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# Contents

Intellectual Property Rights .....	12
Foreword.....	12
Modal verbs terminology.....	12
1 Scope .....	13
2 References .....	13
2.1 Normative references .....	13
2.2 Informative references.....	15
3 Definition of terms, symbols and abbreviations.....	15
3.1 Terms.....	15
3.2 Symbols.....	16
3.3 Abbreviations .....	16
3.4 Document Conventions .....	17
3.4.1 Terminologies .....	17
3.4.2 Fields and Bitmasks in Messages .....	17
4 Architecture & Requirements.....	18
4.1 Architectural aspects .....	18
4.1.1 Functional Split.....	19
4.1.2 Selected Split 7-2x (DL).....	20
4.1.2.1 Description .....	22
4.1.2.2 Benefits and Justification .....	23
4.1.3 Selected Split 7-2x (UL).....	23
4.1.3.1 Description .....	24
4.1.3.2 Benefits and Justification .....	24
4.2 Data Flows.....	24
4.3 Latency Requirements .....	25
4.3.1 Timing Parameter Relationships .....	27
4.3.1.1 O-DU Transmission Window.....	27
4.3.2 U-Plane/ C-Plane Timing.....	28
4.3.3 Computed Latency Methods .....	34
4.3.3.1 Fronthaul Timing Domain.....	35
4.3.3.2 Defined Transport Method.....	36
4.3.3.3 Measured Transport Method .....	37
4.3.4 Latency Categories for O-DU with dynamic timing advance.....	40
4.3.5 Latency Categories for O-DU with fixed timing advance .....	42
4.3.6 Non-Delay Managed U-Plane Traffic.....	43
4.4 Reception Window Monitoring.....	44
4.5 Transmission windows .....	45
4.5.1 Normal Transmission.....	45
4.5.2 Uniformly Distributed Transmission .....	45
4.5.2.1 Overlapping transmission windows .....	45
4.5.3 Ordered Transmission.....	45
4.5.4 Scheduled Transmission .....	46
4.6 O-RU External Antenna Delay Handling .....	47
4.6.1 Minimal O-DU Impact Method (Defined Transport Method).....	47
4.6.1.1 Minimal O-DU Impact Method - Example .....	48
5 Transport & Protocol Architecture.....	52
5.1 Transport Encapsulation Types .....	52
5.1.1 Ethernet Encapsulation .....	52
5.1.2 IP/UDP Encapsulation .....	52
5.1.3 Transport Headers.....	53
5.1.3.1 eCPRI Transport Header .....	53
5.1.3.1.1 ecprVersion (eCPRI protocol revision) .....	54
5.1.3.1.2 ecprReserved (eCPRI reserved).....	54
5.1.3.1.3 ecprConcatenation (eCPRI concatenation indicator).....	54

5.1.3.1.4	ecpriMessage (eCPRI message type).....	54
5.1.3.1.5	ecpriPayload (eCPRI payload size) .....	54
5.1.3.1.6	ecpriRtcid / ecpriPcid (real time control data / IQ data transfer message series identifier).....	55
5.1.3.1.7	ecpriSeqid (message identifier) .....	56
5.1.3.2	1914.3 Transport Header.....	59
5.1.3.2.1	RoEsubType (sub type / message type).....	59
5.1.3.2.2	RoEflowID (flow identifier).....	60
5.1.3.2.3	RoElength (length) .....	60
5.1.3.2.4	RoEorderInfo (order information) .....	60
5.2	Protocol Architecture .....	61
5.2.1	C-plane.....	61
5.2.2	U-plane .....	61
5.2.3	S-plane .....	61
5.3	Quality of Service.....	62
5.4	Data Flow Identification.....	62
5.5	Fragmentation.....	63
5.5.1	Application layer fragmentation .....	63
5.5.2	Radio Transport layer (eCPRI or IEEE-1914.3) fragmentation.....	64
5.5.3	Fragmentation Guideline .....	64
6	Security.....	65
6.1	General .....	65
7	C-plane Protocol.....	66
7.1	General .....	66
7.2	Function.....	66
7.2.1	C-Plane Transport.....	66
7.3	Elementary Procedures.....	66
7.3.1	Scheduling and Beamforming Commands Transfer procedure .....	66
7.3.2	Mixed Numerology and PRACH Handling .....	67
7.3.3	DL Precoding configuration parameters and indications.....	72
7.3.4	LAA Commands Transfer procedure.....	74
7.3.4.1	LBT procedure overview .....	74
7.3.4.2	Definitions.....	75
7.3.4.3	General Guidelines for the LAA-procedure .....	76
7.3.4.3.1	PDSCH Transmission.....	76
7.3.4.3.2	DRS Transmission.....	76
7.3.4.3.3	Congestion Window Information Transmission.....	77
7.3.5	Symbol Numbering and Duration.....	77
7.3.6	Dynamic Spectrum Sharing (DSS) .....	77
7.3.6.1	Dynamic Spectrum Sharing (DSS) via Dedicated Endpoints .....	77
7.3.6.2	Dynamic Spectrum Sharing (DSS) via Section Extension =9 for DSS.....	77
7.3.7	Channel Information based Beamforming.....	78
7.4	Elements for the C-plane Protocol.....	78
7.4.1	General.....	78
7.4.1.1	Section Extensions .....	79
7.4.1.2	Coupling of C-Plane and U-Plane .....	79
7.4.1.2.1	Coupling via sectionId Value .....	79
7.4.1.2.2	Coupling via Frequency and Time .....	80
7.4.1.2.3	Coupling via Frequency and Time with Priorities.....	80
7.4.1.2.4	Coupling via Frequency and Time with Priorities (Optimized) .....	81
7.4.2	Scheduling and Beamforming Commands .....	81
7.4.3	Coding of Information Elements – Transport Layer.....	92
7.4.4	Coding of Information Elements – Application Layer, Common.....	92
7.4.4.1	dataDirection (data direction (gNB Tx/Rx)) .....	92
7.4.4.2	payloadVersion (payload version) .....	92
7.4.4.3	filterIndex (filter index).....	93
7.4.4.4	frameId (frame identifier) .....	93
7.4.4.5	subframeId (subframe identifier) .....	94
7.4.4.6	slotId (slot identifier).....	94
7.4.4.7	startSymbolId (start symbol identifier).....	94
7.4.4.8	numberOfSections (number of sections).....	94

7.4.4.9	sectionType (Section Type) .....	94
7.4.4.10	udCompHdr (user data compression header) .....	94
7.4.4.11	numberOfUEs (number Of UEs).....	95
7.4.4.12	timeOffset (time offset).....	95
7.4.4.13	frameStructure (frame structure).....	95
7.4.4.14	cpLength (cyclic prefix length) .....	96
7.4.5	Coding of Information Elements – Application Layer, Sections .....	97
7.4.5.1	sectionId (section identifier).....	97
7.4.5.2	rb (resource block indicator) .....	97
7.4.5.3	symInc (symbol number increment command).....	97
7.4.5.4	startPrbc (starting PRB of data section description).....	98
7.4.5.5	reMask (resource element mask).....	99
7.4.5.6	numPrbc (number of contiguous PRBs per data section description) .....	99
7.4.5.7	numSymbol (number of symbols).....	100
7.4.5.8	ef (extension flag) .....	100
7.4.5.9	beamId (beam identifier).....	100
7.4.5.10	ueId (UE identifier).....	101
7.4.5.11	freqOffset (frequency offset).....	101
7.4.5.12	regularizationFactor (regularization Factor).....	101
7.4.5.13	ciISample, ciQsample (channel information I and Q values) .....	102
7.4.5.14	laaMsgType (LAA message type).....	102
7.4.5.15	laaMsgLen (LAA message length) .....	102
7.4.5.16	lbtHandle .....	102
7.4.5.17	lbtDeferFactor (listen-before-talk defer factor).....	103
7.4.5.18	lbtBackoffCounter (listen-before-talk backoff counter).....	103
7.4.5.19	lbtOffset (listen-before-talk offset) .....	103
7.4.5.20	MCOT (maximum channel occupancy time).....	103
7.4.5.21	lbtMode (LBT Mode).....	103
7.4.5.22	lbtPdschRes (LBT PDSCH Result).....	104
7.4.5.23	sfStatus (subframe status) .....	104
7.4.5.24	lbtDrsRes (LBT DRS Result).....	104
7.4.5.25	initialPartialSF (Initial partial SF).....	104
7.4.5.26	lbtBufErr (LBT Buffer Error).....	104
7.4.5.27	sfnSf (SFN/SF End) .....	105
7.4.5.28	lbtCWConfig_H (HARQ Parameters for Congestion Window management).....	105
7.4.5.29	lbtCWConfig_T (TB Parameters for Congestion Window management).....	105
7.4.5.30	lbtTrafficClass (Traffic class priority for Congestion Window management).....	105
7.4.5.31	lbtCWR_Rst (Notification about packet reception successful or not).....	105
7.4.5.32	reserved (reserved for future use).....	106
7.4.6	Section Extension Commands .....	106
7.4.6.1	extType (extension type).....	108
7.4.6.2	ef (extension flag) .....	109
7.4.6.3	extLen (extension length).....	109
7.4.7	Coding of Information Elements – Application Layer, Section Extensions .....	109
7.4.7.1	ExtType=1: Beamforming Weights Extension Type .....	109
7.4.7.1.1	bfwCompHdr (beamforming weight compression header) .....	109
7.4.7.1.2	bfwCompParam (beamforming weight compression parameter) .....	110
7.4.7.1.3	bfwI (beamforming weight in-phase value).....	111
7.4.7.1.4	bfwQ (beamforming weight quadrature value) .....	111
7.4.7.2	ExtType=2: Beamforming Attributes Extension Type.....	111
7.4.7.2.1	bfaCompHdr (beamforming attributes compression header).....	111
7.4.7.2.2	bfAzPt (beamforming azimuth pointing parameter).....	112
7.4.7.2.3	bfZePt (beamforming zenith pointing parameter) .....	113
7.4.7.2.4	bfAz3dd (beamforming azimuth beamwidth parameter).....	113
7.4.7.2.5	bfZe3dd (beamforming zenith beamwidth parameter) .....	113
7.4.7.2.6	bfAzSl (beamforming azimuth sidelobe parameter).....	113
7.4.7.2.7	bfZeSl (beamforming zenith sidelobe parameter) .....	113
7.4.7.2.8	zero-padding .....	114
7.4.7.3	ExtType=3: DL Precoding Extension Type .....	114
7.4.7.3.1	codebookIndex (precoder codebook used for transmission).....	115
7.4.7.3.2	layerID (Layer ID for DL transmission).....	115
7.4.7.3.3	txScheme (transmission scheme).....	115

7.4.7.3.4	numLayers (number of layers used for DL transmission) .....	115
7.4.7.3.5	crsReMask (CRS resource element mask).....	116
7.4.7.3.6	crsSymNum (CRS symbol number indication) .....	116
7.4.7.3.7	crsShift (crsShift used for DL transmission) .....	116
7.4.7.3.8	beamIdAP1 (beam id to be used for antenna port 1) .....	116
7.4.7.3.9	beamIdAP2 (beam id to be used for antenna port 2) .....	117
7.4.7.3.10	beamIdAP3 (beam id to be used for antenna port 3) .....	117
7.4.7.4	ExtType=4: Modulation Compression Parameters Extension Type .....	117
7.4.7.4.1	csf (constellation shift flag) .....	117
7.4.7.4.2	modCompScaler (modulation compression scaler value).....	118
7.4.7.5	ExtType=5: Modulation Compression Additional Parameters Extension Type .....	118
7.4.7.5.1	mcScaleReMask (modulation compression power scale RE mask) .....	119
7.4.7.5.2	csf (constellation shift flag) .....	120
7.4.7.5.3	mcScaleOffset (scaling value for modulation compression) .....	120
7.4.7.6	ExtType=6: Non-contiguous PRB allocation in time and frequency domain .....	120
7.4.7.6.1	rbgSize (resource block group size) .....	121
7.4.7.6.2	rbgMask (resource block group bit mask) .....	121
7.4.7.6.3	symbolMask (symbol bit mask) .....	122
7.4.7.6.4	priority .....	122
7.4.7.6.5	repetition (repetition flag).....	123
7.4.7.7	ExtType=7: eAxC Mask Section Extension.....	123
7.4.7.7.1	eAxCmask (eAxC Mask).....	123
7.4.7.8	ExtType=8: Regularization factor .....	124
7.4.7.8.1	regularizationFactor (regularization Factor).....	124
7.4.7.9	ExtType=9: Dynamic Spectrum Sharing parameters .....	124
7.4.7.9.1	technology (interface name) .....	125
7.4.7.10	ExtType=10: Section description for group configuration of multiple ports .....	125
7.4.7.10.1	beamGroupType .....	125
7.4.7.10.2	numPortc .....	126
7.4.7.10.3	Interaction with other Section Extensions .....	126
7.4.7.11	ExtType=11: Flexible Beamforming Weights Extension Type .....	127
7.4.7.11.1	bfwCompHdr (beamforming weight compression header) .....	128
7.4.7.11.2	bfwCompParam for PRB bundle x (beamforming weight compression parameter) .....	128
7.4.7.11.3	numBundPrb (Number of bundled PRBs per beamforming weights) .....	128
7.4.7.11.4	bfwI (beamforming weight in-phase value).....	128
7.4.7.11.5	bfwQ (beamforming weight quadrature value) .....	128
7.4.7.11.6	disableBFWs (disable beamforming weights).....	128
7.4.7.11.7	RAD (Reset After PRB Discontinuity).....	129
7.4.7.12	ExtType=12: Non-Contiguous PRB Allocation with Frequency Ranges .....	129
7.4.7.12.1	priority (priority of section description) .....	130
7.4.7.12.2	symbolMask (symbol bit mask) .....	130
7.4.7.12.3	offStartPrb(r) (offset of PRB range start) .....	131
7.4.7.12.4	numPrb(r) (number of PRBs in PRB range).....	131
7.4.7.13	ExtType=13: PRB Allocation with Frequency Hopping.....	131
7.4.7.13.1	nextSymbolId(n) (offset of PRB range start).....	132
7.4.7.13.2	nextStartPrbc(n) (number of PRBs in PRB range) .....	132
7.4.7.14	ExtType= 14: Nulling-layer Info. for ueId-based beamforming .....	132
7.4.7.14.1	nullLayerInd (null layer indication).....	132
7.4.7.15	ExtType= 15: Mixed-numerology Info. for ueId-based beamforming.....	133
7.4.7.15.1	frameStructure (frame structure) .....	133
7.4.7.15.2	freqOffset (frequency offset) .....	133
7.4.7.15.3	cpLength (cyclic prefix length) .....	133
7.4.7.16	ExtType=16: Section description for antenna mapping in UE channel information based UL beamforming .....	133
7.4.7.16.1	antMask .....	134
7.4.7.17	ExtType= 17: Section description for indication of user port group .....	134
7.4.7.17.1	numUeID .....	134
7.4.7.18	ExtType=18: Section description for Uplink Transmission Management .....	135
7.4.7.18.1	transmissionWindowOffset .....	135
7.4.7.18.2	transmissionWindowSize .....	135
7.4.7.18.3	Type of Transmission (toT).....	136
7.4.7.18.4	Interaction with other Section Extensions .....	136

7.4.7.19	ExtType=19: Section Compact multiple port beamforming information.....	137
7.4.7.19.1	disableBFWs (disable beamforming weights).....	138
7.4.7.19.2	repetition (repeat port info flag).....	138
7.4.7.19.3	numPortc.....	138
7.4.7.19.4	priority (priority of section description).....	138
7.4.7.19.5	symbolMask (resource symbol bitmask).....	138
7.4.7.19.6	bfwCompHdr.....	139
7.4.7.19.7	portReMask (RE bitmask per port).....	139
7.4.7.19.8	portSymbolMask (symbol bitmask per port).....	139
7.4.7.19.9	bfwCompParam (beamforming weight compression parameter).....	139
7.4.7.19.10	beamId (beam identifier for a port).....	139
7.4.7.19.11	bfwI (beamforming weight in-phase value).....	139
7.4.7.19.12	bfwQ (beamforming weight quadrature-phase value).....	139
7.4.7.19.13	Interaction with Other Section Extensions.....	139
7.4.7.20	ExtType=20: Puncturing Extension.....	141
7.4.7.20.1	numPuncPatterns (number of puncturing pattern).....	142
7.4.7.20.2	symbolMask (puncturing pattern symbol mask).....	142
7.4.7.20.3	startPuncPrb (starting PRB to which one puncturing pattern applies).....	142
7.4.7.20.4	numPuncPrb (number of contiguous PRBs to which one puncturing pattern applies).....	142
7.4.7.20.5	puncReMask (puncturing pattern RE mask).....	142
7.4.7.20.6	rb (resource block indicator).....	142
7.4.7.20.7	rbgIncl (rbg included flag).....	143
7.4.7.20.8	rbgSize (rbg size).....	143
7.4.7.20.9	rbgMask (rbg bitmask).....	143
7.4.7.20.9	Interaction with Other Extensions.....	143
7.5	C-Plane Optimizations.....	143
7.5.1	C-Plane Optimization using Section Extension =6.....	143
7.5.2	C-Plane Optimization using Section Extension =7.....	143
7.5.3	C-Plane Optimization using Section Extension =10.....	143
7.5.4	C-Plane Optimization using Section Extension =11.....	144
7.5.4.1	Interaction between Section Extension =11 and Section Extension =6.....	144
7.5.4.2	Interaction between Section Extension =11 and Section Extension =12.....	146
7.5.4.3	Interaction between Section Extension =11 and Section Extension =13.....	148
7.5.5	C-Plane Optimization using Section Extension =12.....	151
7.5.6	C-Plane Optimization using Section Extension =13.....	151
7.5.7	Coupling via Frequency and Time with Priorities.....	152
7.5.7.1	Coupling via Frequency and Time with Priorities (Optimized).....	153
7.5.8	U-Plane Operation Without C-Plane.....	154
7.5.9	Modulation Compression with Section Extension 10.....	154
7.5.10	Optimization with Ext Type = 19.....	157
7.5.11	Optimizations with ExtType=20.....	157
7.6	O-RUs per endpoint and per C-Plane message limits.....	158
7.6.1	O-RU per endpoint processing limits.....	158
7.6.2	O-RU C-Plane message limits.....	158
8	U-plane Protocol.....	159
8.1	General.....	159
8.1.1	U-plane Transport.....	159
8.1.2	U-plane Data Compression.....	159
8.1.3	Digital Power Scaling.....	159
8.1.3.1	Definition of IQ Power in dBFS.....	159
8.1.3.2	Definition of Gain over Fronthaul Interface.....	160
8.1.3.2.1	DL Gain Guideline.....	162
8.1.3.2.2	UL Gain Definition.....	162
8.1.3.3	TX Power Budget Guideline for Category A and Category B O-RUs.....	163
8.2	Elementary Procedures.....	165
8.2.1	IQ Data Transfer procedure.....	165
8.2.2	IQ Data Transfer Procedure Without C-Plane.....	167
8.3	Elements for the U-plane Protocol.....	167
8.3.1	General.....	167
8.3.2	DL/UL Data.....	167
8.3.3	UL/DL Data Coding of Information Elements.....	169

8.3.3.1	dataDirection (data direction (gNB Tx/Rx))	169
8.3.3.2	payloadVersion (payload version)	169
8.3.3.3	filterIndex (filter index)	169
8.3.3.4	frameId (frame identifier)	170
8.3.3.5	subframeId (subframe identifier)	170
8.3.3.6	slotId (slot identifier)	170
8.3.3.7	symbolId (symbol identifier)	170
8.3.3.8	sectionId (section identifier)	170
8.3.3.9	rb (resource block indicator)	170
8.3.3.10	symInc (symbol number increment command)	170
8.3.3.11	startPrbu (startingPRB of user plane section)	170
8.3.3.12	numPrbu (number of PRBs per user plane section)	171
8.3.3.13	udCompHdr (user data compression header)	171
8.3.3.14	reserved (reserved for future use)	172
8.3.3.15	udCompParam (user data compression parameter)	172
8.3.3.16	iSample (in-phase sample)	173
8.3.3.17	qSample (quadrature sample)	173
8.3.3.18	sReSMask (Selective RE Sending Mask)	173
8.3.3.19	udCompLen (PRB field length)	173
8.3.4	DL Data Precoding	174
8.3.5	Data Transfer for Special Cases	174
8.3.5.1	Data Message Mapping and Packetization	174
8.3.5.2	Uplink Data Transfer	174
8.3.5.3	PRACH Data Transfer Without C-Plane	174
8.3.5.4	SRS Data Transfer Without C-Plane	175
8.4	U-Plane Optimizations	175
8.4.1	Coupling via Frequency and Time	175
9	Counters and KPIs	175
9.1	Counters	175
10	Specification Mandatory and Optional Capabilities	178
10.1	General	178
11	S-Plane Protocol	185
11.1	General	185
11.1.1	Overview	185
11.2	Synchronization Baseline	185
11.2.1	List of Reference Documents	185
11.2.2	Clock Model and Synchronization Topology	185
11.2.2.1	Topology configuration LLS-C1 and LLS-C2 Synchronization	186
11.2.2.2	Topology configuration LLS-C3 Synchronization	188
11.2.2.3	Topology configuration LLS-C4 Synchronization	190
11.2.3	Clock Synchronization	190
11.2.4	Profiles	191
11.2.4.1	Physical Layer Frequency Signals (PLFS)	191
11.2.4.2	PTP	191
11.2.4.2.1	Full Timing Support	191
11.2.4.2.2	Partial Timing Support	192
11.2.5	Synchronization Accuracy	192
11.2.5.1	Jitter	193
11.2.5.2	Wander	193
11.2.5.3	Air interface frequency error	193
11.2.5.4	Air interface maximum time error	193
11.3	Time and Frequency Synchronization Requirements	196
11.3.1	Allowed PTP and PLFS clock types and clock classes	196
11.3.2	Frequency and Time Synchronization Requirements across fronthaul network elements	197
11.3.2.1	Configurations LLS-C1 and LLS-C2	197
11.3.2.2	Configuration LLS-C3	200
11.3.2.3	Configuration LLS-C4	202
11.4	Node Behavior Guidelines	204
11.4.1	Configurations LLS-C1 and LLS-C2	204
11.4.1.1	M-Plane disconnected	204



11.4.1.2	O-RU in the FREERUN State .....	205
11.4.1.3	O-DU in the FREERUN state .....	205
11.4.1.4	Operation in LOCKED/HOLDOVER state .....	205
11.4.2	Configurations LLS-C3 .....	206
11.4.2.1	M-Plane disconnected .....	207
11.4.2.2	O-RU in the FREERUN State .....	207
11.4.2.3	O-DU in the FREERUN state .....	207
11.4.2.4	Operation in SYNCED/HOLDOVER state .....	207
11.4.3	Configurations LLS-C4 .....	207
11.4.3.1	M-Plane disconnected .....	208
11.4.3.2	O-RU in the FREERUN State .....	208
11.4.3.3	O-DU in the FREERUN state .....	208
11.4.3.4	Operation in SYNCED/HOLDOVER state .....	208
11.5	S-Plane Handling in Multiple Link Scenarios .....	208
11.6	Announce Messages .....	209
11.7	Elementary Procedures .....	209
11.7.1	PTP Time Synchronization procedure .....	209
11.7.2	System Frame Number Calculation from GPS Time .....	209
12	Beamforming Functionality .....	213
12.1	General .....	213
12.2	Hierarchy of Radiation Structure in O-RU .....	213
12.3	Calibration .....	214
12.4	beamId Use for Various Beamforming Methods .....	214
12.4.1	Predefined-beam Beamforming .....	215
12.4.1.1	Beam Characteristics .....	215
12.4.2	Weight-based dynamic beamforming .....	217
12.4.2.1	Weight-based dynamic frequency-domain or time-domain beamforming (not hybrid) .....	217
12.4.2.2	Weight-based dynamic hybrid beamforming .....	218
12.4.2.2.1	Hybrid beamforming with updatable frequency-domain and time-domain weights .....	218
12.4.2.2.2	Hybrid beamforming with updatable frequency-domain weights and fixed time-domain beams .....	219
12.4.3	Attribute-based dynamic beamforming .....	220
12.4.4	Channel-information-based beamforming .....	221
12.5	O-RU Antenna Model supported by O-RAN .....	221
12.5.1	Coordinate Systems .....	221
12.5.2	O-RU Antenna Model Parameters .....	222
12.5.3	Identification and Ordering of Array Elements .....	223
12.5.4	Relations Between Array Elements .....	224
12.5.5	Model Usage .....	224
13	Support of Shared Cell .....	227
13.1	General .....	227
13.2	Copy and Combine function .....	228
13.2.1	Selective transmission and reception using beamId .....	230
13.3	Delay management for Shared cell .....	233
13.3.1	DL delay management for Shared cell .....	234
13.3.2	UL delay management for Shared cell .....	235
13.4	S-plane for Shared cell .....	237
13.4.1	Node behavior at O-RU in FREERUN state .....	237
13.4.1.1	O-DU .....	237
13.4.1.2	O-RU .....	237
13.5	Cascade-FHM mode .....	238
13.5.1	General .....	238
13.5.2	Copy and Combine function .....	238
13.5.3	Delay management .....	239
Annex A (informative):	Compression Methods .....	243
A.1	Block Floating Point Compression .....	243
A.1.1	Block Floating Point Compression Algorithm .....	243
A.1.2	Block Floating Point Decompression Algorithm .....	244
A.2	Block Scaling Compression .....	244
A.2.1	Block Scaling Compression Algorithm .....	245

A.2.2	Block Scaling Decompression Algorithm.....	245
A.3	$\mu$ -Law Compression .....	246
A.3.1	$\mu$ -Law Compression Algorithm .....	246
A.3.2	$\mu$ -Law Decompression Algorithm .....	247
A.3.3	$\mu$ -Law udCompParam and IQ data format.....	248
A.4	Beamspace Compression and Decompression .....	248
A.4.1	Beamspace Compression Algorithm.....	248
A.4.2	Beamspace Decompression Algorithm.....	250
A.5	Modulation Compression .....	250
A.6	Selective RE sending Compression.....	253
Annex B (informative): Delay Management Use Cases.....		253
B.1	General .....	253
B.2	Latency categories and sub-categories .....	259
B.3	Example Case: Evaluating O-DU / O-RU Combinations.....	263
B.4	Example Case: Non-ideal transport O-DU/O-RU Categories .....	266
Annex C (informative): M-Plane Impacts .....		267
Annex D (informative): IQ Sample and Exponent Packetization for Different Bitwidths.....		268
D.1	General .....	268
D.2	IQ Sample for Little Endian Byte Order .....	273
Annex E (informative): OFDM Phase Compensation.....		279
Annex F (informative): Beamforming Attributes Frame of Reference .....		280
Annex G (informative): LAA Algorithms and Examples .....		282
Annex H (informative): S-Plane detailed frequency and phase error budget analysis, and future ITU-T clock types and classes reference .....		286
H.1	Reference documents .....	286
H.2	Frequency and time error budget analysis.....	286
H.3	Summary of allowed number of switches: .....	290
Annex I (informative): Precoding and Examples .....		293
I.1	Case 1: Tx Diversity 1-CRS Port Ant0, 1 PRB: .....	293
I.2	Case 2: Tx Diversity 2-CRS Port Ant0, Ant1, and 1 PRB .....	293
I.3	Case 3: Tx Diversity 4-CRS Port Ant0,1,2,3 and 1 PRB .....	294
I.4	Case 4: TM3/TM4 3 Layers, 4 Antenna ports.....	296
I.5	CRS location assignment: reMask Bit position for Layer0, 2 and 4 for all possible vShift cases.....	297
Annex J (informative): Beamforming Methods Description.....		300
Annex K (informative): Layers of Array Elements .....		303
K.1	General .....	303
K.2	Use Case A .....	303
K.3	Use Case B .....	304
Annex L (informative): Considerations when operating in non-ideal transport environments .....		305
L.1	General .....	305
L.2	Deployment Scenarios and Performance Considerations .....	305
L.2.1	Low Impact.....	305
L.2.2	Medium Impact.....	305
L.2.3	High Impact .....	305
L.3	HARQ .....	306
L.3.1	Synchronous HARQ .....	306
L.3.1.1	HARQ Interleaving .....	306
L.3.1.2	Predictive HARQ .....	307
L.3.2	Asynchronous HARQ Considerations .....	308
L.4	RACH Considerations .....	308
L.4.1	Non-Ideal Fronthaul RACH Designs.....	309
L.4.1.1	Option-1: Semi-persistent Resource allocation.....	309
L.4.1.2	Option-2: RACH retransmission estimation .....	310
L.5	Other Latency Related Considerations .....	311

L.6	Bandwidth Limitation Considerations.....	312
Annex M (informative): Use Case of Selective Transmission and Reception .....		314
M.1	General .....	314
M.2	Selective transmission and reception with non beamforming O-RUs and 1-to-1 mapping of global beamId and local beamId .....	314
M.3	Selective transmission and reception with beamforming O-RUs and 1-to-N mapping of global beamId and local beamId .....	315
Change History .....		317
History .....		318

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## Foreword

This Technical Specification (TS) has been produced by O-RAN Alliance and approved by ETSI Technical Committee MSG.

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## Modal verbs terminology

In the present document "**shall**", "**shall not**", "**should**", "**should not**", "**may**", "**need not**", "**will**", "**will not**", "**can**" and "**cannot**" are to be interpreted as described in clause 3.2 of the [ETSI Drafting Rules](#) (Verbal forms for the expression of provisions).

"**must**" and "**must not**" are **NOT** allowed in ETSI deliverables except when used in direct citation.

# 1 Scope

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

Release x.y.z

where:

- x the first digit is incremented for all changes of substance, i.e. technical enhancements, corrections, updates, etc. (the initial approved document will have x=01).
- y the second digit is incremented when editorial only changes have been incorporated in the document.
- z the third digit included only in working versions of the document indicating incremental changes during the editing process.

The present document specifies the control plane, user plane and synchronization plane protocols used over the fronthaul interface linking the O-DU (O-RAN Distributed Unit) with the O-RU (O-RAN Radio Unit) with a Lower Layer Functional Split-7-2x based architecture (explained below). The scope of this document includes both LTE and NR (5G). A separate document contains the O-RAN M-Plane (management plane) specification.

In the following, "Layer 1" and "Physical Layer" are assumed to be synonymous.

In the main body of this specification (in any "clause") the information contained therein is normative meaning binding on any compliant system, unless explicitly described as informative (a capability described as "optional" may or may not be included in a compliant system but if it is included it shall comply with the optional capability description). Information contained in an "Annex" to this specification is always informative.

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## 2 References

### 2.1 Normative references

References are either specific (identified by date of publication and/or edition number or version number) or non-specific. For specific references, only the cited version applies. For non-specific references, the latest version of the referenced document (including any amendments) 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 Release 15.

Referenced documents which are not found to be publicly available in the expected location might be found at <https://o-ran.org/Reference>.

NOTE: While any hyperlinks included in this clause were valid at the time of publication, O-RAN cannot guarantee their long term validity.

The following referenced documents are necessary for the application of the present document.

- [1] 3GPP TR 21.905: "Vocabulary for 3GPP Specifications".
- [2] eCPRI Transport Network V1.2 (2018-06-25) "Common Public Radio Interface: Requirements for the eCPRI Transport Network".
- [3] IEEE Std 1588-2008 "Standard for a Precision Clock Synchronization Protocol for Networked Measurement and Control Systems".
- [4] 3GPP TS 38.211 V15.1.0: "NR; Physical channels and modulation".
- [5] R1-1800296, "NR OFDM Symbol Generation Option Analysis", Intel, 3GPP TSG RAN WG1 AH#18-01, Vancouver, Canada, Jan. 22-26, 2018
- [6] R1-1800802, "OFDM signal generation", Nokia, 3GPP TSG RAN WG1 AH#18-01, Vancouver, Canada, Jan. 22-26, 2018
- [7] ORAN-WG4.MP.0-v07.01: "O-RAN Fronthaul Working Group Management Plane Specification, Release 07.01".

- [8] 3GPP TS 38.104 "Base Station (BS) radio transmission and reception", Release 15, v15.2.0 (2018-06).
- [9] 3GPP TS 36.104 "Base Station (BS) radio transmission and reception", Release 16, v16.7.0 (2020-07).
- [10] RFC 1166: "Internet Numbers".
- [11] "IEEE Standard for Local and metropolitan area networks -- Time-Sensitive Networking for Fronthaul," in IEEE Std 802.1CM-2018, 8 June 2018.
- [12] "IEEE Standard for Local and metropolitan area networks -- Time-Sensitive Networking for Fronthaul - Amendment 1: Enhancements to Fronthaul Profiles to Support New Fronthaul Interface, Synchronization, and Syntonization Standards," in IEEE Std 802.1CMde-2020 (Amendment to IEEE Std 802.1CM-2018, Oct. 2020).
- [13] 3GPP. TR 38.801 V14.0.0: "Study on new radio access technology: Radio access architecture and interfaces".
- [14] 3GPP TS 36.213: "Evolved Universal Terrestrial Radio Access (E-UTRA); Physical layer procedures".
- [15] ITU-T G.781 (04/2020): "Synchronization layer functions for frequency synchronization based on the physical layer".
- [16] ITU-T G.810 (08/1996): "Definitions and terminology for synchronization networks".
- [17] ITU-T G.8260 (03/2020): "Definitions and terminology for synchronization in packet networks".
- [18] ITU-T G.8261/Y.1361 (2019) Amendment 2 (10/2020) Timing and synchronization aspects in packet networks
- [19] ITU-T G.8262/Y.1362 (2018) Amendment 1 (03/2020) Timing characteristics of a synchronous Ethernet equipment slave clock
- [20] ITU-T G.8262.1/Y.1362 (2019) Amendment 1 (08/2019) Timing characteristics of an enhanced synchronous equipment slave clock
- [21] ITU-T G.8264/Y.1364 (08/2017) Amendment 1 (03/2018) Distribution of timing information through packet networks
- [22] ITU-T G.8271/Y.1366 (03/2020): "Time and phase synchronization aspects of telecommunication networks".
- [23] ITU-T G.8271.1/Y.1366.1 (10/2020): "Network limits for time synchronization in packet networks with full timing support from the network".
- [24] ITU-T G.8271.2/Y.1366.2 (05/2021): "Network limits for time synchronization in packet networks with partial timing support from the network".
- [25] ITU-T G.8272/Y.1367 (11/2018) Amendment 1 (03/2020) Timing characteristics of primary reference time clocks
- [26] ITU-T G.8272.1/Y.1367. (11/2016) Amendment 2 (08/2019) Timing characteristics of enhanced primary reference time clocks
- [27] ITU-T G.8273/Y.1368 (2018) Corrigendum 1 (10/2020) Framework of phase and time clocks
- [28] ITU-T G.8273.2/Y.1368.2 (10/2020): "Timing characteristics of telecom boundary clocks and telecom time slave clocks".
- [29] ITU-T G.8273.3/Y.1368.3 (10/2017) Amendment. 1 (11/2018) Timing characteristics of telecom transparent clocks for use with full timing support from the network
- [30] ITU-T G.8275/Y.1369 (2020) Amendment 1 (05/2021) Architecture and requirements for packet-based time and phase distribution
- [31] ITU-T G8275.1/Y.1369.1 (2020) Amendment 2 (06/2021) Precision time protocol telecom profile for phase/time synchronization with full timing support from the network
- [32] ITU-T G8275.2/Y.1369.2 (2020) Amendment 2 (06/2021) Precision time protocol telecom profile for time/phase synchronization with partial timing support from the network

- [33] IEEE Std 1588-2019 "Standard for a Precision Clock Synchronization Protocol for Networked Measurement and Control Systems", November 2019.

## 2.2 Informative references

References are either specific (identified by date of publication and/or edition number or version number) or non-specific. For specific references, only the cited version applies. For non-specific references, the latest version of the referenced document (including any amendments) applies.

NOTE: While any hyperlinks included in this clause were valid at the time of publication, ETSI cannot guarantee their long term validity.

The following referenced documents are not necessary for the application of the present document but they assist the user with regard to a particular subject area.

- [i.1] 3GPP TR 38.901: "Study on channel model for frequencies from 0.5 to 100 GHz".
- [i.2] 3GPP TR 36.932: "Scenarios and requirements for small cell enhancements for E-UTRA and E-UTRAN".

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## 3 Definition of terms, symbols and abbreviations

### 3.1 Terms

For the purposes of the present document, the terms 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].

**C-Plane:** Control Plane: refers specifically to real-time control between O-DU and O-RU, and should not be confused with the UE's control plane

**Cascade mode:** Mode of Shared cell which is realized by several O-RUs cascaded in chain. (See clause 13)

**DL:** DownLink: data flow towards the radiating antenna (generally on the LLS interface)

**eAxC:** extended Antenna-Carrier: a data flow for a single antenna (or spatial stream) for a single carrier in a single sector. Includes the fields BandSector\_ID, CC\_ID, RU\_Port\_ID and DU\_Port\_ID (see clauses 5.1.3.1.6 and 5.1.3.2.4)

**FFO:** Fractional Frequency Offset. This is defined as  $\Delta f/f_{\text{norm}}$  which is used to describe frequency error, typically on the output of the T-TSC filter in the O-RU. It is the same as the Fractional Frequency Deviation defined in ITU-T G.810.

**FHM mode:** Mode of Shared cell which is realized by FHM and several O-RUs. (See clause 13)

**Hop:** physical link between 2 s-plane nodes (where node can be O-DU, switch or O-RU) as defined in IEEE 802.1CM

**LAA:** Licensed-assisted access: Carrier aggregation with at least one secondary cell operating in the unlicensed spectrum.

**LLS:** Lower Layer Split: logical interface between O-DU and O-RU when using a lower layer (intra-PHY based) functional split.

**LLS-U:** Lower Layer Split User-plane: logical interface between O-DU and O-RU when using a lower layer functional split.

**LLS-C:** Lower Layer Split Control-plane: logical interface between O-DU and O-RU when using a lower layer functional split.

**High-PHY:** those portions of the PHY processing on the O-DU side of the fronthaul interface, including FEC encode/decode, scrambling, and modulation/demodulation.

**Low-PHY:** those portions of the PHY processing on the O-RU side of the fronthaul interface, including FFT/iFFT, digital beamforming, and PRACH extraction and filtering.

**M-Plane:** Management Plane: refers to non-real-time management operations between the O-DU and the O-RU

**O-CU:** O-RAN Control Unit – a logical node hosting PDCP, RRC, SDAP and other control functions