2-rM
  nonCriticalExtension
}

-- ASN1STOP

```

Conditional presence	Explanation
<i>NoField2rN</i>	The field is optionally present, need N, if field2-rN is absent. Otherwise the field is not present

Finally, it is noted that a critical extension may be introduced in the same release as the one in which the original field was introduced e.g. to correct an essential ASN.1 error. In such cases a UE capability may be introduced, to assist the network in deciding whether or not to use the critically extension.

A.4.3 Non-critical extension of messages

A.4.3.1 General principles

The mechanisms to extend a message in a non-critical manner are defined in A.3.3. W.r.t. the use of extension markers, the following additional guidelines apply:

- When further non-critical extensions are added to a message that has been critically extended, the inclusion of these non-critical extensions in earlier critical branches of the message should be avoided when possible.
- The extension marker ("...") is the primary non-critical extension mechanism that is used but empty sequences may be used if length determinant is not required. Examples of cases where a length determinant is not required:

- at the end of a message;
- at the end of a structure contained in a BIT STRING or OCTET STRING.
- When an extension marker is available, non-critical extensions are preferably placed at the location (e.g. the IE) where the concerned parameter belongs from a logical/functional perspective (referred to as the '*default extension location*').
- It is desirable to aggregate extensions of the same release or version of the specification into a group, which should be placed at the lowest possible level.
- In specific cases it may be preferable to place extensions elsewhere (referred to as the '*actual extension location*') e.g. when it is possible to aggregate several extensions in a group. In such a case, the group should be placed at the lowest suitable level in the message. <TBD: ref to separate example>
- In case placement at the default extension location affects earlier critical branches of the message, locating the extension at a following higher level in the message should be considered.
- In case an extension is not placed at the default extension location, an IE should be defined. The IE's ASN.1 definition should be placed in the same ASN.1 section as the default extension location. In case there are intermediate levels in-between the actual and the default extension location, an IE may be defined for each level. Intermediate levels are primarily introduced for readability and overview. Hence intermediate levels need not 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 separate example>

A.4.3.2 Further guidelines

Further to the general principles defined in the previous section, the following additional guidelines apply regarding the use of extension markers:

- Extension markers within SEQUENCE:
 - Extension markers are primarily, but not exclusively, introduced at the higher nesting levels.
 - Extension markers are introduced for a SEQUENCE comprising several fields as well as for information elements whose extension would result in complex structures without it (e.g. re-introducing another list).
 - Extension markers are introduced to make it possible to maintain important information structures e.g. parameters relevant for one particular RAT.
 - Extension markers are also used for size critical messages (i.e. messages on BCCH, BR-BCCH, PCCH and CCCH), although introduced somewhat more carefully.
 - The extension fields introduced (or frozen) in a specific version of the specification are grouped together using double brackets.
- Extension markers within ENUMERATED:
 - Spare values may be used until the number of values reaches the next power of 2, while the extension marker caters for extension beyond that limit, given that the use of spare values in a later Release is possible without any error cases.
 - A suffix of the form "vXYZ" is used for the identifier of each new value, e.g. "value-vXYZ".


```

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 *childIE1-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
<i>ConfigF</i>	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
        setup
        -- Root encoding
    }

ChildIE2-WithoutEM-vNx0 ::=
    SEQUENCE {
        chIE2-NewField-rN
    }
    OPTIONAL -- Cond ConfigF

-- ASN1STOP
```

Conditional presence	Explanation
<i>ConfigF</i>	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	R ev	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