

Low Level Reader Protocol (LLRP), Version 1.0.1 2

Ratified Standard with Approved Fixed Errata 3

August 13, 2007 4

5 6

Disclaimer

- EPCglobal Inc™ is providing this document as a service to interested industries.
- This document was developed through a consensus process of interested
- 9 parties.
- 10 Although efforts have been to assure that the document is correct, reliable, and
- 11 technically accurate, EPCqlobal Inc makes NO WARRANTY, EXPRESS OR
- IMPLIED, THAT THIS DOCUMENT IS CORRECT, WILL NOT REQUIRE 12
- 13 MODIFICATION AS EXPERIENCE AND TECHNOLOGICAL ADVANCES
- 14 DICTATE, OR WILL BE SUITABLE FOR ANY
- 15 PURPOSE OR WORKABLE IN ANY APPLICATION, OR OTHERWISE. Use of
- 16 this document is with the understanding that EPCglobal Inc has no liability for
- 17 any claim to the contrary, or for any damage or loss of any kind or
- 18 nature.

19

20

21

22 23

24 25 26

27

28 29

30

Copyright notice

© 2006, 2007, EPCglobal Inc.

All rights reserved. Unauthorized reproduction, modification, and/or use of this document is not permitted. Requests for permission to reproduce should be addressed to epcglobal@epcglobalinc.org.

EPCglobal Inc.TM is providing this document as a service to interested industries. This document was developed through a consensus process of interested parties. Although efforts have been to assure that the document is correct, reliable, and technically accurate, EPCglobal Inc. makes NO WARRANTY, EXPRESS OR IMPLIED, THAT THIS DOCUMENT IS CORRECT, WILL NOT REQUIRE MODIFICATION AS EXPERIENCE AND TECHNOLOGICAL ADVANCES DICTATE, OR WILL BE SUITABLE FOR ANY PURPOSE OR WORKABLE IN ANY APPLICATION, OR OTHERWISE. Use of this Document is with the understanding that EPCglobal Inc. has no liability for any claim to the contrary, or for any damage or loss of any kind or nature

Abstract

35

- 36 This document specifies an interface between RFID Readers and Clients. The interface
- 37 protocol is called *low-level* because it provides control of RFID air protocol operation
- 38 timing and access to air protocol command parameters. The design of this interface
- 39 recognizes that in some RFID systems, there is a requirement for explicit knowledge of
- 40 RFID air protocols and the ability to control Readers that implement RFID air protocol
- 41 communications. It also recognizes that coupling control to the physical layers of an
- 42 RFID infrastructure may be useful for the purpose of mitigating RFID interference.

43 Audience for this document

- 44 The target audience for this specification includes:
- 45 RFID Network Infrastructure vendors
- 46 Reader vendors
- 47 EPC Middleware vendors
- 48 System integrators

49 Status of this document

- 50 This section describes the status of this document at the time of its publication. Other
- 51 documents may supersede this document. The latest status of this document series is
- 52 maintained at EPCglobal. See www.epcglobalinc.org for more information.
- 53 This draft fixes errata in version 1.0 of LLRP that was ratified on April 12, 2007. A
- summary of the fixed errata is contained in the table below. Note that Section and Line
- numbers referenced are per version 1 of LLRP. Line numbers may be slightly different in
- 56 this version 1.0.1.
- 57 Comments on this document should be sent to the EPCglobal Software Action Group
- 58 Reader Operations Working Group mailing list at
- 59 sag readerop@epclinklist.epcglobalinc.org.

60 Fixed Errata

Section#	Line #	Description	Disposition
16.2.3.4.1	2921	It should be a generic UHF RFModeTable Parameter (1-n) with Notes under the parameter that for C1G2 it is UHFC1G2RFModeTable	Replace with UHF RFMode Table Parameter (1-n)
15.2.1.3.1.1	2402	No length field	Remove the length field from the abstract
15.2.1.2.1.1.1	2309	No length field	Remove the length field from the abstract
9.2.1.1	1269	Range of Rx sensitivity	0-128 (relative to max sensitivity)

16.1.2	2593	C1G2LLRPCapabilities should be	Replace with
		replaced by AirProtocolLLRPCapabilities Parameter (0-1)	AirProtocolLLRPCapabilities Parameter (0-1)
9.2.4.1.2.1	1336	This is followed by a list of the frequencies (in Khz) in hop table order. The position of a frequency in the list is its ChannelIndex. (These are used by the hopping event parameter)	This is followed by a list of the frequencies (in Khz) in hop table order. The one-based position of a frequency in the list is its ChannelIndex (i.e. the first frequency is referred to as ChannelIndex 1)
9.2.4.1.2.2	1343	This parameter carries the fixed frequency list that can be used by the Reader. The position of a frequency in the list is its ChannelIndex.	This parameter carries the fixed frequency list that can be used by the Reader. The one-based position of a frequency in the list is its ChannelIndex (i.e. the first frequency is refered to as ChannelIndex 1)
12.2.6.2, 13.2.3.8, 13.2.6.2	1825, 2013, 2105	TheseChannelIndexes are used by the RfTransmitter Parameter , Channel Index Parameter, HoppingEventParameter	Possibly denote in these usages that they are 1-based
11.1.3	1552	Delete access spec does not allow 0 like all other access spec commands. This is believed to be an errata	Possibly add zero to mean all access specs, as in other access spec commands.
16.2.7.1	3088	Custom parameter is 0-1. All others are 0-N. This is believed to be an errata	Extend this to 0-N to correct errata
16	2535, 2538	Encoding example:: message length is 32 bits, but shown as 16 bits and 32-bit messageID is not shown	Correct figures to match documentation
14.2.2, 16.2.8.1	2215, 3270	The abstract LLRPStatusParameter contains a field called statusCode. The binding references the same field as ErrorCode	Correct binding section to match abstract
16.4	3480	In 16.4, table 5, "ReaderSensitivityTableEntry" should be ReceiveSensitivyTableElement	Change ReaderSensitivity to ReceiveSensitivity
10.2.1, 16.2.4.1	1452, 2947	In 10.2.1, the field "Current State" is listed as the last element of the ROSpec Parameter, the binding lists the same field as the 4th last element.	Change position of "Current State" field in abstract ROSpec Parameter
16.4	3742	ReadEventNotification	Change to ReaderEventNotification
8.2	1194	Possible Values 0-255	Remove possible values. Changed to unsigned integer
6.1	717	An AlSpec binds a stop trigger and a set of antennas to a set of InventoryParameterSpecs and is identified by a spec Identifier	Change the spec Identifyer to a "one-based index called the SpecIndex"

various	various	multiple instances of Khz	Replace with kHz

62 Contents

63	INDEX OF FIGURES	13
64	INDEX OF TABLES	14
65	1 (INFORMATIVE) GLOSSARY	15
66	2 INTRODUCTION	18
67	3 ROLE WITHIN THE EPCGLOBAL NETWORK ARCHITECTURE	19
68	4 TERMINOLOGY AND TYPOGRAPHICAL CONVENTIONS	21
69	5 OVERVIEW OF LLRP	21
70	5.1 TYPICAL LLRP TIMELINE	22
71	6 LLRP OPERATION	23
72	6.1 INVENTORY, RF SURVEY AND ACCESS OPERATIONS	23
73	6.1.1 Operation Triggers	
74	6.1.1.1 Summary	
<u>75</u>	6.1.1.2 Reader Operation Triggers	33
76	6.1.1.3 Access Operation Triggers	
77	6.2 REPORTING, EVENT NOTIFICATION AND KEEPALIVES	34
78	7 MESSAGES, PARAMETERS AND FIELDS	35
79	7.1 Overview	35
80	7.1.1 Formatting Conventions	
81	7.1.2 Messages	
82	7.1.3 Parameters	
83	7.1.3.1 General Parameters	
84	7.1.3.1.1 Timestamp	
85	7.1.3.1.1.1 UTCT imestamp Parameter	37
86	7.1.3.1.1.2 Uptime Parameter	
87	7.1.4 Fields	
88	7.1.5 Functional Grouping	
89	7.1.6 LLRP Messages and Actions	40
90	8 CUSTOM EXTENSION	41
91	8.1 CUSTOM MESSAGE	42
92	8.2 CUSTOM PARAMETER	
93	8.3 CUSTOM EXTENSION IN COMMANDS	42
94	8.4 CUSTOM EXTENSION IN INDIVIDUAL LLRP PARAMETERS	43
95	8.5 ALLOWABLE PARAMETER EXTENSION	43
96	9 READER DEVICE CAPABILITIES	43
97	9.1 Messages	44
98	9.1.1 GET READER CAPABILITIES	
99	9.1.2 GET READER CAPABILITIES RESPONSE	
00	9.2 PARAMETERS	
01	9.2.1 GeneralDeviceCapabilities Parameter	
02	9.2.1.1 ReceiveSensitivityTableEntry Parameter	45
03	9.2.1.2 PerAntennaReceiveSensitivityRange Parameter	
04	9.2.1.3 PerAntennaAirProtocol Parameter	46

105	9.2.1.4	GPIOCapabilities Parameter	47
106	9.2.2	LLRPCapabilities Parameter	47
107	9.2.3	AirProtocolLLRPCapabilities Parameter	
108	9.2.4	RegulatoryCapabilities Parameter	
109	9.2.4.1	- · · · · · · · · · · · · · · · · · · ·	
110		4.1.1 TransmitPowerLevelTableEntry Parameter	
111		4.1.2 FrequencyInformation Parameter	
112 113		9.2.4.1.2.1 FrequencyHopTable Parameter	
113		9.2.4.1.2.2 FixedFrequencyTable Parameter	
114	10 READEI	R OPERATION (RO)	51
115	10.1 ME	SSAGES	51
116	10.1.1	ADD_ROSPEC	51
117	10.1.2	ADD_ROSPEC_RESPONSE	
118	10.1.3	DELETE_ROSPEC	52
119	10.1.4	DELETE_ROSPEC_RESPONSE	52
120	10.1.5	START ROSPEC	52
121	10.1.6	START ROSPEC RESPONSE	52
122	10.1.7	STOP ROSPEC	53
123	10.1.8	STOP ROSPEC RESPONSE	53
124	10.1.9	ENABLE ROSPEC	53
125	10.1.10	ENABLE ROSPEC RESPONSE	54
126	10.1.11	DISABLE ROSPEC	54
127	10.1.12	DISABLE ROSPEC RESPONSE	54
128	10.1.13	GET ROSPECS	
129	10.1.14	GET ROSPECS RESPONSE	
130		RAMETERS	
131	10.2.1	ROSpec Parameter	
132	10.2.1.	•	
133	10.2	2.1.1.1 ROSpecStartTrigger Parameter	
134	1	10.2.1.1.1.1 PeriodicTriggerValue Parameter	56
135		10.2.1.1.1.2 GPITriggerValue Parameter	
136		2.1.1.2 ROSpecStopTrigger Parameter	
137	10.2.2	AISpec Parameter	
138	10.2.2.1	- F F	58
139 140		2.2.1.1 TagObservationTrigger Parameter	
141	10.2.2.2 10.2.3		
142	10.2.3	RFSurveySpec Parameter	
143		S OPERATION	
144			
144	11.1 ME <i>11.1.1</i>	SSAGESADD ACCESSPEC	
145		ADD_ACCESSSPEC ADD ACCESSSPEC RESPONSE	
140	11.1.2	DELETE ACCESSSPEC_RESPONSE DELETE ACCESSSPEC	
148	11.1.3		
148	11.1.4	DELETE_ACCESSSPEC_RESPONSE	
	11.1.5	ENABLE_ACCESSPEC	
150	11.1.6	ENABLE_ACCESSPEC_RESPONSE	
151	11.1.7	DISABLE_ACCESSSPEC	
152	11.1.8	DISABLE_ACCESSSPEC_RESPONSE	
153	11.1.9	GET_ACCESSPECS	
154	11.1.10	GET_ACCESSSPECS_RESPONSE	
155	11.1.11	CLIENT_REQUEST_OP	
156	11.1.12	CLIENT_REQUEST_OP_RESPONSE	
157		RAMETERS	
158	11.2.1	AccessSpec Parameter	
159	11.2.1.	1 AccessSpecStopTrigger Parameter	65

160	11.2.1.2 AccessCommand Parameter	65
161	11.2.1.2.1 ClientRequestOpSpec Parameter	
162	11.2.2 ClientRequestResponse Parameter	66
163	12 READER DEVICE CONFIGURATION	67
164	12.1 Messages	67
165	12.1.1 GET READER CONFIG	
166	12.1.2 GET READER CONFIG RESPONSE	
167	12.1.3 SET READER CONFIG	
168	12.1.4 SET_READER_CONFIG_RESPONSE	
169		
	12.1.5 CLOSE_CONNECTION	
170	12.1.6 CLOSE_CONNECTION_RESPONSE	
171	12.2 PARAMETERS	
172	12.2.1 LLRPConfigurationStateValue Parameter	
173	12.2.2 Identification Parameter	
174	12.2.3 GPOWriteData Parameter	
175	12.2.4 KeepaliveSpec Parameter	
176	12.2.5 AntennaProperties Parameter	
177	12.2.6 AntennaConfiguration Parameter	
178	12.2.6.1 RFReceiver Parameter	
179	12.2.6.2 RFTransmitter Parameter	
180	12.2.6.3 GPIPortCurrentState Parameter	
181	12.2.6.4 EventsAndReports Parameter	75
182	13 REPORTS, NOTIFICATIONS AND KEEPALIVES	76
183	13.1 Messages	76
184	13.1.1 GET REPORT	
185	13.1.2 RO ACCESS REPORT	
186	13.1.3 KEEPALIVE	
187		
	13.1.4 KEEPALIVE_ACK	
188	13.1.5 READER_EVENT_NOTIFICATION	
189	13.1.6 ENABLE_EVENTS_AND_REPORTS	
190	13.2 PARAMETERS	
191	13.2.1 ROReportSpec Parameter	
192	13.2.1.1 TagReportContentSelector Parameter	
193	13.2.2 AccessReportSpec Parameter	
194	13.2.3 TagReportData Parameter	
195	13.2.3.1 Accumulation of TagReportData	
196	13.2.3.2 EPCData Parameter	
197 198	13.2.3.3 ROSpecID Parameter	
199	- r	
200	13.2.3.5 InventoryParameterSpecID Parameter	
200 201	13.2.3.7 PeakRSSI Parameter	
202	13.2.3.8 ChannelIndex Parameter	
202 203	13.2.3.9 FirstSeenTimestampUTC Parameter	
204	13.2.3.10 FirstSeenTimestampUptime Parameter	
204 205 206	13.2.3.11 LastSeenTimestampUTC Parameter	
206	13.2.3.12 LastSeenTimestampUptime Parameter	
207	13.2.3.13 TagSeenCount Parameter	84
208	13.2.3.14 ClientRequestOpSpecResult Parameter	85
209	13.2.3.15 AccessSpecID Parameter	
210 211	13.2.4 RFSurveyReportData Parameter	
211	13.2.4.1 FrequencyRSSILevelEntry Parameter	
212 213	13.2.5 ReaderEventNotificationSpec Parameter	
213	13.2.5.1 EventNotificationState Parameter	
214 215	13.2.6 ReaderEventNotificationData Parameter	
215	13.2.6.1 Requirements for Ordering of Event Reporting	87

216	13.2.6.2 HoppingEvent Parameter	88
2 17	13.2.6.3 GPIEvent Parameter	88
218	13.2.6.4 ROSpecEvent Parameter	89
219	13.2.6.5 ReportBufferLevelWarningEvent Parameter	
220	13.2.6.6 ReportBufferOverflowErrorEvent Parameter	
221	13.2.6.7 ReaderExceptionEvent Parameter	
222	13.2.6.7.1 OpSpecID Parameter	
223	13.2.6.8 RFSurveyEvent Parameter	
224	13.2.6.9 AISpecEvent Parameter	
225	13.2.6.10 AntennaEvent Parameter	
226	13.2.6.11 ConnectionAttemptEvent Parameter	
227	13.2.6.12 ConnectionCloseEvent Parameter	92
228	14 ERRORS	92
_		
229	14.1 Messages	
230	14.1.1 ERROR_MESSAGE	
231	14.2 Parameters	
232	14.2.1 LLRP Status Codes	93
233	14.2.2 LLRPStatus Parameter	95
234	14.2.2.1 FieldError Parameter	96
235	14.2.2.2 ParameterError Parameter	96
236	15 AIR PROTOCOL SPECIFIC PARAMETERS	97
237	15.1 LLRP AIR PROTOCOL CROSS-REFERENCE TABLES	
238	15.1.1 Class-1 Generation-2 (C1G2) Air Protocol	
239	15.2 LLRP AIR PROTOCOL SPECIFIC PARAMETERS	
240	15.2.1 Class-1 Generation-2 (C1G2) Air Protocol	
241	15.2.1.1 Reader Device Capabilities	
242	15.2.1.1.1 C1G2LLRPCapabilities Parameter	
243	15.2.1.1.2 UHFC1G2RFModeTable Parameter	
244	15.2.1.1.2.1 UHFC1G2RFModeTableEntry Parameter	
245	15.2.1.2 Inventory Operation	
246	15.2.1.2.1 C1G2InventoryCommand Parameter	
247	15.2.1.2.1.1 C1G2Filter Parameter	
248	15.2.1.2.1.1.1 C1G2TagInventoryMask Parameter	102
249	15.2.1.2.1.1.2 C1G2TagInventoryStateAwareFilterAction Parameter	
250 251	15.2.1.2.1.1.3 C1G2TagInventoryStateUnawareFilterAction Parameter	
	15.2.1.2.1.2 C1G2RF Control Parameter	
252 253	15.2.1.2.1.3 C1G2SingulationControl Parameter	104
253 254	15.2.1.2.1.3.1 C1G2TagInventoryStateAwareSingulationAction Parameter	
254 255	15.2.1.3 Access Operation	
256 256	15.2.1.3.1 C1G2TagSpec Parameter	
250 257	15.2.1.3.1.1 C1G2TargetTag Parameter	
258	15.2.1.3.2.1 C1G2 Opspec Farameters	
259 259	15.2.1.3.2.1 C1G2Read Parameter	
260	15.2.1.3.2.2 C1G2white Farameter	
260 261	15.2.1.3.2.4 C1G2Lock Parameter	
262	15.2.1.3.2.4.1 C1G2LockPayload Parameter	
263	15.2.1.3.2.5 C1G2BlockErase Parameter	
264	15.2.1.3.2.6 C1G2BlockWrite Parameter	
265 265	15.2.1.4 Reader Device Configuration.	
2 66	15.2.1.5 Reports	
2 67	15.2.1.5.1 C1G2EPCMemorySelector Parameter	
2 68	15.2.1.5.2 C1G2PC Parameter	
269	15.2.1.5.3 C1G2CRC Parameter	
270	15.2.1.5.4 C1G2SingulationDetails Parameter	
270 271	15.2.1.5.5 C1G2 OpSpec Results	
272	15.2.1.5.5.1 C1G2ReadOpSpecResult Parameter	
273	15.2.1.5.5.2 C1G2WriteOpSpecResult Parameter	
274	15.2.1.5.5.3 C1G2KillOpSpecResult Parameter	

275 276	15.2.1.5.5.4 15.2.1.5.5.5	1 1	
277	15.2.1.5.5.6	* *	
278	16 BINARY ENCOD	ING FOR LLRP	114
279	16.1 Messages		115
280		PEADER CAPABILITIES	
281		PEADER_CAPABILITIES_RESPONSE	
282		ROSPEC	
283	16.1.4 ADD F	ROSPEC RESPONSE	118
284		TE ROSPEC	
285		TE ROSPEC RESPONSE	
286		ROSPEC	
287	16.1.8 START	ROSPEC RESPONSE	119
288		ROSPEC	
289		ROSPEC_RESPONSE	
290		E ROSPEC	
291		LE ROSPEC RESPONSE	
292		LE ROSPEC	
293		LE ROSPEC RESPONSE	
294		OSPECS	
295		OSPECS RESPONSE	
296	16.1.17 ADD A	ACCESSSPEC	121
297		ACCESSSPEC RESPONSE	
298		TE ACCESSSPEC	
299		TE_ACCESSSPEC_RESPONSE	
300		LE ACCESSSPEC	
301		LE ACCESSSPEC RESPONSE	
302		LE ACCESSSPEC	
303		LE ACCESSSPEC RESPONSE	
304		CCESSSPECS	
305		CCESSSPECS RESPONSE	
306		T REQUEST OP	
307		T_REQUEST_OP_RESPONSE	
308		PEPORT	
309		CCESS REPORT	
310		1LIVE	
311	16.1.32 KEEPA	ALIVE ACK	125
312		ER EVENT NOTIFICATION	
313		LE EVENTS AND REPORTS	
314	16.1.35 ERROF	R MESSAGE	126
315		EADER CONFIG	
316	16.1.37 GET R	READER CONFIG RESPONSE	127
317		EADER CONFIG	
318	16.1.39 SET R	EADER CONFIG RESPONSE	128
319		CONNECTION	
320		CONNECTION RESPONSE	
321		 DM_MESSAGE	
322		METERS	
323	16.2.1 TLV an	d TV Encoding of LLRP Parameter	129
324	16.2.1.1 TLV	-Parameters	129
324 325 326		ncoding Guidelines for TLV-Parameters	
<i>3</i> 26		Parameters	
327		ncoding Guidelines for TV-Parameters	
328 329		ll Parameters	
329 330		Timestamp Parameterme Parameter	
JJU	10.2.2.2 UDIII	HIC 1 414HICLE	131

331	16.2.3 Reader Device Capabilities Parameters	131
332	16.2.3.1 GeneralDeviceCapabilities Parameter	
333	16.2.3.1.1 ReceiveSensitivityTableEntry Parameter	
334 335	16.2.3.1.2 PerAntennaReceiveSensitivityRange Parameter	
335	16.2.3.1.3 PerAntennaAirProtocol Parameter	
336	16.2.3.1.4 GPIOCapabilities Parameter	
337	16.2.3.2 LLRPCapabilities Parameter	
338	16.2.3.3 AirProtocolLLRPCapabilities Parameter	
339	16.2.3.4 RegulatoryCapabilities Parameter	
340	16.2.3.4.1 UHFBandCapabilities Parameter	
341	16.2.3.4.1.1 TransmitPowerLevelTableEntry Parameter	
342	16.2.3.4.1.2 FrequencyInformation Parameter	
343	16.2.3.4.1.2.1 FrequencyHopTable Parameter	
344	16.2.3.4.1.2.2 FixedFrequencyTable Parameter	
345	16.2.4 Reader Operations Parameters	
346	16.2.4.1 ROSpec Parameter	
347	16.2.4.1.1 ROBoundarySpec Parameter	
348		
349	16.2.4.1.1.1 ROSpecStartTrigger Parameter	
350		
350 351	16.2.4.1.1.1.2 GPITriggerValue Parameter	
351 352	16.2.4.1.1.2 ROSpecStopTrigger Parameter	
352 353	16.2.4.2 AISpec Parameter	
))))[/	16.2.4.2.1 AISpecStopTrigger Parameter	
354	16.2.4.2.1.1 TagObservationTrigger Parameter	
355	16.2.4.2.2 InventoryParameterSpec Parameter	
356	16.2.4.3 RFSurveySpec Parameter	
357	16.2.4.3.1 RFSurveySpecStopTrigger Parameter	
358	16.2.5 Access Operation Parameters	
359	16.2.5.1 AccessSpec Parameter	
360	16.2.5.1.1 AccessSpecStopTrigger Parameter	
361	16.2.5.1.2 AccessCommand Parameter	
362	16.2.5.1.3 ClientRequestOpSpec Parameter	
363	16.2.5.1.3.1 ClientRequestResponse Parameter	139
364	16.2.6 Configuration Parameters	140
365	16.2.6.1 LLRPConfigurationStateValue Parameter	
366	16.2.6.2 Identification Parameter	
367	16.2.6.3 GPOWriteData Parameter	
368	16.2.6.4 KeepaliveSpec Parameter	
369	16.2.6.5 AntennaProperties Parameter	
370	16.2.6.6 AntennaConfiguration Parameter	
371	16.2.6.7 RFReceiver Parameter	
372	16.2.6.8 RFTransmitter Parameter	
$37\overline{3}$	16.2.6.9 GPIPortCurrentState Parameter	
374	16.2.6.10 EventsAndReports Parameter	
375	16.2.7 Reporting Parameters	
376	16.2.7.1 ROReportSpec Parameter	
377	16.2.7.1.1 TagReportContentSelector Parameter	
378		
379	1 1	
380	\mathcal{E}_{-1}	
381		
201		
004 192	16.2.7.3.3 ROSpecID Parameter (TV-Encoding)	
20 <i>1</i>	16.2.7.3.4 SpecIndex Parameter (TV-Encoding)	
382 383 384 385	16.2.7.3.5 InventoryParameterSpecID Parameter (TV-Encoding)	
202 206	16.2.7.3.6 AntennalD Parameter (TV-Encoding)	
386 387 388	16.2.7.3.7 PeakRSSI Parameter (TV-Encoding)	
)	16.2.7.3.8 ChannelIndex Parameter (TV-Encoding)	
388	16.2.7.3.9 FirstSeenTimestampUTC Parameter (TV-Encoding)	
389	16.2.7.3.10 FirstSeenTimestampUptime Parameter (TV-Encoding)	
390	16.2.7.3.11 LastSeenTimestampUTC Parameter (TV-Encoding)	
391	16.2.7.3.12 LastSeenTimestampUptime Parameter (TV-Encoding)	
392	16.2.7.3.13 TagSeenCount Parameter (TV-Encoding)	146

393	16.2.7.3.14 ClientRequestOpSpecResult Parameter (TV-Encoding)	
394	16.2.7.3.15 AccessSpecID Parameter (TV-Encoding)	
395	16.2.7.4 RFSurveyReportData Parameter	
396	16.2.7.4.1 FrequencyRSSILevelEntry Parameter	
397	16.2.7.5 ReaderEventNotificationSpec Parameter	
398	16.2.7.5.1 EventNotificationState Parameter	
399	16.2.7.6 ReaderEventNotificationData Parameter	
400	16.2.7.6.1 HoppingEvent Parameter	
401	16.2.7.6.2 GPIEvent Parameter	
402	16.2.7.6.3 ROSpecEvent Parameter	
403	16.2.7.6.4 ReportBufferLevelWarningEvent Parameter	
404	16.2.7.6.5 ReportBufferOverflowErrorEvent Parameter	
405	16.2.7.6.6 ReaderExceptionEvent Parameter	
406	16.2.7.6.6.1 OpSpecID Parameter (TV-Encoding)	
407	16.2.7.6.7 RFSurveyEvent Parameter	150
408	16.2.7.6.8 AISpecEvent Parameter	150
409	16.2.7.6.9 AntennaEvent Parameter	150
410	16.2.7.6.10 ConnectionAttemptEvent Parameter	151
411	16.2.7.6.11 ConnectionCloseEvent Parameter	151
412	16.2.8 LLRP Error Parameters	151
413	16.2.8.1 LLRPStatus Parameter	
414	16.2.8.1.1 FieldError Parameter	
415	16.2.8.1.2 ParameterError Parameter	
416	16.2.9 Custom Parameter	
417	16.3 AIR PROTOCOL SPECIFIC PARAMETERS.	
418	16.3.1 Class-1 Generation-2 (C1G2) Protocol Parameters	
419	16.3.1.1 Capabilities Parameters	
420	16.3.1.1.1 C1G2LLRPCapabilities Parameter	
421	16.3.1.1.2 UHFC1G2RFModeTable Parameter	
422	16.3.1.1.2.1 UHFC1G2RFModeTableEntry Parameter	
423	16.3.1.2 Reader Operations Parameters	
424	16.3.1.2.1 C1G2InventoryCommand Parameter	
425	16.3.1.2.1.1 C1G2Filter Parameter	
426	16.3.1.2.1.1.1 C1G2TagInventoryMask Parameter	
427	16.3.1.2.1.1.2 C1G2TagInventoryStateAwareFilterAction Parameter	
428	16.3.1.2.1.1.3 C1G2TagInventoryStateUnawareFilterAction Parameter	
429	16.3.1.2.1.2 C1G2RFControl Parameter	155
430	16.3.1.2.1.3 C1G2SingulationControl Parameter	
431	16.3.1.2.1.3.1 C1G2TagInventoryStateAwareSingulationAction Parameter	
432	16.3.1.3 Access Operation Parameters	156
433	16.3.1.3.1 C1G2TagSpec Parameter	156
434	16.3.1.3.1.1 C1G2TargetTag Parameter	156
435	16.3.1.3.2 C1G2 OpSpecs	156
436	16.3.1.3.2.1 C1G2Read Parameter	
437	16.3.1.3.2.2 C1G2Write Parameter	157
438	16.3.1.3.2.3 C1G2Kill Parameter	
439	16.3.1.3.2.4 C1G2Lock Parameter	
440	16.3.1.3.2.4.1 C1G2LockPayload Parameter	
441	16.3.1.3.2.5 C1G2BlockErase Parameter	
442	16.3.1.3.2.6 C1G2BlockWrite Parameter	
443	16.3.1.4 Configuration Parameters.	
444	16.3.1.5 Reporting Parameters	
445	16.3.1.5.1 C1G2EPCMemorySelector Parameter	
446	16.3.1.5.2 C1G2PC Parameter (TV-Encoding)	
447	16.3.1.5.3 C1G2CRC Parameter (TV-Encoding)	
448	16.3.1.5.4 C1G2CRC Farameter (TV-Encoding)	
449	- · · · · · · · · · · · · · · · · · · ·	
450	16.3.1.5.5 C1G2 OpSpec Results	
451	* *	
452	1 1	
453	16.3.1.5.5.3 C1G2KillOpSpecResult Parameter	
453 454	16.3.1.5.5.4 C1G2LockOpSpecResult Parameter.	
† <i>J'</i> †	16.3.1.5.5.5 C1G2BlockEraseOpSpecResult Parameter	160

173 174 174
174
179
1/2
175
177
178
180
181
182
183
186
186
187

Index of Figures

482	FIGURE 1: LLRP IN THE EPCGLOBAL ARCHITECTURE	19
483	FIGURE 2: LLRP ENDPOINTS	22
484	FIGURE 3: TYPICAL LLRP TIMELINE.	23
485	FIGURE 4: ROSPEC STATECHART	25
486	FIGURE 5: ANTENNA INVENTORY SPEC STATES	26
487	FIGURE 6: ACCESS OPERATIONS INTERLEAVED IN AN ANTENNA INVENTORY OPERATION	27
488	FIGURE 7: CLIENT REQUEST OPSPEC	28
489	FIGURE 8: ACCESS SPEC STATES	
490	FIGURE 9: RFSURVEYSPEC STATES	30
491	FIGURE 10: BOX FORMATS FOR MESSAGES AND PARAMETERS	35
492	FIGURE 11: LLRP MESSAGES AND READER ACTIONS	41
493	Figure 12: Network Order	114
494	FIGURE 13: BIT ORDER IN FIELDS	114
495	FIGURE 14: READER INITIATED CONNECTION (NORMAL)	167
496	FIGURE 15: READER INITIATED CONNECTION (EXCEPTION)	168
497	FIGURE 16: CLIENT INITIATED CONNECTION (NORMAL)	168
498	FIGURE 17: CLIENT INITIATED CONNECTION (EXCEPTION #1)	169
499	FIGURE 18: CLIENT INITIATED CONNECTION (EXCEPTION #2)	169
500	FIGURE 19: CLIENT INITIATED CONNECTION (EXCEPTION #3)	170
501	FIGURE 20: CLIENT INITIATED CONNECTION (EXCEPTION #4)	170
502	FIGURE 21: CLIENT INITIATED CONNECTION (EXCEPTION #5)	171
503	FIGURE 22: READER INITIATED CLOSE	171
504	FIGURE 23: CLIENT INITIATED CLOSE (NORMAL)	172
505	FIGURE 24: CLIENT INITIATED CLOSE (EXCEPTION)	172
506	FIGURE 25: CAPABILITIES	177
507	Figure 26: Configuration	178
508	FIGURE 27: CONFIGURATION COMMANDS	179
509	FIGURE 28: RO COMMANDS	180
510	FIGURE 29: ROSPEC	180
511	FIGURE 30: ACCESS COMMANDS.	
512	FIGURE 31: ACCESSSPEC	181
513	Figure 32: C1G2 Parameters	
514	FIGURE 33: C1G2 INVENTORY COMMAND	
515	FIGURE 34: C1G2 ACCESSSPEC	
516	FIGURE 35: REPORTING AND NOTIFICATION	
517	FIGURE 36: TAGREPORTDATA	
518	FIGURE 37: RFSURVEYREPORTDATA	
519	FIGURE 38: READER EVENT NOTIFICATION DATA	185
520	FIGURE 39: GENERAL DATA	186
521		

522 Index of Tables

523	Table 1: Operation Triggers	32
524	TABLE 2: REPORTING TRIGGERS	34
525	TABLE 3: AIR PROTOCOL ENUMERATIONS USED IN LLRP	38
	TABLE 4: MESSAGE LISTING	
527	TABLE 5: PARAMETER LISTING	162
528		

1 (Informative) Glossary

529

This section provides a non-normative summary of terms used within this specification.

Term	Meaning
Access	The operation of communicating with (reading from and/or writing to) a Tag. An individual Tag must be uniquely identified prior to access. Access comprises multiple commands, some of which employ one-time-pad based covercoding of the R=>T link.
Air Interface	The complete communication link between a Reader and a Tag including the physical layer, collision arbitration algorithm, command and response structure, and data-coding methodology.
Antenna	An atomic, specifically-addressable RF transmission and/or reception device used for communication with RFID tags. For the purposes of this spec, multiplicity of antenna is going to be referred to as antennas.
Capabilities	The set of intrinsic Reader properties relevant to protocol operation. This may include physical, functional, or protocol support information.
Compatibility	A general term used to describe a consistency of terminology and/or operation between one or more specifications and/or implementations. It is specifically not intended to be used to define expectations on protocol operation. The proper term for this is 'Interoperability' as defined below.
Configuration	Data and parameters to control specific operation of a Reader or the Client that is typically instantiated at boot time or as a result of specific management actions on a timescale much greater than the operations of LLRP. It is possible that certain parameters may be controlled via LLRP and have corresponding default configuration parameters.
Client	From the perspective of LLRP, a <i>Client</i> is synonymous with <i>Controller</i> (see below). The specification uses the term Client to identify the endpoint opposite to the Reader.
Controller	The function that implements the Reader Protocol (Interface) opposite the Reader (i.e., an LLRP endpoint). In the EPCGlobal Architecture, this function could comprise part of the Filtering & Collection (Role), but it may be implemented in a wide range of devices, including dedicated RFID infrastructure, Readers, and middleware running on server hardware.

Term	Meaning
GPI	General purpose input
GPO	General purpose output
Interference	There are two types of interference that impact a RFID system's operating capacity: Reader-to-tag, and Reader-to-Reader. Reader-to-tag interference happens when a tag receives signals of comparable strengths from more than one Reader at the same time. This causes the tag to respond arbitrarily to the Readers, and makes its state unpredictable. Reader-to-Reader interference happens when a Reader in the midst of listening to a tag's reply at a particular frequency, receives signals much stronger than the tag's reply, from another Reader operating at the same frequency at the same time. This causes the Reader's receiver logic to not be able to correctly decode the tag's reply. Both these interference scenarios can potentially degrade the system performance.
Interoperability	The ability for two implementations of protocol endpoints to properly function with each other. Proper function may require negotiation of supported capabilities between the two endpoints.
Interrogator	Synonymous with Reader. The EPCglobal Class-1 Gen-2 air protocol specification refers to Readers as Interrogators. However, since the term Reader is included in the title of this specification <i>Low Level Reader Protocol</i> , the term Reader is used instead of Interrogator.
Inventory	The operation of identifying Tags. A Reader begins an inventory round by transmitting a Query command (Query starts the round) in one of four sessions. One or more Tags may reply. The Reader detects a single Tag reply and requests the PC, EPC, and CRC-16 from the Tag. Inventory comprises multiple commands. An inventory round operates in one and only one session (defined below) at a time.
LLRP	Low Level Reader Protocol
LLRP connection	Instance of LLRP between the Reader and the Client.
LLRP endpoint	The endpoints of a LLRP instance (i.e., either a Reader or a Client).

Term	Meaning
Q	A parameter that a Reader uses to regulate the probability of Tag response. A Reader commands Tags in an inventory round to load a Q-bit random (or pseudo-random) number into their slot counter; the Reader may also command Tags to decrement their slot counter. Tags reply when the value in their slot counter is zero. Q is an integer in the range $(0,15)$; the corresponding Tag-response probabilities range from $20 = 1$ to $2-15 = 0.000031$.
Q algorithm	A collision-arbitration algorithm where Tags load a random (or pseudo-random) number into a slot counter, decrement this slot counter based on Reader commands, and reply to the Reader when their slot counter reaches zero.
Reader	The function that implements the RFID Reader (Role) in the EPCGlobal Architecture Specification. It is one of the two endpoints of the Reader Protocol (Interface) which is, for the purposes of this specification, LLRP. The Reader comprises of one or more antennas which are used to communicate with RFID tags. Note that a Reader can not only read RFID tags, it can perform other operations on tags such as write and kill.
Receive Sensitivity	Receiver sensitivity is a measure of the weakest tag signal an RFID reader is able to detect and demodulate. Changing this affects the minimum detectable signal (MDS) so as to prevent weaker responses from tying up the receiver. The other commonly used term for such a control is squelch.
Select	The operation of choosing a tag population for inventory and access. A Select command may be applied successively to select a particular Tag population based on user-specified criteria. This operation is analogous to selecting records from a database.
Session	An inventory process comprising a Reader and an associated Tag population. A Reader chooses one of four sessions and inventories Tags within that session. The Reader and associated Tag population operate in one and only one session for the duration of an inventory round. For each session, Tags maintain a corresponding inventoried flag. Sessions allow Tags to keep track of their inventoried status separately for each of four possible time-interleaved inventory processes, using an independent inventoried flag for each process.
Singulation	Identifying an individual Tag in a multiple-Tag environment.
Spec	The document uses the term 'Spec' to denote the parameter specification for an operation.

Term	Meaning
UTC	Coordinated Universal Time (UTC) is the international time standard as maintained by the Bureau International des Poids et Mesures (BIPM).

2 Introduction

531

540

541

542

- This document specifies an interface between RFID Readers and Clients. The design of
- 533 this interface recognizes that in some RFID systems, there is a requirement for explicit
- knowledge of RFID air protocols and the ability to control Readers that implement RFID
- air protocol communications. It also recognizes that coupling control to the physical
- layers of an RFID infrastructure may be useful for the purpose of mitigating RFID
- 537 interference. The interface described herein, and the functionality it implies, is called
- "Low Level Reader Protocol," or LLRP.
- Following are the responsibilities of this interface:
 - Provide means to command an RFID Reader to inventory tags (read the EPC codes carried on tags), read tags (read other data on the tags apart from the EPC code), write tags, and execute other protocol-dependent access commands (such as 'kill' and 'lock' from EPCglobal Class 1 Generation 2).
- Provide means for robust status reporting and error handling during tag access operations.
- Provide means for conveying tag passwords necessary to effect commands that may require them, such as the 'Kill' command in the EPCglobal Class 1 Generation 2 UHF Air Interface Protocol.
- Provide means to control the forward and reverse RF link operation to manage RF power levels and spectrum utilization, and assess RF interference, among RFID Readers in a system.
- Provide means to control aspects of Tag Protocol operation, including protocol parameters and singulation parameters.
- Provide means to facilitate the addition of support for new air protocols.
- Provide means for the retrieval of Reader device capabilities.
- Provide means for vendors of Reader devices to define vendor-specific extensions to the protocol in a manner that is non-interfering among vendors, and which, to the extent possible, is vendor-administered.
- In addition LLRP is "regulatory requirements-aware," such that its functions are applicable in regulatory jurisdictions worldwide.

The overall organization of this specification is as follows: - General Overview (sections 3-6); Abstract Model (sections 7-15, 17), which describes the protocol, its message types and contents without specifying the protocol syntax; Binary Encoding (section 16), which specifies the syntax for representing the abstract protocol; Tranport Binding (section 18), which specifies the mechanism for delivery of protocol messages; Informative Descriptions (sections 19-21). Guidelines for adding support of a new air protocol to LLRP are presented in section 15.1.

3 Role within the EPCglobal Network Architecture

The RFID infrastructure consists of network elements that participate in the management (e.g., read/write/lock) and transmission of tag data. The consumers of the tag data are the Client network elements (e.g., end-user applications). The network elements between the tag and the Clients form the conduit to transport tag data over the network to the applications, and convey tag operational commands over the network to the tags. The EPCGlobal Architecture (ARC) framework has outlined the roles and the associated functions performed by the various elements in this network. The elements relevant to the LLRP specification are the Tags, Readers and F&C Role.

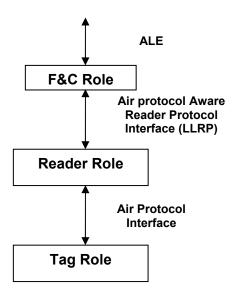


Figure 1: LLRP in the EPCGlobal Architecture

568569

570

571

572

573

574

575576

- Figure 1 illustrates the position of LLRP in the EPCGlobal architecture stack between the F&C role and the Tag role.
- The responsibilities of the elements and interfaces below the F&C role can be classified into three broad functional groups: tag data processing (*Data path*), Reader device management (*Management path*) and Reader control and coordination (*Control path*).
- With the advent of sophisticated air protocols like UHF Class-1 Gen-2, and deployments of larger numbers of Readers, the need for Reader control and coordination (*Control path*) of the network of Readers in the architecture becomes important. The LLRP interface facilitates the control path function by exposing air protocol relevant control

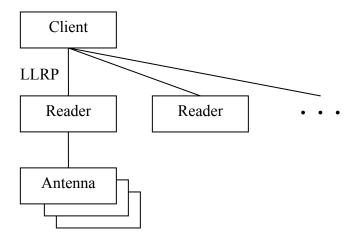
- knobs to the F&C role. To that effect, LLRP is designed to be extensible in terms of supporting multiple air protocols.
- The physical and logical requirements for the communication between the Reader and the tag are defined by the air protocol. Specifically, the air protocol defines the signaling
- layer of the communication link, the Reader and tag operating procedures and commands,
- and the collision arbitration (also known as singulation) scheme to identify a specific tag
- 593 in a multiple-tag environment. One such air protocol is the EPCGlobal Class-1
- 594 Generation 2 (C1G2) protocol. The tag memory in the C1G2 protocol is logically
- separated into four distinct banks: reserved memory, EPC memory, TID memory and
- user memory. The physical memory map of the tag is vendor-specific. The air protocol
- 597 commands that access memory have a parameter that selects the bank, and an address
- 598 parameter to select a particular memory location within that bank.
- The fundamental operations a Reader performs on a tag population are inventory and access. Inventory is the operation of identifying tags, and comprises multiple air protocol
- 601 commands. Using the singulation scheme, the Reader detects a single tag reply and
- 602 requests the EPC memory contents from the tag. Access is the operation of
- 603 communicating with (reading from and/or writing to) a tag. An individual tag must be
- 604 uniquely identified prior to access. Similar to the inventory operation, access comprises
- 605 multiple air protocol commands. In addition, a Reader can choose a subset of the tag
- 606 population for inventory and access. This operation is called Select in the C1G2 protocol.
- The select operation is used to select and/or de-select a particular tag population for the
- subsequent inventory and/or access operation. This helps focus the operations on the
- desired subset of tags, and also thins the tag population participating in the singulation
- operation, thereby improving the overall singulation rate.
- It is anticipated that overall system performance may be optimized by tuning the RF,
- singulation and air protocol parameters within and across Readers. The performance can
- be further optimized if the tuning is done cognizant of the RF environment in the vicinity
- of the Reader.
- The LLRP interface between the Client and the Reader facilitates the management of
- Reader devices to mitigate Reader-to-tag and Reader-to-Reader interference and
- maximize the efficiency of singulation and data operations over the tag population. This
- 618 is achieved by enabling the Reader device operation at the full performance level of the
- air protocol. In addition, LLRP provides the interface to transport the results of RF
- monitoring (a.k.a RF survey) if the Reader device is capable of performing that function.
- In addition, there will be a number of applications that perform operations on the RFID
- tag data. Operations may range from reading EPC IDs to performing other tag access
- operations exposed by the air protocol like read, write, kill, lock, etc. Multiple application
- 624 requirements translate into a set of access operations that a Reader or a set of Readers
- perform on tags as and when they are in the field of view. The LLRP interface provides a
- scalable mechanism to manage the access operations at the Reader devices.
- 627 Lastly, scalable device management capabilities are critical for operations of a large
- 628 network of Reader devices. The LLRP interface facilitates device status and error
- reporting, and device capabilities discovery.

4 Terminology and Typographical Conventions

- Within this specification, the terms SHALL, SHALL NOT, SHOULD, SHOULD NOT,
- MAY, NEED NOT, CAN, and CANNOT are to be interpreted as specified in Annex G of
- the ISO/IEC Directives, Part 2, 2001, 4th edition [ISODir2]. When used in this way,
- 634 these terms will always be shown in ALL CAPS; when these words appear in ordinary
- 635 typeface they are intended to have their ordinary English meaning. However in this
- document only a subset of the terms listed above SHALL be used. The subset of
- acceptable terms includes the following: SHALL, SHALL NOT and MAY. The terms
- 638 SHOULD, SHOULD NOT, NEED NOT, CAN, and CANNOT, SHALL NOT be used.
- All sections of this document, with the exception of section 1-3, 19-21, are normative,
- except where explicitly noted as non-normative. All figures within the document are non-
- normative unless otherwise specified.
- The following typographical conventions are used throughout the document:
- 643 ALL CAPS type is used for the special terms from [ISODir2] enumerated above.
- 644 ALL_CAPS_UNDERSCORE type is used for LLRP message names.
- CamelBackType is used for LLRP parameter and data field names.
- Monospace type is used to denote programming language, UML, and XML identifiers,
- as well as for the text of XML documents.

5 Overview of LLRP

- 649 LLRP is specifically concerned with providing the formats and procedures of
- 650 communications between a Client and a Reader. The LLRP protocol data units are called
- 651 messages. Messages from the Client to the Reader include getting and setting
- configuration of Readers, capabilities discovery of Readers and managing the inventory
- and access operations at the Readers. Messages from the Reader to the Client include the
- reporting of Reader status, RF survey, and inventory and access results.
- 655 LLRP is an application layer protocol and does not provide retransmission, or reordering
- 656 facilities. State consistency between the Client and the Reader is critical for the correct
- 657 functioning of the system. Using LLRP messages, the Client updates the Reader state
- which includes Reader configuration parameters, dynamically created data structures
- 659 (e.g., ROSpecs, AccessSpecs, etc), and possibly vendor defined data. For this reason,
- 660 LLRP requires acknowledgements for the Client to Reader transactions this provides a
- fail-safe mechanism at the LLRP layer to cope with network error situations. Also, to
- cope with intermittent connections, a Client can request a Reader's configuration state to
- confirm that a Reader's state is consistent with the Client after the Client reconnects (see
- 664 LLRPConfigurationStateValue in section 12.2.1). The Reader to Client messages are
- primarily reports, status notifications or keepalives. Only the keepalives are
- primarily reports, status notifications of keepanves. Only the keepa
- acknowledged by the Client.



670

671

672

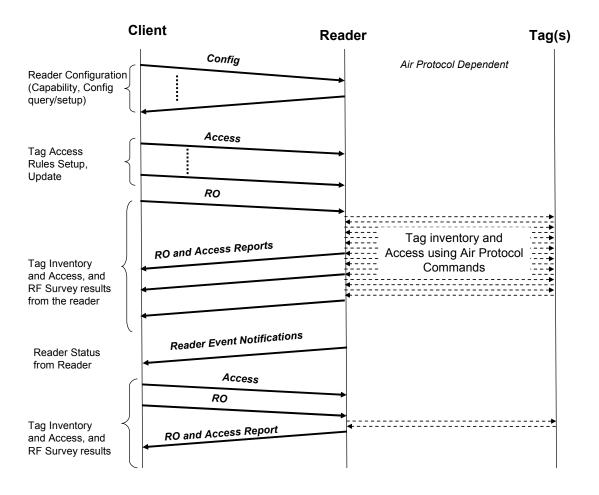
673

Figure 2: LLRP Endpoints

As shown in Figure 2, from LLRP's perspective, a Reader contains a collection of one or more antennas. Moreover, Readers as used in this specification may not necessarily be in one-to-one correspondence with hardware devices.

5.1 Typical LLRP Timeline

- 674 LLRP operation consists of the following phases of execution:
- Capability discovery
- Device configuration
- [optional] Inventory and access operations setup
- Inventory cycles executed
- If tag conditions matched, access operations will be executed during inventory cycle execution. Access operations include reading, writing, and locking tag memory, killing tags, etc.
- RF Survey operations executed
- Reports returned to the Client
- A typical timeline of both LLRP and air protocol interactions between a Client, a Reader and a population of tags is depicted in Figure 3.



690 691

692

693 694

695

698

Figure 3: Typical LLRP Timeline

6 LLRP Operation

- LLRP uses protocol data units called messages (See section 7.1.2 for details) to communicate between the Client and the Reader. Using LLRP, the Client updates or retrieves configuration of the Reader; by doing so, it controls the Reader's operation. This section provides an overview of the abstract model of the LLRP interface, and the data structures used in LLRP to and from the Reader.
- Section 19 presents an informative description of the LLRP object model based upon UML notation.

6.1 Inventory, RF Survey and Access Operations

- 699 LLRP is based upon an abstraction of RFID air protocols and their respective commands.
- There are two principal concepts to the LLRP abstraction of RF operations by a Reader:
- 1) Reader Operations, and 2) Access operations. The remainder of this section provides a
- detailed description of these LLRP concepts.

- Reader Operations (RO) define the parameters for operations such as Antenna Inventory
- and RF Survey. Access Operations define the parameters for performing data access
- operations to and from a tag.
- 706 The timing control of an operation is specified using boundary specification, which
- specifies how the beginning (using start trigger) and the end (using stop trigger) of the
- operation is to be determined.
- An antenna inventory (AI) is the smallest unit of interaction between a Reader and tags in
- 710 the antenna's *field-of-view (FOV)*. An *InventoryParameterSpec* defines the parameters to
- be used during the inventory operation including protocol, protocol-specific parameters,
- and RF parameters. During an AI, the tags in the FOV of the antennas are singulated
- using air protocol commands based on the contents of the *InventoryParameterSpec*. An
- 714 AISpec binds a stop trigger and a set of antennas to a set of InventoryParameterSpecs,
- and is identified by a one based index called the SpecIndex. The stop trigger defines the
- 716 termination condition of the aggregate AISpec operation comprising of N * M antenna
- 717 inventory operations, where N and M are the cardinality of the antenna set and
- 718 *InventoryParameterSpecs* set respectively. For example, if there is a single antenna and a
- single *InventoryParameterSpec* defined in an *AISpec*, the AI operation specified by the
- 720 <antenna, *InventoryParameterSpec>* tuple is bounded by the stop trigger specification.
- 721 It should be noted that the stop trigger specification of each individual AI is not specified,
- which means the Reader is not limited to execute the AIs in the order in which they
- appear in an AISpec. The timing control and the sequencing of the individual AIs within
- an AISpec will be determined by the Reader.
- 725 RF Survey is an operation during which the Reader performs a scan and measures the
- 726 power levels across a set of frequencies at an antenna. The RF survey operational
- 727 parameters are described in a RFSurveySpec and it defines the survey operation at a
- single antenna. It comprises an identifier for the spec, an antenna identifier, stop trigger
- and set of parameters for the survey operation.
- 730 A Reader Operation (RO) describes the operations to be executed at one or more
- antennas of the Reader. A RO comprises at least one Spec, where a Spec is either an
- 732 AISpec or a RFSurveySpec. If a RO comprises multiple Specs, each Spec is an AISpec or
- a RFSurveySpec. Each RO's operational parameters are described in a ROSpec. The
- 734 ROSpec contains a spec identifier, the boundary specification for the entire RO operation,
- priority, a list of AISpecs and/or RFSurveySpecs, and optionally a reporting specification.
- 736 The reporting specification defines the contents of RO Report and the trigger conditions
- 737 when to send the inventory report and survey report. The order of AISpec and
- 738 RFSurveySpec execution within a ROSpec is the order in which they appear in the
- 739 *ROSpec*.
- 740 Figure 4 illustrates the statechart of a *ROSpec*. The *ROSpec* has three states: Disabled,
- 741 Inactive and Active. The Client configures a new ROSpec using an ADD ROSPEC
- 742 message for the ROSpec. The ROSpec starts at the Disabled state waiting for the
- 743 ENABLE ROSPEC message for the *ROSpec* from the Client, upon which it transitions
- 744 to the Inactive state. The ROSpec does not respond to start or stop triggers in the
- 745 Disabled state. The Client disables a *ROSpec* using a DISABLE ROSPEC message for
- 746 the *ROSpec*.

747 The *ROSpec* transitions from the Inactive state to the Active state when ROSpecStartCondition occurs for the *ROSpec*. The *ROSpec* transitions back to the inactive state when ROSpecDoneCondition happens.

ROSpecStartCondition = ROSpecStartTrigger or START_ROSPEC

ROSpecDoneCondition = AllSpecsDone or ROSpecStopTrigger or preempted or (STOP ROSPEC message for the ROSpec from the Client)

The *ROSpec* when undefined is no longer considered for execution. The Client undefines the *ROSpec* using a DELETE ROSPEC message for the *ROSpec*.

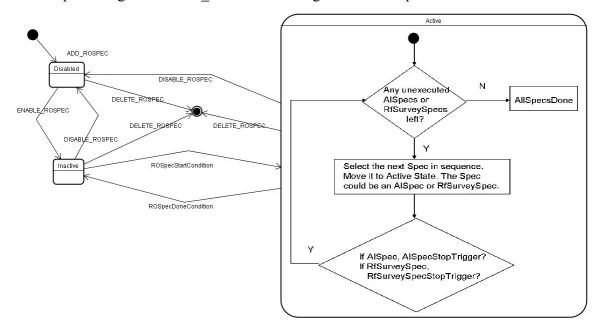


Figure 4: ROSpec Statechart

LLRP supports configuring multiple *ROSpecs*. Each *ROSpec* has a priority field. The default is for all the *ROSpecs* to have the same priority. Since the start trigger for the *ROSpec* can be an asynchronous event, there may be situations where a *ROSpec's* start trigger event occurs when the Reader is busy executing another *ROSpec*. The Client, when setting up a *ROSpec*, can set the appropriate priority so that a high priority *ROSpec* can preempt a currently active lower priority *ROSpec* and start execution as soon as the ROSpecStartCondition for the higher priority, inactive *ROSpec* occurs. The *ROSpec* that got preempted transitions to the Inactive state.

Figure 5 illustrates the *AISpec* statechart. When the parent *ROSpec* moves to the active state, each *AISpec* in the *ROSpec* starts at the inactive state. During an active *ROSpec's* execution, when an inactive *AISpec* is selected for execution, that *AISpec* moves to the active state. If there are multiple antennas and *InventoryParameterSpecs* in that *AISpec*, the Reader picks the next antenna, *InventoryParameterSpec>* to execute. In the figure,

the ID of the selected antenna is A, and the protocol for the selected InventoryParameterSpec is P. The Reader starts tag singulation for air protocol P on antenna A using the operational parameters specified in the *InventoryParameterSpec*. This involves one or more air protocol commands from the Reader via the antenna to the tags in the antenna's FOV. The tags get singulated and each tag's EPC information is received by the antenna. If further tag memory operations are to be performed, such as writing or reading other memory regions, it will be performed at this point. As illustrated in Figure 6, these access operations are interleaved with the execution of an AISpec. Access operations are described using AccessSpecs. AccessSpecs describe the tags (TagSpec) on which some operations are to be performed, the operations to be performed (OpSpec), the boundary specification, and optionally a reporting specification for the Access operation. The AccessSpec may contain antenna information at which this access operation needs to be executed and contains the air protocol to be used to perform the access operations. In addition, to accommodate scenarios where an access operation needs to be performed only during a particular ROSpec execution, the AccessSpec optionally contains the ROSpec information. There can be one or more AccessSpecs set up at the Reader.

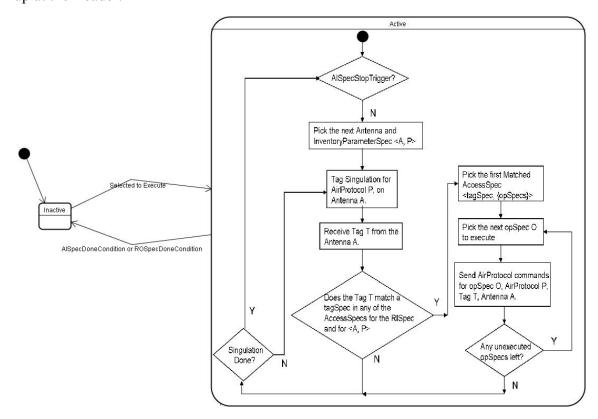


Figure 5: Antenna Inventory Spec States

768

769

770

771

772

773

774

775

776

777

778

779

780

781

782

783

784

785 786

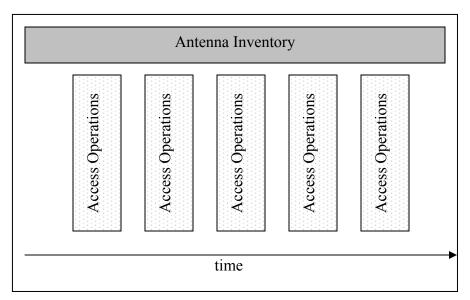


Figure 6: Access Operations Interleaved in an Antenna Inventory Operation

In Figure 5, when tags are received as a result of singulation, a check is performed to determine if the received tag matches the TagSpec defined in any of the Active (See statechart in Figure 8) AccessSpecs. In case there are multiple AccessSpecs that get matched during a tagSpec lookup, the Reader will execute the first AccessSpec that matches, where the ordering of the AccessSpecs is the order in which the AccessSpecs were created by the Client.

When an AccessSpec is executed, the set of operations as specified in OpSpecs of the *AccessSpec* are performed on the tag, which results in one or more air protocol commands and responses transacted between the Reader and the tag via antenna A over air protocol P. In order to support cases where the Reader needs to query the Client for further information to complete the operation on the tag, there is an OpSpec called the ClientRequestOpSpec.

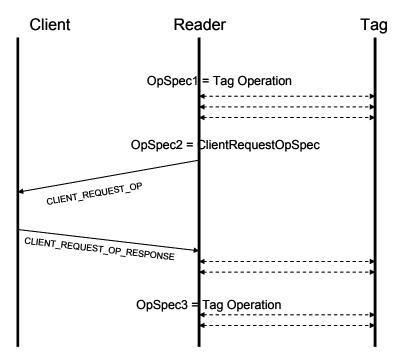


Figure 7: Client Request OpSpec

Figure 7 illustrates the message interaction between the Client, Reader and Tag for a ClientRequestOpSpec. For OpSpecs that are not ClientRequestOpSpec, the Reader performs the operations on the tag using the the air protocol commands. If an OpSpec is of the ClientRequestOpSpec, the Reader sends the result of the ongoing AccessSpec till that point in a CLIENT_REQUEST_OP message, so that the Client has all the relevant information to send a response. The client response is carried in a CLIENT_REQUEST_OP_RESPONSE message. This message is the set of OpSpecs that the reader should execute. The reader continues to execute the OpSpecs within an AccessSpec until all opSpecs have been executed or until an error occurs. When execution completes, the reader resumes the inventory operation.

The AISpec transitions back to the inactive state when AISpecDoneCondition occurs or when the parent *ROSpec*'s ROSpecDoneCondition occurs.

AISpecDoneCondition = AISpecStopTrigger

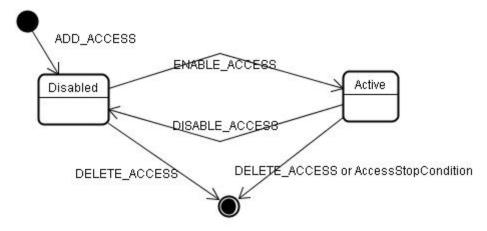


Figure 8: Access Spec States

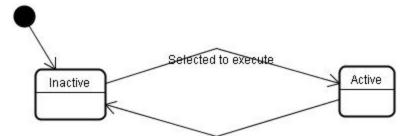
Figure 8 illustrates the *AccessSpec* 's states. The Client configures an *AccessSpec* using an ADD_ACCESS_SPEC message for the *AccessSpec*. The *AccessSpec* starts at the Disabled state, waiting for an ENABLE_ACCESS_SPEC message from the Client for that *AccessSpec*, upon which it enters the Active state. It is only in the Active state that the *AccessSpec* is considered for execution. The Client can disable an *AccessSpec* using a DISABLE_ACCESS_SPEC message for the *AccessSpec*. The *AccessSpec* when undefined is no longer considered for execution. The Client undefines the *AccessSpec* using a DELETE ACCESS_SPEC message for the *AccessSpec*.

In order for the Reader to take a local action to limit the validity of an *AccessSpec*, the Client can configure a stop trigger for the *AccessSpec*. An example use case of the stop trigger is when an AccessSpec is defined on all the antennas, and the desired behavior is to operate on the tag only once, the first time it is seen at any antenna. When the AccessStopCondition occurs, the *AccessSpec* transitions to undefined and is no longer considered for execution.

AccessStopCondition = AccessSpecStopTrigger

Figure 9 illustrates the *RFSurveySpec* statechart. When the parent *ROSpec* moves to the active state, each *RFSurveySpec* in the *ROSpec* starts at the inactive state. During an active *ROSpec's* execution, when an inactive *RFSurveySpec* is selected for execution, that *RFSurveySpec* moves to the active state. In the active state, the Reader executes the survey operation as specified by the *RFSurveySpec*. The *RFSurveySpec* transitions back to the inactive state when the RFSurveySpecDoneCondition occurs or when the parent *ROSpec*'s ROSpecDoneCondition occurs.

RFSurveyStopCondition = RFSurveySpecStopTrigger



RfSurveyStopCondition or ROSpecDoneCondition

849

850851

852

853

854

855

856

857 858

859

860

861

862

863

864

865866

867868

869

870

Figure 9: RFSurveySpec States

In summary, the Reader operation and Access operation specific data structures pass the following information between a Client and a Reader:

ROSpec: Details of a Reader operation

• ROSpecID: This identifier is generated by the Client. This identifier is used by the Client to perform operations on this ROSpec, like start, stop, enable, disable and delete. Reports that are generated as a result of the execution of this ROSpec also carry this identifier.

• ROBoundarySpec:

- ROSpecStartTrigger, ROSpecStopTrigger: This is the start and stop trigger for this ROSpec. The triggers that are specifiable for a ROSpec are listed in Table 1.
- Priority: This is the priority of this ROSpec.
- CurrentState: This is the current state of the ROSpec disabled, inactive, active. This field is kept up to date by the Reader based on the ROSpec's current state.
- Set of Specs: Each Spec is either an AISpec or RFSurveySpec. The Specs are executed in the order in which it is defined in the ROSpec. The position of the Spec (AISpec or RFSurveySpec) in the ROSpec is called the SpecIndex. The SpecIndex is used during reporting to identify the spec inside of ROSpec whose execution generated the data in the report. The numbering of SpecIndex is 1 based.
- ROReportingSpec: If specified, this defines when to send the results of this ROSpec, and also the contents and format of the report.

871872

873

874

875

876877

878

AISpec: Details of one of more antenna inventory operations

- AISpecStopTrigger: This is the stop trigger for the AISpec. The triggers that are specifiable for an AISpec are listed in Table 1.
- Set of Antenna IDs: This is the set of antennas at which the inventory operations described in the InventoryParameterSpecs are executed. If there are N antennas and M InventoryParameterSpecs, the Reader will execute the M inventory operations at each of the specified antennas. Thus, in aggregate, the Reader will

- execute N * M AIs (Antenna inventory operations). The ordering of the AIs is determined by the Reader.
 - Set of InventoryParameterSpecs: There can be one or more InventoryParameterSpecs specified as part of the AISpec. Collectively, they are bound by the AISpecStopTrigger. The order in which the antenna inventory operations described as <Antenna, InventoryParameterSpec> are executed is determined in a proprietary manner inside the Reader.

- **InventoryParameterSpec**: Operational parameters for an inventory using a single air protocol.
 - InventoryParameterSpecID: This identifier is generated by the Client. Reports that are generated as a result of the execution of this InventoryParameterSpec carry this identifier.
 - Air Protocol: This is the air protocol that is used to inventory the tags in the field of view of the antenna.
 - Set of Antenna Configuration Settings: Each Antenna Configuration setting comprises of
 - o Antenna ID: The identifier of the antenna
 - o RFTransmitterSettings: This describes the configuration of the transmitter during the inventory operation.
 - o RFReceiverSettings: This describes the configuration of the receiver during the inventory operation.
 - o AirProtocolInventoryCommandSettings parameters: This describes the configuration of the air protocol parameters for the inventory operation.

RFSurveySpec: Details of a RF Survey operation

- RFSurveySpecID: This identifier is generated by the Client. Reports that are generated as a result of the survey operation carry this identifier.
- RFSurveySpecStopTrigger: This is the stop trigger for the RFSurveySpec. The triggers that are specifiable for a RFSurveySpec are listed in Table 1.
 - AntennaID: This is the antenna at which the survey operation is to be executed.
- StartFrequency: This is the starting channel for which power levels need to be measured during this RF survey operation.
 - EndFrequency: This is the ending channel for which power levels need to be measured during this RF survey operation. The RF survey operation is performed on frequency channels between the specified Start Frequency and End frequency.

AccessSpec: Details of an access operation.

- AccessSpecID: This identifier is generated by the Client upon creation of this AccessSpec. This identifier is used by the Client to perform operations on this AccessSpec, like start, stop and delete. Reports that are generated as a result of the execution of this AccessSpec also carry this identifier.
- AntennaID: This is the identifier of the antenna for whose tag observations this AccessSpec is executed.
 - Air Protocol: This is the air protocol used to perform access operations on the tag.
- ROSpecID: This is the identifier of the ROSpec during whose tag observations this AccessSpec is executed.
- CurrentState: This is the current state of the AccessSpec disabled, active. This field is kept up to date by the Reader based on the AccessSpec's current state.
 - AccessSpecStopTrigger: If specified, this is the trigger to undefine the AccessSpec upon the occurrence of the stop trigger.
 - AccessCommand: This parameter is used to configure the air protocol parameters for the access operation. At a minimum, this specifies the tag filters for which the access operations are to be performed, and the list of operations to be performed on the tag.
 - TagSpec: This describes the tag filters and is specified in terms of the air protocol's tag memory layout.
 - List of OpSpecs: This is specified in terms of the air protocol's tag access operations. The order of execution is determined by the order in which it is configured in the AccessSpec.
 - AccessReportSpec: If specified, this defines when to send the results of this AccessSpec, and also the contents and format of the report.

6.1.1 Operation Triggers

This section describes the triggers that can be configured using LLRP to control the various operations.

6.1.1.1 **Summary**

923

928

929

930

931

932

933

934

935

936

937 938

939

940

941

944

The specific triggers used to control the various operations are presented in a tabular fashion.

947 Table 1: Operation Triggers

Trigger Name	ROSpecStart	ROSpecStop	AISpecStop	AccessSpecStop	RFSurveySpec Stop
GPI Trigger	X	-	-	-	-
GPI Trigger with Timeout	-	X	X	-	-
N attempts	-	-	X	-	-

N tag observations	-	-	X	-	-
No tag observations for t ms	-	-	X	-	-
Immediate	X	-	-	-	-
Null	X	X	X	X	X
Time Based Periodic	X	-	-	-	-
Time Based Duration	-	X	X	-	X
Operation Count	-	-	-	X	X

6.1.1.2 Reader Operation Triggers

The triggers SHALL operate as follows:

- Null: When used as a start or a stop trigger, it implies no start or stop conditions have been specified, respectively.
- Immediate: This is used as a start trigger. Operations using this trigger will start immediately.
- Time-based: There are two different types of time-based triggers defined in LLRP periodic and duration.
 - Periodic: This is used as a start trigger. This is specified using UTC time [UTC], offset and period. For one-shot inventory, period is set to 0, and for periodic inventory operation, period > 0. If UTC time is not specified, the first start time is determined as (time of message receipt + offset), else, the first start time is determined as (UTC time + offset). Subsequent start times = first start time + k * period (where, k > 0).
 - o Duration: This is used as a stop trigger.
- Tag observation based: There are three different types of tag-observation based triggers defined in LLRP. They are all used only as stop triggers. Each of these trigger types have a timeout value. So the trigger event happens when either the tag observation event happens or the timeout expires.
 - o Upon seeing N tags, or timeout.
 - o Upon seeing no more new tags for t milliseconds, or timeout
 - o N attempts to see all the tags in the field of view, or timeout
- External events: These are due to events received at Reader interfaces like signal transition on a GPI port or a message on the network port.
 - o GPI event at a GPI port, or a timeout
 - Client triggers: A Client can instruct the Reader to start/stop a particular operation using LLRP messages.

- Operation count: This is used as a stop trigger for RFSurvey. This trigger limits the number of times the Reader takes survey measurements across the specified frequency range.
- AI and RFSurvey specs do not contain start triggers. The first spec (AISpec or RFSurveySpec) starts when the ROSpec enters the active state. The kth Spec in the ROSpec starts immediately after the completion of the k-1th Spec.
- When Null is specified as a stop trigger for a Spec ((either AISpec or RFSurveySpec), the execution of the Spec is stopped only when the parent ROSpec's ROSpecDoneCondition occurs.

6.1.1.3 Access Operation Triggers

985

991992

993

994

995

996

997

998

999

- AccessSpecs do not contain start triggers. An AccessSpec when enabled using ENABLE_ACCESS_SPEC will transition to the active state. There is only one type of stop trigger for controlling the validity of an AccessSpec:
- Operation count: This is used as a stop trigger. This trigger is useful to limit the number of times the instance of the operation is executed during its lifetime.

6.2 Reporting, Event Notification and Keepalives

- The results of the inventory, access and RF survey operations, will be sent by the Reader to the Client in the form of reports. Using LLRP, the Client is capable of setting up the triggers that determine when the report is to be sent by the Reader, and also the contents and format of the report. The report message is RO_ACCESS_REPORT. The triggers and report contents can be configured in one of the following ways:
 - Differently for each ROSpec and AccessSpec when creating them using the ADD ROSPEC and ADD ACCESSSPEC messages, respectively.
 - Global default using the SET READER CONFIG message.
- Table 2 summarizes the triggers available in LLRP to control when the RO report and the AccessReport is to be generated and sent by the Reader.

1002 Table 2: Reporting Triggers

Trigger Name	ROReport	AccessReport
None	X	-
(Upon N tags or End of Spec), where Spec = AISpec or RFSurveySpec	X	-
Upon N tags or End of ROSpec	X	-
End of AccessSpec	-	X
Whenever ROReport is generated for the RO that triggered the execution of	-	X

	this AccessSpec		
1002	uns recessopee		
1003 1004 1005 1006	In addition to data reports, the Client can configure the Reader to enable or disable notification of events as and when it happens at the Reader. Some examples of events are frequency hop, buffer overflow, etc.		
1007 1008 1009 1010 1011	In order to monitor the LLRP-layer connectivity with the Reader, the Client can configure the Reader to send Keepalives periodically. The Keepalive message is acknowledged by the Client, using which, the Reader can also monitor the LLRP-layer connectivity with a Client. The Keepalives can be disabled. If enabled, the periodicity of the message is specified by the Client.		
1012	7 Messages, Parameters and Fields		
1013 1014 1015 1016	LLRP is a message-oriented protocol made up of data elements called protocol data units. This section provides the details of each message type and parameter type, and expresses them in an abstract manner. The section starts with an overview of the message types and parameters, where the messages are grouped into separate functional groups.		
1017	7.1 Overview		
1018 1019 1020	LLRP provides an extensible mechanism to support existing and new air protocols. It is achieved by decoupling messages from parameters – using a common message structure across air protocols, and providing extensibility in the form of parameters.		
1021	7.1.1 Formatting Conventions		
1022	LLRP messages and parameters are defined using the graphical notation below.		
	The contents of a LLRP message are listed within a box with a double line border such as this.		

The contents of a LLRP message parameter are listed with a box with a single line border such as this.

Figure 10: Box Formats for Messages and Parameters

Contained within the box is an ordered list of sub-parameters and fields contained within the message or parameter. The field/parameter names are shown in **boldface**, followed

- by the data type and a brief description of the field/parameter when necessary. Fields
- with values that are restricted to a subset of the range of their data type have their
- possible and legal values shown in *italics* below the field name.

- Fields are composed of one of the following basic data types:
- 1033 **Bit** An integer with only two possible values, 0 or 1
- 1034 **Bit Array** A sequence of bits.
- 1035 **Byte Array** A sequence of bytes.
- 1036 **Boolean** A field that can take the values TRUE or FALSE.
- 1037 **Integer** An integer can take any whole number. When this value is used in the abstract
- specification, the *Possible Values* element will specify the possible and legal value for a
- 1039 particular field.
- 1040 **Short Array** A sequence of unsigned short integers
- 1041 **Signed Integer** A signed integer can take any whole number value between -2³¹ through
- 1042 2³¹-1 inclusive. Within the abstract specification, the *Possible Values* element will
- enumerate any restrictions beyond these limits for a particular field.
- 1044 **Signed Short Integer** A signed short integer can take any whole number value between
- 1045 -2¹⁵ through 2¹⁵-1 inclusive. Within the abstract specification, the *Possible Values*
- element will enumerate any restrictions beyond these limits for a particular field
- 1047 Unsigned Integer An unsigned integer is a value that is between 0 through 2³²-1
- 1048 inclusive. Within the abstract specification, the *Possible Values* element will enumerate
- any restrictions beyond these limits for a particular field.
- 1050 Unsigned Long Integer An unsigned long integer is a value that is between 0 through
- 1051 2⁶⁴-1 inclusive. Within the abstract specification, the *Possible Values* element will
- enumerate any restrictions beyond these limits for a particular field.
- 1053 Unsigned Short Integer An unsigned short integer is a value that is between 0 through
- 1054 2¹⁶-1 inclusive. Within the abstract specification, the *Possible Values* element will
- enumerate any restrictions beyond these limits for a particular field.
- 1056 UTF-8 String A sequence of UTF-8 [UTF8] encoded characters.
- 1057 In addition to the basic types, fields can be defined as 'lists' of a basic type. A list is an
- ordered set of a basic type. The order is preserved by all bindings.

1059 **7.1.2 Messages**

- 1060 Each Message contains:
- Version value that indicates the version of the protocol for this message.
- Message Type value that uniquely identifies it within a protocol message.
- Message ID: The Reader behavior SHALL be based upon starting the processing of messages in the order received over LLRP, however, the completion of

- 1065 execution of the message processing MAY not necessarily be in the same order inside the Reader. Hence, the Reader responses to the messages may be in a 1066 different order than the order of the Client messages. The Message ID is to 1067 1068 facilitate multiple outstanding messages/requests from Client or Reader. communications between the Client and the Reader is primarily of a request-1069 response type - requests/commands from the Client to the Reader, and response 1070 1071 from the Reader to the Client. The Message ID is used to associate a Reader 1072 response with the original Client message.
- In addition, it may contain mandatory or optional parameters.

1074 7.1.3 Parameters

- 1075 LLRP Parameters are used to communicate specific details of LLRP operation in LLRP
- 1076 Messages. Each Parameter contains:
- Parameter Type value that uniquely identifies it within a Message.
- In addition, it may contain individual fields or sub-parameters.

1079 **7.1.3.1 General Parameters**

- 1080 This section describes the set of parameters that are used in multiple messages or
- parameters.

1082 *7.1.3.1.1 Timestamp*

- The timestamps in LLRP messages or parameters can be either the uptime or the UTC
- time [UTC]. If a Reader has an UTC clock, all timestamps reported by the Reader
- SHALL use an UTC timestamp parameter. If a Reader has no UTC clock capability, all
- timestamps reported by the Reader SHALL use the uptime parameter.

1087 7.1.3.1.1.1 UTCTimestamp Parameter

- 1088 Compliance requirement: Compliant Readers and Clients that have UTC clocks
- 1089 SHALL implement this parameter.

UTCTimestamp Parameter

MicroSeconds: Unsigned Long Integer. This is the time elapsed since the Epoch (00:00:00 UTC, January 1, 1970) measured in microseconds.

1090 **7.1.3.1.1.2** Uptime Parameter

- 1091 Compliance requirement: Compliant Readers and Clients that do not have UTC clocks
- 1092 SHALL implement this parameter. Compliant Readers and Clients that have UTC clocks
- 1093 MAY implement this parameter.

Uptime Parameter

Microseconds: Unsigned Long Integer. This is the time elapsed since boot, measured in microseconds.

1094 **7.1.4 Fields**

- Messages and parameters may contain individual fields. In this section, we present the
- enumerations and the interpretation of the value of zero for certain fields.
- 1097 ProtocolID: This is the identifier of the air protocol. The air protocol enumerations used
- in the LLRP protocol are as follows:
- 1099 Table 3: Air Protocol Enumerations used in LLRP

Air Protocol Enumerations

Protocol ID: Integer

Possible Values:

```
Value Protocol

----

0 Unspecified air protocol
1 EPCGlobal Class 1 Gen 2
2-255 Reserved for future use
```

1100 **Compliance requirement**: Compliant Readers and Clients SHALL use this enumeration.

1101

1107

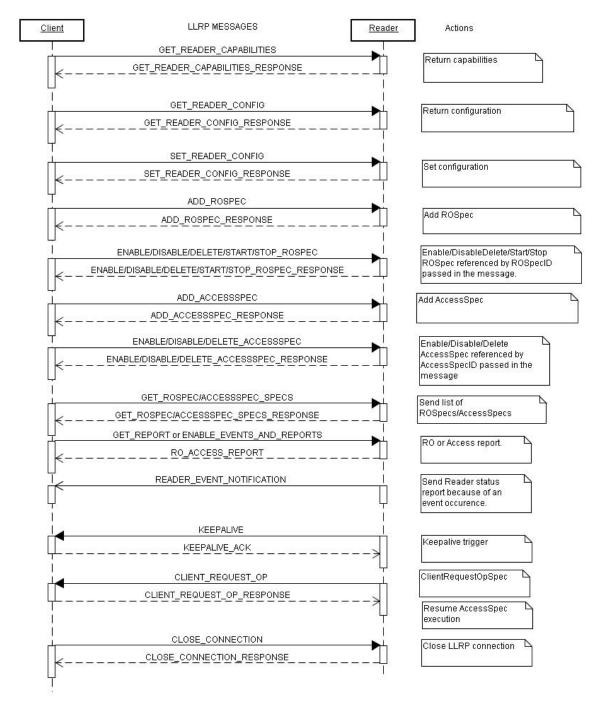
- AntennaID, ROSpecID, AccessSpecID, GPIPort, GPOPort: These fields are identifiers
- for LLRP-related objects within the Reader. For example, AntennaID is the identifier of
- the antenna; ROSpecID is the identifier of the ROSpec. The objects are indexed from 1.
- 1105 A value of non-zero for a field is a specific instance of the respective object. A value of
- zero means all instances of the respective object.

7.1.5 Functional Grouping

- 1108 The LLRP messages are grouped into:
- **Reader device capabilities**: Messages that query Reader capabilities. They include
- o GET READER CAPABILITIES
- 1112 O GET READER CAPABILITIES RESPONSE
- **Reader operations control**: Messages that control the Reader's air protocol inventory and RF operations. They include
- 1115 o ADD ROSPEC
- o ADD ROSPEC RESPONSE
- 1117 o DELETE ROSPEC

1118	 DELETE_ROSPEC_RESPONSE
1119	o START_ROSPEC
1120	 START_ROSPEC_RESPONSE
1121	o STOP_ROSPEC
1122	 STOP_ROSPEC_RESPONSE
1123	 ENABLE_ROSPEC
1124	 ENABLE_ROSPEC_RESPONSE
1125	o DISABLE_ROSPEC
1126	 DISABLE_ROSPEC_RESPONSE
1127	o GET_ROSPECS
1128	 GET_ROSPECS_RESPONSE
1129 1130	• Access control: Messages that control the tag access operations performed by the Reader. They include
1131	o ADD_ACCESSSPEC
1132	 ADD_ACCESSSPEC_RESPONSE
1133	o DELETE_ACCESSSPEC
1134	 DELETE_ACCESSSPEC_RESPONSE
1135	 ENABLE_ACCESSSPEC
1136	 ENABLE_ACCESSSPEC_RESPONSE
1137	o DISABLE_ACCESSSPEC
1138	 DISABLE_ACCESSSPEC_RESPONSE
1139	o GET_ACCESSSPECS
1140	o GET_ACCESSSPECS_RESPONSE
1141	CLIENT_REQUEST_OP
1142	 CLIENT_REQUEST_OP_RESPONSE
1143 1144	• Reader device configuration: Messages that query/set Reader configuration, and close LLRP connection. They include
1145	o GET_READER_CONFIG
1146	 GET_READER_CONFIG_RESPONSE
1147	o SET_READER_CONFIG
1148	 SET_READER_CONFIG_RESPONSE
1149	 CLOSE_CONNECTION
1150	o CLOSE_CONNECTION_RESPONSE

1151 • **Reports**: These are messages that carry different reports from the Reader to the 1152 Client. Reports include Reader device status, tag data, RF analysis report. They include 1153 o GET REPORT 1154 1155 o RO ACCESS REPORT 1156 READER EVENT NOTIFICATION 1157 KEEPALIVE 1158 KEEPALIVE ACK 1159 ENABLE EVENTS AND REPORTS 1160 • Custom Extension: This is a common mechanism for messages that contain vendor defined content 1161 1162 o CUSTOM MESSAGE • Errors: Typically the errors in the LLRP defined messages are conveyed inside 1163 of the responses from the Reader. However, in cases where the message received 1164 by the Reader contains an unsupported message type, or a CUSTOM MESSAGE 1165 with unsupported parameters or fields, the Reader SHALL respond with this 1166 1167 generic error message. 1168 ERROR MESSAGE 1169 LLRP parameters are used to communicate specific settings of LLRP operation in the messages. A parameter contains one or more fields, and in some cases also may nest one 1170 1171 or more other parameters. Typically, each message type has its own set of parameters; however, there may be 1172 1173 exceptions in some cases, where two different message types use the same parameter 1174 because they require the same setting exposed by the parameter. 7.1.6 LLRP Messages and Actions 1175 1176 This section describes the corresponding LLRP-related actions in the Reader upon receiving the various LLRP protocol messages. Figure 11 uses UML synchronous 1177 messaging notation. Messages are asynchronous. 1178



1180 Figure 11: LLRP Messages and Reader Actions

8 Custom Extension

1179

1181

LLRP supports vendor extensions for defining commands and parameters within certain commands. All LLRP bindings support these extension mechanisms.

1184 **8.1 CUSTOM MESSAGE**

- This message carries a vendor defined format from Reader to Client or Client to Reader.
- 1186 In addition to the version and messageID, the custom message also carries the
- information below.

CUSTOM MESSAGE

Vendor Identifier: Unsigned Integer. IANA Private Enterprise Number

Message Subtype: Integer Possible Values: 0-255.

Data: vendor specific format

1188

- No requirements are made as to the content or parameters contained within the Data
- portion of these messages. Clients MAY ignore CUSTOM_MESSAGEs. Readers
- 1191 SHALL accept CUSTOM_MESSAGE and return an ERROR_MESSAGE if
- 1192 CUSTOM MESSAGE is unsupported by the Reader or the CUSTOM MESSAGE
- 1193 contains fields and/or parameters that are unsupported by the Reader.

1194 **8.2 Custom Parameter**

- 1195 Certain Messages and Parameter Sets within LLRP allow for the insertion of vendor
- defined parameters. These custom parameters have the following format.

Custom Parameter

Vendor Identifier: Unsigned Integer. IANA Private Enterprise Number

Parameter Subtype: Unsigned Integer Data: vendor specific format

1197

1202

- 1198 Clients SHALL accept messages (except for CUSTOM MESSAGE) that contain custom
- parameters but MAY ignore all custom parameters within these messages. Readers
- 1200 SHALL accept messages (except for CUSTOM MESSAGE) that contain custom
- parameters and SHALL return an error when such parameters are unsupported.

8.3 Custom Extension in Commands

- 1203 The following commands allow one or more custom Parameters in their message
- 1204 structure:
- 1205 GET READER CAPABILITIES
- 1206 GET READER CONFIG
- 1207 GET READER CAPABILITIES RESPONSE

OLI_NEAD	PER_CONFIG_RESPONSE
SET_READ	ER_CONFIG
8.4 Custom Ex	tension in Individual LLRP Parameters
custom Parameter ty	extension to parameters where the parameter set is defined with a pe in the abstract model. All custom extension points will be marked and using the notation
Custom Extension 1	Point List: List of <custom parameter=""> [optional]</custom>
The following exam custom extension par	apple illustrates a fictitious parameter that allows the embedding of trameters.
Example Param	ieter
Field1: Unsigned In	nteger
relatedData: Exam	iple Sub Parameter
Custom Extension	Point List: List of <custom parameter=""> [optional]</custom>
All parameter value SHALL NOT extend the possible values in	Parameter Extension es are specified within the abstract binding. A Reader or Client d the range of fields defined within the abstract specification unless ndicate ranges for user defined options.
1 ,	lentification Parameter defines a field to carry the ID type.
IDType: Integer	
Possible Values:	
IDType	ID MAC address
0 1	EPC
A Client or Reader a those values shown (
A Client or Reader a those values shown (upon receiving a value)	dhering to the standard SHALL generate an IDType field with only (0-1). A Reader or Client implementation SHALL generate an error

1237 1238

1239 9.1 Messages

1240 9.1.1 GET READER CAPABILITIES

- 1241 This message is sent from the Client to the Reader. The Client is able to request only a
- subset or all the capabilities from the Reader.
- 1243 Compliance requirement: Compliant Readers and Clients SHALL implement this
- message.

GET_READER_CAPABILITIES

RequestedData: Integer

Possible Values:

te ratties.		
Value	Requested Data	
0	All	
1	General Device Capabilities	
2	LLRP Capabilities	
3	Regulatory Capabilities	
4	Air Protocol LLRP Capabilities	

Custom Extension Point List: List of <custom Parameter > [optional]

1245

1246 9.1.2 GET_READER_CAPABILITIES_RESPONSE

- 1247 This is the response from the Reader to the GET READER CAPABILITIES message.
- The response contains the LLRPStatus Parameter and the list of parameters for the
- 1249 requested capabilities conveyed via RequestedData in the
- 1250 GET READER CAPABILITIES message.
- 1251 Compliance requirement: Compliant Readers and Clients SHALL implement this
- message.

GET_READER_CAPABILITIES_RESPONSE

Response Data: Set of LLRP Parameters.

Possible Values: The possible members are

<LLRPStatus Parameter>, and,

one or more from the set

< GeneralDeviceCapabilities Parameter,

LLRPCapabilities Parameter,

RegulatoryCapabilities Parameter,

AirProtocolLLRPCapabilities Parameter >.

Custom Extension Point List: List of <custom Parameter > [optional]

1253 **9.2 Parameters**

9.2.1 GeneralDeviceCapabilities Parameter

- 1255 This parameter carries the general capabilities of the device like supported air protocols,
- version of the Reader firmware, device hardware and software information, and receive
- sensitivity table.
- 1258 Compliance requirement: Compliant Readers and Clients SHALL implement this
- parameter.

GeneralDeviceCapabilities Parameter

Device manufacturer name: Unsigned Integer. The IANA Private Enterprise Number (PEN).

Model name: Unsigned Integer **Firmware version**: UTF-8 String

Maximum number of antennas supported: Unsigned Short Integer

CanSetAntennaProperties: Boolean. If set to true, the Client can set antenna properties (Section 12.2.5), else, the Client can not set it, but only query it using GET_READER_CONFIG.

Receive Sensitivity Table: List of <ReceiveSensitivityTableEntry Parameter>

Per Antenna Receive Sensitivity Range: List of <PerAntennaReceiveSensivityRange Parameter>

Air protocol supported per antenna: N instances of<PerAntennaAirProtocol Parameter>, where N = Maximum number of antennae supported.

GPIO Support: <GPIO Capabilities Parameter>

HasUTCClockCapability: Boolean. If set to true, the Reader reports time based on UTC timestamps (Section 7.1.3.1.1.1) in its reports, else, the Reader reports time based on Uptime (Section 7.1.3.1.1.2) in its reports.

1260 **9.2.1.1 ReceiveSensitivityTableEntry Parameter**

- 1261 This parameter specifies the index into the Receive Sensitivity Table for a receive
- sensitivity value. The receive sensitivity is expressed in dB and the value is relative to the
- maximum sensitivity. If the Reader does not allow control of receive sensitivity, a table
- of one entry is returned, the entry having the value of zero.
- 1265 If the Reader allows control of receive sensitivity and the Reader also supports multiple
- antennas where the antennas can have different receive sensitivity values, then the
- Receive Sensitivity Table should be a set of values representing the union of sensitivity
- values for all antennas.
- 1269 Compliance requirement: Compliant Readers and Clients SHALL implement this
- parameter.

ReceiveSensitivityTableEntry Parameter

Index: Unsigned Short Integer

Receive sensitivity value: Integer. The value is in dB relative to the maximum

sensitivity.

Possible Values: 0 to 128.

1271 9.2.1.2 PerAntennaReceiveSensitivityRange Parameter

- For a particular antenna, this parameter specifies the Reader's valid index range in the
- Receive Sensitivity Table. A Reader should report this parameter if the Reader allows
- 1274 control of receive sensitivity (i.e., the Reader reports a Receive Sensitivity Table with
- more than one entry) and the Reader supports multiple antennas where the antennas can
- have different receive sensitivity values.
- 1277 If this parameter is omitted, then the Client SHALL assume that for all of the Reader's
- antennas the index range is the same as in the Receive Sensitivity Table.
- 1279 Compliance requirement: Compliant Readers and Clients MAY implement this
- parameter.

PerAntennaReceiveSensitivityRange Parameter

Antenna ID: Unsigned Short Integer

Possible Values:

1 to N, where N is the maximum number of antennas supported by the device.

ReceiveSensitivityIndexMin: Unsigned Short Integer

Possible Values:

0 to S, where S is the number of Receive Sensitivity Table entries reported by the Reader.

ReceiveSensitivityIndexMax: Unsigned Short Integer

Possible Values:

Mn to S, where Mn is the ReceiveSensitivityIndexMin and S is the number of Receive Sensitivity Table entries reported by the Reader.

1281 9.2.1.3 PerAntennaAirProtocol Parameter

1282 Compliance requirement: Compliant Readers and Clients SHALL implement this

parameter.

PerAntennaAirProtocol Parameter

Antenna ID: Unsigned Short Integer

Possible Values:

1 to N, where N is the maximum number of antennas supported by the device.

Air protocols supported: List of Protocol Ids enumerated based on Table 3.

1284 **9.2.1.4 GPIOCapabilities Parameter**

- 1285 This parameter describes the GPIO capabilities of the Reader. A value of zero for
- NumGPIs indicates that the Reader does not have general purpose inputs. A value of zero
- for NumGPOs indicates that the Reader does not have general purpose outputs.

1288

- 1289 Compliance requirement: Compliant Readers and Clients SHALL implement this
- 1290 parameter.

GPIOCapabilities Parameter

NumGPIs: Unsigned Short Integer. Number of general purpose inputs supported by the device.

NumGPOs: Unsigned Short Integer. Number of general purpose outputs supported by the device.

9.2.2 LLRPCapabilities Parameter

- 1292 This parameter describes the LLRP protocol capabilities of the Reader. These include
- optional LLRP commands and parameters, capacities of data structures used in LLRP
- operations, and air protocol specific capabilities used by LLRP.
- 1295 Compliance requirement: Compliant Readers and Clients SHALL implement this
- parameter. Readers MAY support RFSurvey, MAY support tag inventory state aware
- singulation, MAY support UTC clocks, MAY support buffer fill warning reports, MAY
- 1298 support EventAndReportHolding upon reconnect, and MAY support
- 1299 ClientRequestOpspec. Readers SHALL support at least one ROSpec, one AISpec per
- ROSpec, one InventoryParameterSpec per AISpec, one AccessSpec, and one OpSpec per
- 1301 AccessSpec.

LLRPCapabilities Parameter

CanDoRFSurvey: Boolean. If set to true, the Reader can perform RFSurvey operations (Section 10.2.3).

CanDoTagInventoryStateAwareSingulation: Boolean. If set to true, the Reader can support tag inventory state aware singulation.

CanReportBufferFillWarning: Boolean. If set to true, the Reader can report buffer fill warning in the reader event notification (Section 13.2.6.5).

MaxNumROSpecs: Integer. If zero, there is no limit. This is the maximum number of ROSpecs that can be configured at the Reader.

MaxNumSpecsPerROSpec: Integer. If zero, there is no limit. This is the maximum number of Specs (either AISpec or RFSurveySpec) that can be configured as part of a

ROSpec at the Reader.

MaxNumInventoryParameterSpecsPerAISpec: Integer. If zero, there is no limit. This is the maximum number of InventoryParameterSpecs that can be configured per AISpec.

MaxPriorityLevelSupported: Integer. This is the maximum priority level supported in the reader. If set to less than or equal to 1, the Reader has no preemption support.

Possible Values: 0-7.

1302

1305

MaxNumAccessSpecs: Integer. If zero, there is no limit. This is the maximum number of AccessSpecs that can be configured at the Reader.

MaxNumOpSpecsPerAccessSpec: Integer. If zero, there is no limit. This is the maximum number of OpSpecs that can be configured per AccessSpec at the Reader.

SupportsClientRequestOpSpec: Boolean. If set to true, the Reader supports client request OpSpecs (Section 11.2.1.2.1).

ClientRequestOpSpecTimeout: Unsigned Short Integer (in milliseconds). The time the Reader will wait for the CLIENT_REQUEST_OP_RESPONSE from the Client after sending a RO_ACCESS_REPORT message upon executing the ClientRequestOpSpec OpSpec. This field is valid only if the Reader supports ClientRequestOpSpec (Section 11.2.1.2.1). If this field is 0, there is no limit.

SupportsEventAndReportHolding: Boolean. If set to True, the Reader supports the EventsAndReports Parameter and the ENABLE_EVENTS_AND_REPORTS message. If set to false, the Reader does not support the ENABLE_EVENTS_AND_REPORTS message or the EventsAndReports Parameter.

9.2.3 AirProtocolLLRPCapabilities Parameter

Compliance requirement: Compliant Readers and Clients SHALL implement this parameter.

AirProtocolLLRPCapabilities Parameter

Each air protocol's capabilities are expressed in a different LLRP Parameter. Each protocol's air protocol capabilities parameter SHALL be referenced not more than once. The air protocol specific capabilities LLRP Parameters are defined in section 15.1.

9.2.4 RegulatoryCapabilities Parameter

- 1306 This parameter carries the RF regulation specific attributes. They include regulatory
- 1307 standard, frequency band information, power levels supported, frequencies supported,
- and any air protocol specific values that are determined based on regulatory restriction.
- 1309 The regulatory standard is encoded using two Integer fields, <Country Code,
- 1310 Communications standard> and it specifies the current operational regulatory mode of the
- device. This should not be used to reflect the ability to operate in regulatory
- environments which require configuration different from the current. This version of the
- 1313 LLRP protocol will have support for only the UHF band.

Compliance requirement: Compliant Readers and Clients SHALL implement this parameter.

RegulatoryCapabilities Parameter

Country Code: Unsigned Short Integer. This field carries the numeric code of the country as specified in ISO 3166 [ISO3166]. 0 means unspecified.

Communications Standard: Unsigned Short Integer. This field carries the enumerations of the communications standard as specified below.

Possible Values:

Value	Communications Standard
0	Unspecified
1	US FCC Part 15
2	ETSI 302-208
3	ETSI 300-220
4	Australia LIPD 1W
5	Australia LIPD 4W
6	Japan: ARIB STD T89
7	Hong Kong: OFTA 1049
8	Taiwan: DGT LP0002
9	Korea: MIC Article 5-2
10-65535	Reserved for future use

UHFBandCapabilities: <UHFBandCapabilities Parameter> [optional]

Custom Extension Point List: List of <custom Parameter> [optional]

1316 **9.2.4.1 UHFBandCapabilities Parameter**

Compliance requirement: Compliant Readers and Clients SHALL implement this parameter.

UHFBandCapabilities Parameter

TransmitPowerTable: List of <TransmitPowerLevelTableEntry Parameter>

Frequency Information: < Frequency Information Parameter >

UHF RFModeTable: List of LLRP Parameter.

Possible Values:

Each air protocol's UHF RF mode table is expressed as a different LLRP parameter. Each protocol SHALL be referenced not more than once. The air protocol's UHF RF mode table capabilities LLRP Parameters are defined in section 15.1.

1319 9.2.4.1.1 TransmitPowerLevelTableEntry Parameter

- This parameter specifies the index into the TransmitPowerLevelTable for a transmit
- power value. The transmit power is expressed in dBm*100 to allow fractional dBm
- representation and is the conducted power at the connector of the Reader.

- 1323 Compliance requirement: Compliant Readers and Clients SHALL implement this
- parameter.

TransmitPowerLevelTableEntry Parameter

Index: Integer

Possible Values: 0-255

Transmit power value: Signed short integer. Transmit power expressed in dBm*100 to allow fractional dBm representation.

- 1325 9.2.4.1.2 FrequencyInformation Parameter
- 1326 Compliance requirement: Compliant Readers and Clients SHALL implement this
- parameter.

Frequency Information Parameter

Hopping: Boolean

Freq Hop Info: Zero or more instances of <FrequencyHopTable Parameter>. This is transmitted only when Hopping = true.

Fixed Freq Info: At most one instance of <FixedFrequencyTable>. This is transmitted only when Hopping = false.

- 1328 9.2.4.1.2.1 FrequencyHopTable Parameter
- 1329 This parameter carries the frequency hop table parameters. This is used for Readers
- operating in regions with frequency hopping regulatory requirements. If the Reader is
- capable of storing multiple hop tables, the Reader may send all of them to the Client.
- Each hop table contains:
- HopTableID which is the index of the frequency hop table returned by the Reader.
- This is followed by a list of the frequencies (in kHz) in hop table order. The onebased position of a frequency in the list is defined as its ChannelIndex (i.e. the first frequency is referred to as ChannelIndex one).
- Compliance requirement: Compliant Readers and Clients SHALL implement this parameter when operating in frequency hopping regulatory regions.

FrequencyHopTable Parameter

HopTableID: Integer *Possible Values*: 0 - 255

Frequency Hop List: List of unsigned integers. Frequency in kHz.

- 1339 If multiple frequency hop tables are supported by the Reader, each table can be sent using
- a separate Frequency Hop Table Parameter.
- 1341 9.2.4.1.2.2 FixedFrequencyTable Parameter

- 1342 This parameter carries the fixed frequency list that can be used by the Reader. The one-
- based position of a frequency in the list is defined as its ChannelIndex (i.e. the first
- frequency is referred to as ChannelIndex one).
- 1345 Compliance requirement: Compliant Readers and Clients SHALL implement this
- parameter when operating in fixed frequency regulatory regions.

Fixed Frequency Parameter

Frequency List: List of unsigned integers. Frequency in kHz.

1347 10 Reader Operation (RO)

- 1348 This section presents the messages and the parameters used by the Client for specifying
- 1349 RO.

1350 **10.1 Messages**

1351 **10.1.1 ADD_ROSPEC**

- 1352 An ADD ROSPEC message communicates the information of a *ROSpec* to the Reader.
- 1353 LLRP supports configuration of multiple ROSpecs. Each ROSpec is uniquely identified
- using a ROSpecID, generated by the Client. The ROSpec starts at the Disabled state
- waiting for the ENABLE ROSPEC message for the ROSpec from the Client, upon which
- it transitions to the Inactive state.
- 1357 The Client SHALL add a ROSpec in a Disabled State i.e., CurrentState field in the
- 1358 ROSpec Parameter (section 10.2.1) SHALL be set to disabled. If the CurrentState value
- 1359 is different than disabled, an error SHALL be returned in the
- 1360 ADD ROSPEC RESPONSE (e.g. P FieldError).
- 1361 Compliance requirement: Compliant Readers and Clients SHALL implement this
- message.

ADD ROSPEC

ROSpec: ROSpec Parameter

1363 **10.1.2 ADD_ROSPEC_RESPONSE**

- 1364 This is the response by the Reader to an ADD ROSPEC message. If all the parameters
- specified in the ADD_ROSPEC command are successfully set, then the success code is
- returned in the LLRPStatus parameter. If there is an error, the appropriate error code is
- returned in the LLRPStatus parameter.
- 1368 Compliance requirement: Compliant Readers and Clients SHALL implement this
- message.

ADD ROSPEC RESPONSE

Response: LLRPStatus Parameter

1370 **10.1.3 DELETE_ROSPEC**

- 1371 This command is issued by the Client to the Reader. This command deletes the ROSpec
- at the Reader corresponding to ROSpecID passed in this message.
- 1373 Compliance requirement: Compliant Readers and Clients SHALL implement this
- message.

DELETE ROSPEC

ROSpecID: Unsigned Integer. The identifier of the ROSpec to delete. 0 indicates to delete all ROSpecs.

1375 **10.1.4 DELETE_ROSPEC_RESPONSE**

- 1376 This is the response by the Reader to a DELETE_ROSPEC command. If there was a
- 1377 ROSpec corresponding to the ROSpecID that the Reader was presently executing, and
- the Reader was successful in stopping that execution, then the success code is returned in
- the LLRPStatus parameter. If there is an error, the appropriate error code is returned in
- the LLRPStatus parameter.
- 1381 Compliance requirement: Compliant Readers and Clients SHALL implement this
- message.

DELETE ROSPEC RESPONSE

Response: LLRPStatus Parameter

1383 **10.1.5 START_ROSPEC**

- 1384 This message is issued by the Client to the Reader. Upon receiving the message, the
- Reader starts the ROSpec corresponding to ROSpecID passed in this message, if the
- 1386 ROSpec is in the enabled state.
- 1387 Compliance requirement: Compliant Readers and Clients SHALL implement this
- message.

START_ROSPEC

ROSpecID: Unsigned Integer. The identifier of the ROSpec to start.

Possible Values: 0 is disallowed.

1389 **10.1.6** START_ROSPEC_RESPONSE

- 1390 This is the response by the Reader to a START_ROSPEC command. If there was a
- ROSpec corresponding to the ROSpecID in the enabled state, and the Reader was able to
- start executing that ROSpec, then the success code is returned in the LLRPStatus
- parameter. If there is an error, the appropriate error code is returned in the LLRPStatus
- parameter.
- 1395 Compliance requirement: Compliant Readers and Clients SHALL implement this
- message.

START ROSPEC RESPONSE

Response: LLRPStatus Parameter

1397 **10.1.7 STOP ROSPEC**

- This message is issued by the Client to the Reader. Upon receiving the message, the
- Reader stops the execution of the ROSpec corresponding to the ROSpecID passed in this
- 1400 message. STOP ROSPEC overrides all other priorities and stops the execution. This
- basically moves the ROSpec's state to Inactive. This message does not the delete the
- 1402 ROSpec.
- 1403 Compliance requirement: Compliant Readers and Clients SHALL implement this
- message.

STOP ROSPEC

ROSpecID: Unsigned Integer. The identifier of the ROSpec to stop.

Possible Values: 0 is disallowed.

1405 **10.1.8 STOP_ROSPEC_RESPONSE**

- 1406 This is the response by the Reader to a STOP_ROSPEC command. If the Reader was
- 1407 currently executing the ROSpec corresponding to the ROSpecID, and the Reader was
- able to stop executing that ROSpec, then the success code is returned in the LLRPStatus
- parameter. If there is an error, the appropriate error code is returned in the LLRPStatus
- parameter.
- 1411 Compliance requirement: Compliant Readers and Clients SHALL implement this
- message.

STOP ROSPEC RESPONSE

Response: LLRPStatus Parameter

1413 **10.1.9 ENABLE_ROSPEC**

- 1414 This message is issued by the Client to the Reader. Upon receiving the message, the
- Reader moves the ROSpec corresponding to the ROSpecID passed in this message from
- the disabled to the inactive state.
- 1417 Compliance requirement: Compliant Readers and Clients SHALL implement this
- 1418 message.

ENABLE ROSPEC

ROSpecID: Unsigned Integer. The identifier of the ROSpec to enable. If set to 0, all ROSpecs are enabled.

1419 10.1.10 ENABLE ROSPEC RESPONSE

- 1420 This is the response by the Reader to a ENABLE ROSPEC command. If there was a
- 1421 ROSpec corresponding to the ROSpecID, and the Reader was able to enable that
- 1422 ROSpec, then the success code is returned in the LLRPStatus parameter. If there is an
- error, the appropriate error code is returned in the LLRPStatus parameter.
- 1424 Compliance requirement: Compliant Readers and Clients SHALL implement this
- message.

ENABLE ROSPEC RESPONSE

Response: LLRPStatus Parameter

1426 **10.1.11 DISABLE_ROSPEC**

- 1427 This message is issued by the Client to the Reader. Upon receiving the message, the
- Reader moves the ROSpec corresponding to the ROSpecID passed in this message to the
- 1429 disabled state.
- 1430 Compliance requirement: Compliant Readers and Clients SHALL implement this
- message.

DISABLE ROSPEC

ROSpecID: Unsigned Integer. The identifier of the ROSpec to disable. If set to 0, all ROSpecs are disabled.

1432 **10.1.12 DISABLE_ROSPEC_RESPONSE**

- 1433 This is the response by the Reader to a DISABLE_ROSPEC command. If there was a
- 1434 ROSpec corresponding to the ROSpecID, and the Reader was able to disable that
- 1435 ROSpec, then the success code is returned in the LLRPStatus parameter. If there is an
- error, the appropriate error code is returned in the LLRPStatus parameter.
- 1437 Compliance requirement: Compliant Readers and Clients SHALL implement this
- message.

DISABLE ROSPEC RESPONSE

Response: LLRPStatus Parameter

1439 **10.1.13 GET_ROSPECS**

- 1440 This is the request from the Client to the Reader to retrieve all the ROSpecs that have
- been configured at the Reader.
- 1442 Compliance requirement: Compliant Readers and Clients SHALL implement this
- message.

GET ROSPECS

1444 10.1.14 GET ROSPECS RESPONSE

- 1445 This is the response by the Reader to a GET ROSPECS command. If there are no
- ROSpecs configured at the Reader, the response is just the LLRPStatus parameter with
- the success code. Else, a list of ROSpec parameter is returned by the Reader, along with
- the success code in the LLRPStatus parameter.
- 1449 Compliance requirement: Compliant Readers and Clients SHALL implement this
- message.

GET ROSPECS RESPONSE

Status: LLRPStatus Parameter

Response: List of <ROSpec Parameter> that are in the order in which they are added.

1451 10.2 Parameters

1452 **10.2.1 ROSpec Parameter**

- 1453 This parameter carries the information of the Reader inventory and survey operation.
- 1454 Compliance requirement: Compliant Readers and Clients SHALL implement this
- parameter.

ROSpec Parameter

ROSpecID: Unsigned Integer; 0 is an illegal ROSpecID for a ROSpec.

Priority: Integer. Lower numbered priority values are given higher priority.

Possible Values: 0-7.

CurrentState: Integer

Possible Values:

Value	Definition
0	Disabled
1	Inactive
2	Active

ROBoundarySpec: ROBoundarySpec ParameterListOfSpecs: List of <AISpec

Parameter> and/or <RFSurveySpec Parameter> and/or Custom Parameter.

ROReportSpec: ROReportSpec Parameter [optional] (Section 13.2.1)

1456 **10.2.1.1 ROBoundarySpec Parameter**

- This parameter carries the lifetime of the command, ROStartTrigger and ROStopTrigger
- parameters.
- 1459 Compliance requirement: Compliant Readers and Clients SHALL implement this
- parameter.

ROBoundarySpec Parameter

ROSpecStartTrigger: ROSpecStartTrigger Parameter **ROSpecStopTrigger:** ROSpecStopTrigger Parameter

1461 10.2.1.1.1 ROSpecStartTrigger Parameter

- 1462 Compliance requirement: Compliant Readers and Clients SHALL implement this
- parameter.

ROSpecStartTrigger Parameter

ROSpecStartTriggerType: Integer

Possible Values:

```
Value Definition
-----
0 Null - No start trigger. The only way to start the
    ROSpec is with a START_ROSPEC from the Client.
1 Immediate
2 Periodic
3 GPT
```

PeriodicTriggerValue: PeriodicTriggerValue Parameter [Optional]. This parameter SHALL be present when ROSpecStartTriggerType = 2.

GPITriggerValue: GPITriggerValue Parameter [Optional]. This parameter SHALL be present when ROSpecStartTriggerType = 3.

1464 10.2.1.1.1.1 PeriodicTriggerValue Parameter

- Periodic trigger is specified using UTC time, offset and period.
- For one-shot inventory, period is set to 0, and for periodic inventory operation period > 0.
- 1467 If UTC time is not specified, the first start time is determined as (time of message receipt
- + offset), else, the first start time is determined as (UTC time + offset). Subsequent start
- times = first start time + k * period (where, k > 0).
- 1470 If the Reader does not support UTC clock (as indicated by HasUTCClockCapability), and
- it receives the UTC time as part of the PeriodicTriggerValue parameter from the Client,
- the Reader SHALL return an error.
- 1473 Compliance requirement: Compliant Readers and Clients SHALL implement this
- 1474 parameter. Compliant Readers and Clients MAY implement the UTCTimestamp
- 1475 parameter.

PeriodicTriggerValue Parameter

UTC Time: <UTCTimestamp Parameter> [Optional]

Offset: Unsigned Integer. Time offset specified in milliseconds.

Period: Unsigned Integer. Time period specified in milliseconds

- 1476 10.2.1.1.1.2 GPITriggerValue Parameter
- 1477 This trigger is tied to an event on the General Purpose Input (GPI) of the Reader. The
- event is represented as a boolean type, and it is up to the internal implementation of the
- Reader to map exact physical event to a boolean type. For example, a $0 \rightarrow 1$ and a $1 \rightarrow 0$
- transition on an input pin of the Reader could be mapped to a boolean true and a boolean
- false event respectively.
- 1482 This trigger parameter has a timeout value field. The timeout is useful for specifying a
- fail-safe timeout when this trigger is used as a stop trigger. When the timeout is 0, it
- indicates that there is no timeout. When used as a start trigger, the timeout value SHALL
- be ignored.
- 1486 Compliance requirement: Compliant Readers and Clients SHALL implement this
- parameter. Readers that do not support GPIs SHALL return zero for numGPIs in the
- capabilities discovery. If the Client sets up the GPI trigger for such a Reader, the Reader
- 1489 SHALL send an error message for the ADD ROSPEC message and not add the ROSpec.

GPITriggerValue Parameter

GPIPortNum: Unsigned Short Integer.

Possible Values: 1-65535. Zero is invalid.

GPIEvent: Boolean. The Boolean value that causes a GPI event to trigger.

Timeout: Unsigned Integer. Trigger timeout in milliseconds. If set to zero, it indicates

there is no timeout.

1490 10.2.1.1.2 ROSpecStopTrigger Parameter

1491 Compliance requirement: Compliant Readers and Clients SHALL implement this

1492 parameter.

1493

ROSpecStopTrigger Parameter

ROSpecStopTriggerType: Integer

Possible Values:

Value	Definition
0	Null - Stop when all AISpecs are done, or when Preempted, or with a STOP_ROSPEC from the Client.
1	Duration
2	GPI with a timeout value

DurationTriggerValue: Duration in milliseconds. This field is ignored when ROSpecStopTriggerType != 1.

GPITriggerValue: GPITriggerValue Parameter [Optional]. This parameter SHALL be present when ROSpecStopTriggerType = 2.

10.2.2 AlSpec Parameter

1494 This parameter defines antenna inventory operations.

1495 **Compliance Requirement:** Compliant Readers and Clients SHALL implement this parameter.

AISpec Parameter

AISpecStopTrigger: <AISpecStopTrigger Parameter>

AntennaIDs: Short Array. If this set contains an antenna ID of zero, this AISpec will utilize all the antennas of the Reader.

InventoryParameterSpecs: <List of InventoryParameterSpec Parameter>

Custom Extension Point List: List of <custom Parameter> [Optional]

1497 **10.2.2.1 AlSpecStopTrigger Parameter**

- 1498 This parameter defines the stop (i.e., terminating boundary) of an antenna inventory
- 1499 operation.
- 1500 **Compliance Requirement:** Compliant Readers and Clients SHALL implement this
- parameter. If a Reader reports NumGPIs (see GPIO Capabilities Parameter) greater than
- zero, then the Reader SHALL support GPI Trigger.

AISpecStopTrigger Parameter

AISpecStopTriggerType: Integer

Possible Values:

Value	Definition
0	Null - Stop when ROSpec is done.
1	Duration
2	GPI with a timeout value
3	Tag observation

Duration Trigger: Unsigned Integer. Duration of AISpec in milliseconds. This field SHALL be ignored when AISpecStopTriggerType != 1.

GPI Trigger: GPITrigger value Parameter [Optional]. This field SHALL be present when AISpecStopTriggerType = 2.

TagObservation Trigger: TagObservation Trigger Parameter [Optional]. This field SHALL be present when AISpecStopTriggerType = 3.

1503 10.2.2.1.1 TagObservationTrigger Parameter

1504 **Compliance requirement**: Compliant Readers and Clients SHALL implement this parameter.

Tag ObservationTrigger Parameter TriggerType: Integer Possible Values: Value Modulation O Upon seeing N tag observations, or timeout

1 Upon seeing no more new tag observations for t ms, or timeout

N attempts to see all tags in the FOV, or timeout

NumberOfTags: Unsigned Short Integer. This field SHALL be ignored when TriggerType != 0.

NumberOfAttempts; Unsigned Short Integer. This field SHALL be ignored when TriggerType != 2.

T: Unsigned Short Integer. Idle time between tag responses in milliseconds. This field SHALL be ignored when TriggerType != 1.

Timeout: Unsigned Integer; Trigger timeout value in milliseconds. If set to zero, it indicates that there is no timeout.

1506 **10.2.2.2 InventoryParameterSpec Parameter**

This parameter defines the inventory operation to be performed at all antennas specified in the corresponding AISpec. This parameter is composed of an InventoryParameterSpecID, a ProtocolID, and zero or more optional antenna configuration parameters. Antenna configurations for antennas not indicated by the AntennaIDs within the AISpec are ignored by the reader.

15121513

1514

Compliance Requirement: Compliant Readers and Clients SHALL implement this parameter.

InventoryParameterSpec Parameter

InventoryParameterSpecID: Unsigned Short Integer. 0 is illegal.

ProtocolID: Integer. Enumeration based on Table 3.

AntennaConfiguration: List of <AntennaConfiguration Parameter> (Section 12.2.6) [Optional]

Custom Extension Point List: List of <Custom Parameter> [Optional]

1515 **10.2.3 RFSurveySpec Parameter**

- 1516 This parameter defines RF Survey operations. RF Survey is an operation during which
- 1517 the Reader performs a scan and measures the power levels across a set of frequencies at
- an antenna. This parameter defines the identifier of the antenna where this survey is to be
- performed, the duration of the survey operation (specified via stop trigger), and the range
- of frequencies to measure power levels of.
- 1521 Compliance Requirement: Compliant Readers and Clients MAY implement this
- 1522 parameter.

RFSurveySpec Parameter

Antenna ID: Unsigned Short Integer.

Possible Values: 1 to N, where N is the maximum number of antennas supported

by the Reader.

RFSurveySpecStopTrigger: RFSurveySpecStopTrigger parameter

StartFrequency: Unsigned Integer. The start (lower bound) frequency to survey specified in kHz.

EndFrequency: Unsigned Integer in kHz. The end (upper bound) frequency to survey specified in kHz.

Custom Extension Point List: List of <custom Parameter> [Optional]

1523 **10.2.3.1 RFSurveySpecStopTrigger Parameter**

- 1524 This parameter defines the stop trigger for RF Survey operations.
- 1525 **Compliance Requirement:** Compliant Readers and Clients MAY implement this
- parameter.

RFSurveySpecStopTrigger Parameter

StopTriggerType: Integer

Possible Values:

Value	Definition
0	Null
1	Duration
2	N iterations through the frequency range

Duration: Unsigned Integer; The maximum duration of the RFSurvey operation specified in milliseconds. This field SHALL be ignored when StopTriggerType != 1. When StopTriggerType = 1, the value SHALL be greater than zero.

N: Unsigned Integer. The maximum number of iterations through the specified frequency range. This field SHALL be ignored when StopTriggerType != 2. When StopTriggerType = 2, the value SHALL be greater than zero.

1527 **11 Access Operation**

- 1528 This section presents the messages and the parameters used by the Client for specifying
- access operation.

1530

11.1 Messages

1531 **11.1.1 ADD_ACCESSSPEC**

- 1532 This command creates a new AccessSpec at the Reader. The AccessSpec starts at the
- 1533 Disabled state waiting for the ENABLE ACCESSSPEC message for the AccessSpec
- 1534 from the Client, upon which it transitions to the Active state. The AccessSpecID is
- generated by the Client.
- 1536 The Client SHALL add an AccessSpec in a Disabled State i.e., CurrentState field in the
- 1537 AccessSpec Parameter (section 11.2.1) SHALL be set to false. If the CurrentState value

- 1538 is different than false, an error SHALL be returned in the
- 1539 ADD ACCESSSPEC RESPONSE (e.g. P FieldError).
- 1540 Compliance requirement: Compliant Readers and Clients SHALL implement this
- message.

ADD ACCESSSPEC

AccessSpec: AccessSpec parameter

1542 11.1.2 ADD_ACCESSSPEC_RESPONSE

- 1543 This is the response by the Reader to an ADD_ACCESSSPEC command. If the
- parameters passed in that ADD_ACCESSSPEC command were successfully accepted
- and set at the Reader, then the success code is returned in the LLRPStatus parameter.
- However, if the AccessSpec was not successfully created at the Reader, the Reader sends
- a LLRPStatus parameter describing the error in the message.
- 1548 Compliance requirement: Compliant Readers and Clients SHALL implement this
- message.

ADD_ACCESSSPEC_RESPONSE

Response: LLRPStatus Parameter

1550 11.1.3 DELETE_ACCESSSPEC

- 1551 This command is issued by the Client to the Reader. The Reader deletes the AccessSpec
- 1552 corresponding to the AccessSpecId, and this AccessSpec will stop taking effect from the
- next inventory round.
- 1554 Compliance requirement: Compliant Readers and Clients SHALL implement this
- message.

DELETE_ACCESSSPEC

AccessSpecID: Unsigned Integer.

Possible Values: If set to 0, all AccessSpecs are deleted.

1556 11.1.4 DELETE_ACCESSSPEC_RESPONSE

- 1557 This is the response by the Reader to a DELETE ACCESSSPEC command. If there was
- an AccessSpec at the Reader corresponding to the AccessSpecID passed in the
- 1559 DELETE ACCESSSPEC command, and the Reader was successful in deleting that
- AccessSpec, then the success code is returned in the LLRPStatus parameter. If there is an
- error, the appropriate error code is returned in the LLRPStatus parameter.
- 1562 Compliance requirement: Compliant Readers and Clients SHALL implement this
- message.

DELETE ACCESSSPEC RESPONSE

Response: LLRPStatus Parameter

1564 11.1.5 ENABLE ACCESSSPEC

- 1565 This message is issued by the Client to the Reader. Upon receiving the message, the
- Reader moves the AccessSpec corresponding to the AccessSpecID in this message from
- the Disabled state to the Active state. The Reader executes this access-spec until it gets a
- 1568 DISABLE_ACCESSSPEC or a DELETE_ACCESSSPEC from the Client. The
- AccessSpec takes effect with the next (and subsequent) inventory rounds.
- 1570 Compliance requirement: Compliant Readers and Clients SHALL implement this
- message.

ENABLE ACCESSSPEC

AccessSpecID: Unsigned Integer. If set to 0, all AccessSpecs are enabled.

1572 11.1.6 ENABLE_ACCESSSPEC_RESPONSE

- 1573 This is the response by the Reader to a START_ACCESSSPEC command. If there was
- an AccessSpec corresponding to the AccessSpecID, and the Reader was able to move that
- 1575 AccessSpec from the disabled to the active state, then the success code is returned in the
- 1576 LLRPStatus parameter. If there is an error, the appropriate error code is returned in the
- 1577 LLRPStatus parameter.
- 1578 Compliance requirement: Compliant Readers and Clients SHALL implement this
- message.

ENABLE ACCESSSPEC RESPONSE

Response: LLRPStatus Parameter

1580 11.1.7 DISABLE_ACCESSSPEC

- 1581 This message is issued by the Client to the Reader. Upon receiving the message, the
- Reader stops the execution of the AccessSpec corresponding to AccessSpecID in this
- message. This basically moves the AccessSpec's state to Disabled. This message does not
- delete the AccessSpec. The AccessSpec will stop taking effect from the next inventory
- 1585 round.
- 1586 Compliance requirement: Compliant Readers and Clients SHALL implement this
- message.

DISABLE ACCESSSPEC

AccessSpecID: Unsigned Integer. If set to 0, all AccessSpecs are disabled.

1588 11.1.8 DISABLE_ACCESSSPEC_RESPONSE

- 1589 This is the response by the Reader to a STOP ACCESSSPEC command. If the Reader
- was currently executing the AccessSpec corresponding to the AccessSpecID, and the
- Reader was able to disable that AccessSpec, then the success code is returned in the
- 1592 LLRPStatus parameter. If there is an error, the appropriate error code is returned in the
- 1593 LLRPStatus parameter.
- 1594 Compliance requirement: Compliant Readers and Clients SHALL implement this
- message.

DISABLE ACCESSSPEC RESPONSE

Response: LLRPStatus Parameter

1596 **11.1.9 GET ACCESSSPECS**

- 1597 This is the request from the Client to the Reader to retrieve all the AccessSpecs that have
- been configured at the Reader.
- 1599 Compliance requirement: Compliant Readers and Clients SHALL implement this
- message.

GET ACCESSSPECS

1601 11.1.10 GET_ACCESSSPECS_RESPONSE

- 1602 This is the response by the Reader to a GET_ACCESSSPECS command. If there are no
- AccessSpecs configured at the Reader, the response is just the LLRPStatus parameter
- with the success code. Else, a list of <AccessSpecID, AccessSpec parameter> is returned
- by the Reader, along with the LLRPStatus parameter containing the success code. The
- order of the AccessSpecs listed in the message is normatively the order in which the
- 1607 AccessSpecs were created at the Reader.
- 1608 Compliance requirement: Compliant Readers and Clients SHALL implement this
- message.

GET ACCESSSPECS RESPONSE

Status: LLRPStatus Parameter

Response: List of <AccessSpec Parameter>. The ordering of the AccessSpecs in this

list is the order in which the AccessSpecs were created at the Reader.

1610 **11.1.11 CLIENT_REQUEST_OP**

- 1611 This message is sent by the Reader to the Client upon executing a ClientRequestOpSpec
- OpSpec (section 11.2.1.2.1). This message carries the TagReportData (section 13.2.3)
- that contains information collected for the tag which includes singulation results and the
- results of OpSpecs executed till that point.

1615 **Compliance requirement**: Compliant Readers and Clients MAY implement this message.

CLIENT_REQUEST_OP

TagReport: <TagReportData Parameter> (Section 13.2.3)

1617 11.1.12 CLIENT_REQUEST_OP_RESPONSE

- 1618 This is the response by the Client to the Reader. This is in response to the
- 1619 CLIENT REQUEST OP sent by the Reader due to the execution of a
- 1620 ClientRequestOpSpec. This is a response to the CLIENT_REQUEST_OP message; thus,
- the messageID in this message is the messageID of the CLIENT_REQUEST_OP.
- 1622 Compliance requirement: Compliant Readers and Clients MAY implement this
- message. Readers that do not support ClientRequestOpSpec MAY ignore this message.

CLIENT REQUEST OP RESPONSE

Response: ClientRequestResponse Parameter

1624

1625 11.2 Parameters

1626 11.2.1 AccessSpec Parameter

- 1627 This parameter carries information of the Reader access operation.
- 1628 Compliance requirement: Compliant Readers and Clients SHALL implement this
- parameter.

AccessSpec Parameter

AccessSpecID: Unsigned Integer. 0 is illegal.

Antenna ID: Unsigned Short Integer. If 0, this spec is operational on all antennas.

ProtocolID: Integer.

Possible Values: Enumeration based on Table 3.

CurrentState: Boolean. This is the current state of the AccessSpec. false = Disabled, true = Active.

li de Melive.

ROSpecID: Unsigned Integer. If 0, this spec is operational for all ROSpecs.

AccessSpecStopTrigger: AccessSpecStopTrigger Parameter
Access Command Operation: AccessCommand Parameter
AccessReportSpec: AccessReportSpec Parameter [Optional]

Custom Extension Point List: List of <custom Parameter> [Optional]

1630 11.2.1.1 AccessSpecStopTrigger Parameter

1631 Compliance requirement: Compliant Readers and Clients SHALL implement this

parameter.

AccessSpecStopTrigger Parameter

AccessSpecStopTriggerType: Integer

Possible Values:

```
Value Definition
---- 0 Null - No stop trigger defined.
1 Operation count
```

OperationCountValue: Unsigned Short Integer. A count to indicate the number of times this Spec is executed before it is deleted. If set to 0, this is equivalent to no stop trigger defined.

1633 11.2.1.2 AccessCommand Parameter

- 1634 This parameter defines the air protocol access-specific settings. It contains a TagSpec and
- an OpSpec Parameter. The TagSpec specifies the tag filters in terms of air protocol
- specific memory capabilities (e.g., memory banks, pointer and length). The OpSpec
- specifies all the details of the operations required for the air protocol specific access
- operation commands.
- 1639 Compliance requirement: Compliant Readers and Clients SHALL implement this
- parameter.

AccessCommand Parameter

TagSpec: LLRP Parameter

Possible Values:

Each air protocol's TagSpec parameter is expressed as a different LLRP Parameter. The air protocol specific TagSpec LLRP Parameters are defined in section 15.1. This field carries a single TagSpec parameter corresponding to the air protocol referenced by the ProtocolID in the AccessSpec Parameter.

OpSpec: List of LLRP Parameters

Possible Values:

Each parameter can be either an air protocol specific OpSpec LLRP Parameter or a <ClientRequestOpSpec Parameter>.

Regarding the air protocol specific OpSpec LLRP Parameter: Each air protocol's OpSpec parameter is expressed as a different LLRP Parameter. The air protocol specific OpSpec LLRP Parameters are defined in section 15.1. The list of OpSpecs in this field is comprised of OpSpec parameters corresponding to the air protocol referenced by the ProtocolID in the AccessSpec Parameter.

Custom Extension Point List: List of <Custom Parameter> [Optional]

1641

1665

- In case there are multiple AccessSpecs that get matched during a TagSpec lookup, the
- Reader SHALL only execute the first enabled AccessSpec that matches, where the
- ordering of the AccessSpecs is the order in which the AccessSpecs were created by the
- 1645 Client.
- 1646 The order of execution of OpSpecs within an AccessSpec is the order in which the
- 1647 OpSpecs were set up in the AccessSpec. If an OpSpec execution fails, the Reader
- 1648 SHALL stop the execution of the AccessSpec.

1649 11.2.1.2.1 ClientRequestOpSpec Parameter

- 1650 This parameter is sent as part of the possible values for the AccessSpec OpSpec list. One
- or more ClientRequestOpSpec operations may be performed on a tag in succession.
- 1652 Upon executing a ClientRequestOpSpec Parameter, a Reader will immediately send the
- 1653 CLIENT REQUEST OP message to the Client. This CLIENT REQUEST OP message
- 1654 carries the TagReportData (section 13.2.3) that contains information collected for the tag
- which includes singulation results and the results of OpSpecs executed till that point.
- 1656 A global timeout is associated with this request. If the Client does not return a
- 1657 ClientRequestResponse within the *ClientRequestOpSpecTimeout* (LLRP Capabilities)
- period, or the AirProtocolOpSpec List is empty in the ClientRequestResponse, the
- execution of the AccessSpec is cancelled.
- 1660 Compliance requirement: Compliant Readers and Clients MAY implement this
- 1661 parameter. Readers that do not support ClientRequestOpSpec SHALL set
- SupportClientRequestOpSpec to false in LLRPCapabilities. If such a Reader receives an
- ADD ACCESSSPEC with an AccessSpec that contained this OpSpec parameter, the
- Reader SHALL return an error for that message, and not add the AccessSpec.

ClientRequestOpSpec Parameter

OpSpecID: Unsigned Short Integer.

Possible Values: 0 is an illegal value.

11.2.2 ClientRequestResponse Parameter

- 1666 This parameter describes the list of OpSpecs that the Reader has to execute on the tag for
- which a Client request was initiated. The AccessSpecID is the identifier of the
- AccessSpec that had the Client request; the EPC data is the singulated data of the tag for
- which this Client request was initiated. The AirProtocolOpSpec list contained in the
- 1670 ClientRequestResponse SHALL be processed as the next OpSpecs sent over the air
- interface. If the AirProtocolOpSpec List is empty, then the execution of the AccessSpec
- specified by AccessSpecID is cancelled.
- 1673 **Compliance requirement**: Compliant Readers MAY implement this parameter. Readers
- that do not support ClientRequestOpSpec MAY ignore this parameter.

ClientRequestResponse Parameter

AccessSpecID: Unsigned Integer. The ID of the AccessSpec that triggered this request.

EPCdata: <EPCData Parameter>. The electronic product code of the RFID tag that triggered this request.

AirProtocolOpSpecList: List of LLRP OpSpec Parameter.

Possible Values:

Each air protocol's OpSpec parameter is expressed as a different LLRP Parameter. The air protocol specific OpSpec LLRP Parameters are defined in section 15.1. This field carries a list of OpSpec parameters corresponding to the air protocol referenced by ProtocolID in the AccessSpec that generated the Client request.

1675 **12 Reader Device Configuration**

1676 This section contains the messages and parameters for getting and setting configuration.

1677 12.1 Messages

1678 **12.1.1 GET_READER_CONFIG**

- 1679 This command is issued by the Client to get the current configuration information of the
- Reader. The Requested Data passed in the command represents the parameter(s) of
- interest to the Client that has to be returned by the Reader.
- 1682 Compliance requirement: Compliant Readers and Clients SHALL implement this
- message.

GET READER CONFIG

RequestedData: Integer

Possible Values:

Value	Requested Data
0	All
1	Identification
2	AntennaProperties
3	AntennaConfiguration
4	ROReportSpec
5	ReaderEventNotificationSpec
6	AccessReportSpec
7	LLRPConfigurationStateValue
8	KeepaliveSpec
9	GPIPortCurrentState
10	GPOWriteData
11	EventsAndReports

AntennaID: Unsigned Short Integer. This field is ignored when RequestedData != 0 or 2 or 3. If the AntennaID is 0, get antenna information (AntennaProperties, AntennaConfiguration) for all antennas.

GPIPortNum: Unsigned Short Integer. This field is ignored when RequestedData != 0 or 9. If the GPIPortNum is 0, get GPI port current state for all GPI ports.

GPOPortNum: Unsigned Short Integer. This field is ignored when RequestedData != 0 or 10. If the GPOPortNum is 0, get GPO port current state for all GPO ports.

Custom Extension Point List: List of <custom Parameter> [Optional]

12.1.2 GET_READER_CONFIG_RESPONSE

This is the response by the Reader to the GET_READER_CONFIG message. The response is the LLRPStatus Parameter and the list of configuration parameters based on the RequestedData in GET_READER_CONFIG. If the GET_READER_CONFIG message did not have any errors, the success code is returned in the LLRPStatus parameter, and in addition the requested configuration parameters are returned. If there is an error, the appropriate error code is returned in the LLRPStatus parameter. The response contains at most one instance of each configuration parameter except for two cases, which are as follows:

- If RequestedData is 0, 2 or 3, and AntennaID is set to 0 in the GET_READER_CONFIG message, the Reader SHALL return one instance of AntennaProperties Parameter or AntennaConfiguration Parameter per requested antenna.
- If RequestedData is 0 or 9 (10), and GPIPortNum (GPOPortNum) is set to 0 in the GET_READER_CONFIG message, and, if the Reader supports GPI (GPO), the Reader SHALL return one instance of GPIPortCurrentState (GPOWriteData) Parameter per requested GPI Port (GPO Port).
- **Compliance requirement**: Compliant Readers and Clients SHALL implement this message.

GET READER CONFIG RESPONSE **Status:** LLRPStatus Parameter **Response Data**: Set of LLRP Parameters. Possible Values: The possible members are zero or more of {< LLRPConfigurationStateValue Parameter>, <ReaderEventNotificationSpec Parameter>, <Antenna Properties Parameter>, <Antenna Configuration Parameter>, <ROReportSpec Parameter>, <AccessReportSpec Parameter>, <Identification Parameter>, <KeepaliveSpec Parameter>, <GPIPortCurrentState Parameter>, <GPOWriteData Parameter>, <EventsAndReports Parameter> **Custom Extension Point** List: List of <custom Parameter> [Optional]

12.1.3 SET_READER_CONFIG

- 1704 This command is issued by the Client to the Reader. This command sets the Reader
- 1705 configuration using the parameters specified in this command. Values passed by the
- 1706 SET_READER_CONFIG SHALL apply for the duration of the LLRP connection, or
- until the values are changed by additional SET_READER_CONFIG messages.
- 1708 For example, ROReportSpec defines the reporting of ROReport format and trigger for a
- 1709 ROSpec. ROReportSpec sent as part of SET_READER_CONFIG becomes the default
- 1710 ROReportSpec for the Reader. A ROReportSpec sent as part of ROSpec in the
- 1711 ADD_ROSPEC command overrides the default value for that ROSpec. However, in
- 1712 cases where there is no ROReportSpec specified in a ROSpec sent as part of
- 1713 ADD_ROSPEC, that particular ROSpec inherits the default ROReportSpec.
- 1714 The data field ResetToFactoryDefault informs the Reader to set all configurable values to
- factory defaults before applying the remaining parameters.
- 1716 Compliance requirement: Compliant Readers and Clients SHALL implement this
- 1717 message.

1703

SET READER CONFIG

ResetToFactoryDefault: Boolean. If true, the Reader will set all configurable values to factory defaults before applying the remaining parameters.

Configuration Data: Set of LLRP Parameters

Possible Values: The possible members of the set are

{<ReaderEventNotificationSpec Parameter>,

- <Antenna Properties Parameter>,
- <Antenna Configuration Parameter>,
- <ROReportSpec Parameter>,
- <AccessReportSpec Parameter>,
- <KeepaliveSpec Parameter>,
- <GPOWriteData Parameter>,
- <GPIPortCurrentState Parameter>,
- <EventsAndReports Parameter>}

Custom Extension Point List: List of <custom Parameter> [Optional]

1718 12.1.4 SET_READER_CONFIG_RESPONSE

- 1719 This is the response by the Reader to a SET READER CONFIG command. If all the
- parameters specified in the SET READER CONFIG command are successfully set, then
- the success code is returned in the LLRPStatus parameter. If there is an error, the
- appropriate error code is returned in the LLRPStatus parameter.
- 1723 Compliance requirement: Compliant Readers and Clients SHALL implement this
- message.

SET_READER_CONFIG_RESPONSE

Response: < LLRPStatus Parameter>

1725 **12.1.5 CLOSE_CONNECTION**

- 1726 This command is issued by the Client to the Reader. This command instructs the Reader
- to gracefully close its connection with the Client. Under normal operating conditions, a
- 1728 Client SHALL attempt to send this command before closing an LLRP connection. A
- 1729 Client should wait briefly for the Reader to respond with a
- 1730 CLOSE CONNECTION RESPONSE.
- 1731 Upon receipt of this command, the Reader SHALL respond with the
- 1732 CLOSE CONNECTION REPONSE message and it should then attempt to close the
- 1733 connection between the Reader and Client.

- 1734 Having executed a CLOSE CONNECTION command, a Reader MAY persist its
- 1735 configuration state as defined by the ReaderConfigurationStateValue parameter specified
- 1736 in section 12.2.1.
- 1737 Compliance requirement: Compliant Readers and Clients SHALL implement this
- message.

CLOSE_CONNECTION

1739 12.1.6 CLOSE_CONNECTION_RESPONSE

- 1740 This is the response by the Reader to a CLOSE_CONNECTON command from the
- 1741 Client. Upon receiving a CLOSE CONNECTION command, the Reader SHALL
- attempt to send this response to the Client. After attempting to send this response, the
- 1743 Reader SHALL close its connection with the Client.
- 1744 Compliance requirement: Compliant Readers and Clients SHALL implement this
- message.

CLOSE_CONNECTION_RESPONSE

Status: <LLRPStatus Parameter>

1746

1747

1753

12.2 Parameters

1748 **12.2.1 LLRPConfigurationStateValue Parameter**

- 1749 This parameter, LLRPConfigurationStateValue, is a 32-bit value which represents a
- 1750 Reader's entire LLRP configuration state including: LLRP configuration parameters,
- vendor extension configuration parameters, ROSpecs, and AccessSpecs. A Reader
- 1752 SHALL change this value only:
 - Upon successful execution of any of the following messages:
- 1754 o ADD ROSPEC
- 1755 o DELETE_ROSPEC
- o ADD ACCESSSPEC
- o DELETE ACCESSSPEC
- o SET READER CONFIG
- 1759 Any CUSTOM_MESSAGE command that alters the reader's internal configuration.
- Upon an automatically deleted AccessSpec due to completion of OperationCountValue number of operations (Section 11.2.1.1).
- 1763 A Reader SHALL not change this value when the CurrentState of a ROSpec or AccessSpec changes.

- 1765 The mechanism used to compute the LLRP configuration state value is implementation
- dependent. However, a good implementation will insure that there's a high probability
- that the value will change when the Reader's configuration state changes.
- 1768 It is expected that a Client will configure the Reader and then request the Reader's
- 1769 configuration state value. The Client will then save this state value. If this value does not
- change between two requests for it, then a Client may assume that the above components
- of the LLRP configuration have also not changed.

1772

- 1773 Compliance requirement: Compliant Readers and Clients SHALL implement this
- parameter. When requested by a Client, the Reader SHALL compute a state value based
- 1775 upon the Reader's current configuration state. Upon each request, the Reader SHALL
- 1776 return the same state value provided a Client has not altered the Reader's configuration
- state between requests. Aside from this requirement, the computation of the state value is
- implementation dependent.

LLRPConfigurationStateValue Parameter

LLRPConfigurationStateValue: Unsigned Integer

1779 **12.2.2 Identification Parameter**

- 1780 This parameter carries an identification parameter that is unique within the local
- administration domain. The identifier could be the Reader MAC address or EPC. The
- 1782 IDType defines the type of the identification value contained in this Parameter.
- 1783 Compliance requirement: Compliant Readers and Clients SHALL implement this
- 1784 parameter.

1785

Identification Parameter

IDType: Integer

Possible Values:

IDType ID

0 MAC address

1 EPC

Reader ID: Byte array. If IDType=0, the MAC address SHALL be encoded as EUI-64.[EUI64]

12.2.3 GPOWriteData Parameter

- This parameter carries the data pertinent to perform the write to a general purpose output port.
- 1788 Compliance requirement: Compliant Readers and Clients MAY implement this
- 1789 parameter. Readers that do not support GPOs SHALL set NumGPOs in the
- 1790 GPIOCapabilities to zero. If such a Reader receives a SET READER CONFIG with

- GPOWriteData Parameter, the Reader SHALL return an error message and not process
- any of the parameters in that message.

GPOWriteData Parameter

GPO Port Number: Unsigned Short Integer. 0 is invalid.

GPO Data: Boolean. The state to output on the specified GPO port.

1793 **12.2.4 KeepaliveSpec Parameter**

- 1794 This parameter carries the specification for the keepalive message generation by the
- 1795 Reader. This includes the definition of the periodic trigger to send the keepalive message.
- 1796 **Compliance requirement**: Compliant Readers and Clients SHALL implement this parameter.

KeepaliveSpec Parameter

KeepaliveTriggerType: Integer

Possible Values:

```
Value Definition
---- 0 Null - No keepalives SHALL be sent by the Reader
1 Periodic
```

PeriodicTriggerValue: Integer. Time interval in milliseconds. This field is ignored when KeepaliveTriggerType is not 1.

1798 **12.2.5 AntennaProperties Parameter**

- 1799 This parameter carries a single antenna's properties. The properties include the gain and
- 1800 the connectivity status of the antenna. The antenna gain is the composite gain and includes
- the loss of the associated cable from the Reader to the antenna. The gain is represented in
- dBi*100 to allow fractional dBi representation.
- 1803 **Compliance requirement**: Compliant Readers and Clients MAY implement this parameter.

Antenna Properties Parameter

AntennaID: Unsigned Short Integer

Possible Values:

1 to N, where N is the maximum number of antennas supported by the device.

AntennaGain: Signed short integer. The gain of the antenna in dBI*100 (dB relative to Isotropic) to allow for fractional dBi representation.

AntennaConnected: Boolean. False = not connected, True = connected.

1805 12.2.6 AntennaConfiguration Parameter

- 1806 This parameter carries a single antenna's configuration and it specifies the default values
- 1807 for the parameter set that are passed in this parameter block. The scope of the default
- values is the antenna. The default values are used for parameters during an operation on
- this antenna if the parameter was unspecified in the spec that describes the operation.
- 1810 **Compliance requirement**: Compliant Readers and Clients SHALL implement this parameter.

AntennaConfiguration Parameter

Antenna ID: Unsigned Short Integer. If set to zero, this configuration applies to all the antennas.

RFReceiverSettings: <RFReceiver Parameter> [Optional]

RFTransmitterSettings: <RFTransmitter Parameter> [Optional]

AirProtocolInventoryCommandSettings: List of LLRP parameters. [Optional]

Possible Values:

Each air protocol's inventory command parameter is expressed as a different LLRP Parameter. The air protocol specific inventory command LLRP Parameters are defined in section 15.1. This field is a list of inventory command LLRP Parameters, one per air protocol, that the Client would like to use as the default inventory command setting for inventory operations using the air protocol on this antenna.

- 1812 **12.2.6.1 RFReceiver Parameter**
- 1813 This Parameter carries the RF receiver information. The Receiver Sensitivity defines the
- sensitivity setting at the receiver. The value is the index into the ReceiveSensitivityTable
- 1815 (section 9.2.1.1).
- 1816 Compliance requirement: Compliant Readers and Clients SHALL implement this
- parameter.

RFReceiver Parameter

ReceiverSensitivity: Unsigned Short Integer - an index into the ReceiveSensitivity Table (section 9.2.1.1)

1818 **12.2.6.2 RFTransmitter Parameter**

- 1819 This Parameter carries the RF transmitter information. The Transmit Power defines the
- 1820 transmit power for the antenna expressed as an index into the TransmitPowerTable
- (section 9.2.4.1.1). The HopTableID is the index of the frequency hop table to be used by
- the Reader (section 9.2.4.1.2.1) and is used when operating in frequency-hopping
- regulatory regions. This field is ignored in non-frequency-hopping regulatory regions.
- The ChannelIndex is the one-based channel index in the FixedFrequencyTable to use
- during transmission (section 9.2.4.1.2.2) and is used when operating in non-frequency-

- 1826 hopping regulatory regions. This field is ignored in frequency-hopping regulatory
- regions.
- 1828 Compliance requirement: Compliant Readers and Clients SHALL implement this
- parameter.

RFTransmitter Parameter

Transmit Power: Unsigned Short Integer - an index into the Transmit Power table.

HopTableID: Unsigned Short Integer

ChannelIndex: Unsigned Short Integer. This is the index of the frequency to use.

1830 **12.2.6.3 GPIPortCurrentState Parameter**

- 1831 This Parameter carries the current configuration and state of a single GPI port. In a
- 1832 SET READER CONFIG message, this parameter is used to enable or disable the GPI
- 1833 port using the GPIConfig field; the GPIState field is ignored by the reader. In a
- 1834 GET READER CONFIG message, this parameter reports both the configuration and
- state of the GPI port.
- 1836
- 1837 When a ROSpec or AISpec is configured on a GPI-capable reader with GPI start and/or
- stop triggers, those GPIs must be enabled by the client with a SET READER CONFIG
- message for the triggers to function.
- 1840
- 1841 Compliance requirement: Compliant Readers and Clients MAY implement this
- 1842 parameter. Readers that do not support GPIs SHALL set NumGPIs in the
- 1843 GPIOCapabilities to zero. If such a Reader receives a GET READER CONFIG with a
- 1844 GPIPortCurrentState Parameter, the Reader SHALL return an error message and not
- process any of the parameters in that message.

GPIPortCurrentState Parameter

GPIPortNum: Unsigned Short Integer. Zero is illegal.

GPIConfig: Boolean (0 for disabled, 1 for enabled)

GPIState: Integer (ignored in SET READER CONFIG messages)

Possible Values:

Value	Defi	initior	ſ	
			-	
0	GPI	state	is	low
1	GPI	state	is	high
2	GPI	state	is	unknown

1846 **12.2.6.4 EventsAndReports Parameter**

- 1847 This parameter controls the behavior of the Reader when a new LLRP connection is
- 1848 established. In a SET READER CONFIG message, this parameter is used to enable or
- 1849 disable the holding of events and reports upon connection using the
- 1850 HoldEventsAndReportsUponReconnect field. In a GET READER CONFIG message,
- 1851 this parameter reports the current configuration. If the

- HoldEventsAndReportsUponReconnect is true, the reader will not deliver any reports or
- 1853 events (except the ConnectionAttemptEvent) to the Client until the Client issues an
- 1854 ENABLE EVENTS AND REPORTS message. Once the
- 1855 ENABLE_EVENTS_AND_REPORTS message is received the reader ceases its hold on
- events and reports for the duration of the connection.

1857

- 1858 **Compliance requirement**: Compliant Readers and Clients MAY implement this parameter.
 - **EventsAndReports Parameter**

HoldEventsAndReportsUponReconnect: Boolean. (False does not hold reports and events, True holds reports and events)

1860 13 Reports, Notifications and Keepalives

- 1861 This section describes the messages and parameters used in reports, event notifications
- and keepalives that are generated by the Reader and sent to the Client.
- 1863 The Reader SHALL send reports only when
- A reporting trigger (ROReportTrigger or AccessReportTrigger) generates a report while a connection is open, or
- In response to an explicit Client request (GET_REPORT or ENABLE EVENTS AND REPORTS), or
- A notification event occurs and the event is enabled.
- 1869 The triggers may be specified per ROSpec and AccessSpec using ROReportSpec and
- 1870 AccessReportSpec parameters. In a report, the Reader SHALL send new data (results of
- 1871 ROSpecs and/or AccessSpecs) acquired since the last report message. The tag report data
- 1872 generated by the AccessReport trigger SHALL NOT duplicate the tag report data
- generated by the ROReportTrigger, and vice-versa.

1874 13.1 Messages

1875 13.1.1 GET REPORT

- 1876 This message is issued by the Client to the Reader to get the tag reports. In response to
- this message, the Reader SHALL return tag reports accumulated.
- 1878 Compliance requirement: Compliant Readers and Clients SHALL implement this
- 1879 message.

GET_REPORT

1880 **13.1.2 RO ACCESS REPORT**

- This message is issued by the Reader to the Client, and it contains the results of the RO
- and Access operations. The ROReportSpec and AccessReportSpec parameters define the
- 1883 contents and triggers for this message.
- 1884 Compliance requirement: Compliant Readers and Clients SHALL implement this
- 1885 message.

RO ACCESS REPORT

InventoryAccessReportData: List of <TagReportData Parameter> [Optional]

RFSurveyReportData: List of <RFSurveyReportData Parameter> [Optional]

Custom Extension Point List: List of <custom Parameter> [Optional]

1886 13.1.3 KEEPALIVE

- 1887 This message is issued by the Reader to the Client. This message can be used by the
- 1888 Client to monitor the LLRP-layer connectivity with the Reader. The Client configures the
- trigger at the Reader to send the Keepalive message. The configuration is done using the
- 1890 KeepaliveSpec parameter (section 12.2.4).
- 1891 Compliance requirement: Compliant Readers and Clients SHALL implement this
- message.

KEEPALIVE

1893 **13.1.4 KEEPALIVE_ACK**

- 1894 A Client SHALL generate a KEEPALIVE ACK in response to each KEEPALIVE
- received by the reader.
- 1896 Compliance requirement: Compliant Readers and Clients SHALL implement this
- message.

KEEPALIVE_ACK

1898 13.1.5 READER_EVENT_NOTIFICATION

- 1899 This message is issued by the Reader to the Client whenever an event that the Client
- 1900 subscribed to occurs. The pertinent event data is conveyed using the
- 1901 ReaderEventNotificationData parameter.
- 1902 Compliance requirement: Compliant Readers and Clients SHALL implement this
- 1903 message.

READER EVENT NOTIFICATION

ReaderEventNotificationData: ReaderEventNotificationData Parameter

1904

1905 13.1.6 ENABLE_EVENTS_AND_REPORTS

- 1906 This message can be issued by the Client to the Reader after a LLRP connection is
- 1907 established. The Client uses this message to inform the Reader that it can remove its hold
- on event and report messages. Readers that are configured to hold events and reports on
- reconnection (See Section 12.2.6.4) respond to this message by returning the tag reports
- accumulated (same way they respond to GET_REPORT (See Section 13.1.1)).
- 1911 **Compliance requirement**: Compliant Readers and Clients MAY implement this message.
 - ENABLE EVENTS AND REPORTS

1913

1914 **13.2 Parameters**

1915 **13.2.1 ROReportSpec Parameter**

- 1916 This Parameter carries the Reader inventory and RF survey reporting definition for the
- 1917 antenna. This parameter describes the contents of the report sent by the Reader and
- defines the events that cause the report to be sent.
- 1919 The ROReportTrigger field defines the events that cause the report to be sent.
- 1920 The TagReportContentSelector parameter defines the desired contents of the report. The
- 1921 ROReportTrigger defines the event that causes the report to be sent by the Reader to the
- 1922 Client.
- See section 13.2.6.1 for details about the order that reports are to be sent with respect to
- 1924 Reader event notifications.
- 1925 Compliance requirement: Compliant Readers and Clients SHALL implement this
- 1926 parameter.

ROReportSpec Parameter

ROReportTrigger: Integer

Possible Values:

Value Definition
----0 None
1 (Upon N TagReportData Parameters or End of AISpec)
Or (End of RFSurveySpec) - N=0 is unlimited.
2 Upon N TagReportData Parameters or End of ROSpec N=0 is unlimited.

N: Unsigned Short Integer. This is the number of TagReportData Parameters used in ROReportTrigger = 1 and 2. If N = 0, there is no limit on the number of TagReportData Parameters. This field SHALL be ignored when ROReportTrigger =

0.

ReportContents: <TagReportContentSelector Parameter>

Custom Extension Point List: List of <Custom Parameter> [Optional]

1927 **13.2.1.1 TagReportContentSelector Parameter**

- 1928 This parameter is used to configure the contents that are of interest in TagReportData. If
- enabled, the field is reported along with the tag data in the TagReportData.
- 1930 Compliance requirement: Compliant Readers and Clients SHALL implement this
- 1931 parameter.

TagReportContentSelector

EnableROSpecID: Boolean **EnableSpecIndex:** Boolean

EnableInventoryParameterSpecID: Boolean

EnableAntennaID: Boolean

EnableChannelIndex: Boolean

EnablePeakRSSI: Boolean

EnableFirstSeenTimestamp: Boolean **EnableLastSeenTimestamp**: Boolean

EnableTagSeenCount: Boolean

AirProtocolSpecificEPCMemorySelector: LLRP parameter.

Possible Values:

Each air protocol's EPC memory selector parameter is expressed as a different LLRP Parameter. The air protocol specific EPC memory selector LLRP Parameters are defined in section 15.1. This field is the EPC memory selector LLRP Parameter corresponding to the air protocol referenced by the ProtocolID in the ROSpec that the ROReportSpec is part of.

EnableAccessSpecID: Boolean

1932 13.2.2 AccessReportSpec Parameter

- 1933 This parameter sets up the triggers for the Reader to send the access results to the Client.
- 1934 In addition, the Client can enable or disable reporting of ROSpec details in the access
- 1935 results.
- 1936 **Compliance requirement**: Compliant Readers and Clients SHALL implement this
- 1937 parameter.

AccessReportSpec

AccessReportTrigger: Integer Possible Values: Value Definition ----0 Whenever ROReport is generated for the RO that triggered the execution of this AccessSpec. 1 End of AccessSpec

13.2.3 TagReportData Parameter

1938 1939

1940

1941

1942 1943

1944

1945

1946

1947

1948 1949

1950

This report parameter is generated per tag per accumulation scope. The only mandatory portion of this parameter is the EPCData parameter. If there was an access operation performed on the tag, the results of the OpSpecs are mandatory in the report. The other sub-parameters in this report are optional. LLRP provides three ways to make the tag reporting efficient:

- (i) Allow parameters to be enabled or disabled via TagReportContentSelector (section 13.2.1.1) in TagReportSpec.
- (ii) If an optional parameter is enabled, and is absent in the report, the Client SHALL assume that the value is identical to the last parameter of the same type received. For example, this allows the Readers to not send a parameter in the report whose value has not changed since the last time it was sent by the Reader.
- 1951 (iii) Allow accumulation of tag reports. See next section for details of accumulation.
- 1953 **Compliance Requirement:** Compliant Readers and Clients SHALL implement this parameter.

TagReportData Parameter

EPCData: <EPCData Parameter>

ROSpecID: <ROSpecID Parameter> [Optional]

SpecIndex: <SpecIndex Parameter> [Optional]

InventoryParameterSpecID: <InventoryParameterSpecID Parameter> [Optional]

AntennaID: <AntennaID Parameter> [Optional]

PeakRSSI: <PeakRSSI Parameter> [Optional]

ChannelIndex: < ChannelIndex Parameter > [Optional]

FirstSeenTimestampUTC: <UTCFirstSeenTimestamp Parameter> [Optional]

FirstSeenTimeStampUptime: <UptimeFirstSeenTimestamp Parameter> [Optional]

LastSeenTimestampUTC: <UTCLastSeenTimestamp Parameter> [Optional]

LastSeenTimeStampUptime: <UptimeLastSeenTimestamp Parameter> [Optional]

TagSeenCount: <TagSeenCount Parameter> [Optional]

AirProtocolTagData: LLRP Parameters (e.g., C1G2EPC-PC, C1G2EPC-CRC) [Optional]

Possible Values:

Each air protocol's AirProtocolTagData parameter is expressed as a different LLRP Parameter. The air protocol specific AirProtocolTagData LLRP Parameters are defined in section 15.1. This field is the AirProtocolTagData LLRP Parameter corresponding to the air protocol referenced by the ProtocolID of the InventoryParameterSpec during whose execution this tag was observed.

AccessSpecID: AccessSpecID Parameter [Optional]

OpSpecResultList: List of LLRP parameters [Optional]

Possible Values of each LLRP Parameter: Air protocol specific OpSpecResult parameter or <ClientRequestOpSpecResult Parameter>.

Regarding the air protocol specific OpSpecResult parameter: Each air protocol's OpSpecResult parameter is expressed as a different LLRP Parameter. The air protocol specific OpSpecResult LLRP Parameters are defined in section 15.1. This field is a list of OpSpecResult LLRP Parameters corresponding to the air protocol referenced by the ProtocolID of the AccessSpec.

Custom Extension Point List: List of <Custom Parameter> [Optional]

1955 **13.2.3.1** Accumulation of TagReportData

- A Reader MAY accumulate multiple tag reports into a single tag report. If a Reader
- accumulates, the Reader SHALL follow the accumulation rules specified in this section.
- The following specifies the rules for accumulating multiple tag observations into a single
- 1959 TagReportData:

1960

1961

1962

1964

1965

1966

1967

1968

1969

1970 1971

1972

1973

- EPCData:
 - The Reader SHALL not accumulate tag reports that do not have the same EPCData value.
- OpSpecResultList:
 - o The Reader SHALL not accumulate tag reports that do not have the same value for the OpSpec results in the OpSpecResultList.
 - SpecID, SpecIndex, InventoryParameterSpecID, AntennaID, AirProtocolTagData, AccessSpecID:
 - These fields are optional, and their reporting can be enabled by the Client.
 If the Client has enabled one or more fields listed above, the Reader SHALL not accumulate tag reports that do not have the same value for all the enabled fields
 - FirstSeenTimestamp, LastSeenTimestamp, PeakRSSI, TagSeenCount, ChannelIndex

- o These fields are optional, and their reporting can be enabled by the Client. 1974 If the field is enabled, the Reader sets the value of these fields as follows: 1975 1976 FirstSeenTimestamp: The Reader SHALL set it to the time of the 1977 first observation amongst the tag reports that get accumulated in the TagReportData. 1978 1979 LastSeenTimestamp: The Reader SHALL set it to the time of the last observation amongst the tag reports that get accumulated in the 1980 1981 TagReportData. 1982 PeakRSSI: The Reader SHALL set it to the maximum RSSI value 1983 observed amongst the tag reports that get accumulated in the TagReportData. 1984 1985 • ChannelIndex: The Reader MAY set it to the index of the first 1986 channel the tag was seen. 1987 TagSeenCount: The Reader SHALL set it to the number of tag 1988 reports that get accumulated in the TagReportData.
- **1989 13.2.3.2 EPCData Parameter**
- 1990 This parameter carries the EPC identifier information.
- 1991 Compliance requirement: Compliant Readers and Clients SHALL implement this
- 1992 parameter.

EPCData Parameter

EPC: Bit array

- 1993 **13.2.3.3 ROSpecID Parameter**
- 1994 This parameter carries the ROSpecID information.
- 1995 Compliance requirement: Compliant Readers and Clients SHALL implement this
- 1996 parameter.

ROSpecID Parameter

ROSpecID: Unsigned Integer

1997 **13.2.3.4** SpecIndex Parameter

- 1998 This parameter carries the SpecIndex information. The SpecIndex indicates the item
- within the ROSpec that was being executed at the time the tag was observed.
- 2000 **Compliance requirement**: Compliant Readers and Clients SHALL implement this parameter.

SpecIndex Parameter

SpecIndex: Unsigned Short Integer

- 2002 13.2.3.5 InventoryParameterSpecID Parameter
- This parameter carries the InventoryParameterSpecID information.
- 2004 Compliance requirement: Compliant Readers and Clients SHALL implement this
- 2005 parameter.

InventoryParameterSpecID Parameter

InventoryParameterSpecID: Unsigned Short Integer

- **2006 13.2.3.6 AntennalD Parameter**
- 2007 This parameter carries the AntennaID information.
- 2008 Compliance requirement: Compliant Readers and Clients SHALL implement this
- 2009 parameter.

AntennaID Parameter

AntennaID: Unsigned Short Integer

- **2010 13.2.3.7 PeakRSSI Parameter**
- 2011 This parameter carries the PeakRSSI information.
- 2012 Compliance requirement: Compliant Readers and Clients SHALL implement this
- 2013 parameter.

PeakRSSI Parameter

PeakRSSI: Signed Integer. The peak received power of the EPC backscatter in dBm.

Possible Values:

-128 to +127.

- 2014 **13.2.3.8 ChannelIndex Parameter**
- 2015 This parameter carries the one-based ChannelIndex value.
- 2016 Compliance requirement: Compliant Readers and Clients SHALL implement this
- 2017 parameter.

ChannelIndex Parameter

ChannelIndex: Unsigned Integer

Possible Values: 0 to 255.

- 2018 13.2.3.9 FirstSeenTimestampUTC Parameter
- This parameter carries the FirstSeenTimestamp information in UTC.
- 2020 Compliance requirement: Compliant Readers and Clients that have UTC clocks
- 2021 SHALL implement this parameter.

FirstSeenTimestampUTC Parameter

Microseconds: Unsigned long Integer. This is the time elapsed since the Epoch (00:00:00 UTC, January 1, 1970) measured in microseconds.

2022 13.2.3.10 FirstSeenTimestampUptime Parameter

- This parameter carries the FirstSeenTimestamp information in Uptime.
- 2024 Compliance requirement: Compliant Readers and Clients that do not have UTC clocks
- 2025 SHALL implement this parameter. Compliant Readers and Clients that have UTC clocks
- 2026 MAY implement this parameter.

FirstSeenTimestampUptime Parameter

Microseconds: Unsigned long Integer. This is the time elapsed since boot, measured in microseconds.

2027 13.2.3.11 LastSeenTimestampUTC Parameter

- This parameter carries the LastSeenTimestamp information in UTC.
- 2029 Compliance requirement: Compliant Readers and Clients that have UTC clocks
- 2030 SHALL implement this parameter.

LastSeenTimestampUTC Parameter

Microseconds: Unsigned long Integer. This is the time elapsed since the Epoch (00:00:00 UTC, January 1, 1970) measured in microseconds.

2031 **13.2.3.12 LastSeenTimestampUptime Parameter**

- This parameter carries the LastSeenTimestamp information in Uptime.
- 2033 Compliance requirement: Compliant Readers and Clients that do not have UTC clocks
- 2034 SHALL implement this parameter. Compliant Readers and Clients that have UTC clocks
- 2035 MAY implement this parameter.

LastSeenTimestampUptime Parameter

Microseconds: Unsigned long Integer. This is the time elapsed since boot, measured in microseconds.

2036 **13.2.3.13 TagSeenCount Parameter**

- 2037 This parameter carries the tag seen count information. If TagSeenCount > 65535 for the
- 2038 report period, the reader SHALL report 65535.
- 2039 Compliance requirement: Compliant Readers and Clients SHALL implement this
- 2040 parameter.

TagSeenCount Parameter

Count: Unsigned Short Integer

2041 13.2.3.14 ClientRequestOpSpecResult Parameter

2042 **Compliance requirement**: Compliant Readers and Clients MAY implement this parameter.

ClientRequestOpSpecResult Parameter

OpSpecID: Unsigned Short Integer. 0 is illegal.

2044 13.2.3.15 AccessSpecID Parameter

- This parameter carries the AccessSpecID information.
- 2046 **Compliance requirement**: Compliant Readers and Clients SHALL implement this parameter.

AccessSpecID Parameter

AccessSpecID: Unsigned Integer

2048 **13.2.4 RFSurveyReportData Parameter**

- This describes the content of the RF Survey Report.
- 2050 **Compliance requirement**: Compliant Readers and Clients MAY implement this
- 2051 parameter.

RFSurveyReportData Parameter

ROSpecID: <ROSpecID Parameter> [Optional]

SpecIndex: <SpecIndex Parameter> [Optional]

FrequencyPowerLevelList: List of <FrequencyRSSILevelEntry Parameter>

Custom Extension Point List: List of <custom Parameter > [Optional]

2052 **13.2.4.1** FrequencyRSSILevelEntry Parameter

2053 **Compliance requirement**: Compliant Readers and Clients MAY implement this

2054 parameter.

FrequencyRSSILevelEntry Parameter

Timestamp: Either <UTCTimestamp Parameter> or <Uptime Parameter>

Frequency: Unsigned Integer. The frequency on which the measurement was taken, specified in kHz.

Bandwidth: Unsigned Integer. The measurement bandwidth of the measurement in kHz.

Average RSSI: Integer in dBm. The average power level observed at this frequency.

Possible Values:

-128 to + 127

Peak RSSI: Integer in dBm. The peak power level observed at this frequency.

Possible Values:
-128 to + 127

2055 **13.2.5** ReaderEventNotificationSpec Parameter

- This parameter is used by the Client to enable or disable notification of one or more Reader events. Notification of buffer overflow events and connection events (attempt/close) are mandatory, and not configurable.
- 2059 **Compliance requirement**: Compliant Readers and Clients SHALL implement this parameter.

ReaderEventNotificationSpec Parameter

EventNotificationSpecTable: List of <EventNotificationState Parameter>

2061 13.2.5.1 EventNotificationState Parameter

- This parameter is used to enable or disable notification of a single Reader event type.
- 2063 **Compliance requirement**: Compliant Readers and Clients SHALL implement this parameter.

EventNotificationState Parameter EventType: Possible Values: Value Definition _____ Upon hopping to next channel (e.g., in FCC regulatory region) 1 GPI event ROSpec event (start/end/preempt) Report buffer fill warning Reader exception event RFSurvey event (start/end) 6 AISpec event (end) AISpec event (end) with singulation details Antenna event (disconnect/connect) **NotificationState:** Boolean; enable = true, disable = false.

13.2.6 ReaderEventNotificationData Parameter

2065

2066 2067

2068

2069

2070

2071

This parameter describes the contents of the event notification sent by the Reader, and defines the events that cause the notification to be sent. Event notification messages may be sent by the Reader due to connection establishment/closing event, critical events such as hopping, fault-detection in a Reader functional block, buffer overflow, due to the activation of a Reader accessory trigger input (e.g. motion detection), or due to performance monitoring events such as abnormalities in the RF environment.

2072 Timestamp is the time that the events reported occurred.

2073 **Compliance requirement**: Compliant Readers and Clients SHALL implement this parameter.

```
ReaderEventNotificationData Parameter
Timestamp: Either <UTCTimestamp Parameter> or <Uptime Parameter>
Events: List of events.
Possible Values: The possible members of the list are
 <HoppingEventParameter>,
 <GPIEvent Parameter>,
 <ROSpecEvent Parameter>,
 <ReportBufferLevelWarningEvent Parameter>,
 <ReportBufferOverflowErrorEvent Parameter>,
 <ReaderExceptionEvent Parameter>,
 <RFSurveyEvent Parameter>,
 <AISpecEvent Parameter>,
 <AntennaEvent Parameter>,
 <ConnectionAttemptEvent Parameter>,
 <ConnectionCloseEvent Parameter>
Custom Extension Point List: List of <custom Parameter> [optional]
```

2075 13.2.6.1 Requirements for Ordering of Event Reporting

- LLRP assumes a reliable stream transport mechanism. Messages sent through LLRP will arrive in the order that they were sent over the transport and binding utilized. Status events within the same message SHALL be ordered chronologically.
- Status events delivered by reader event notifications are useful, especially in conjunction with the tag report data. The following describes the requirements of the reader event notifications ordering with respect to the ordering of tag reports and Reader Event
- 2082 Notifications.
- The following requirements are made on the ordering of Event Parameters with respect to
- 2084 each other and to tag report Parameters. These statements apply if the respective status
- 2085 events and report triggers are enabled.
- 2086 If the start of an ROSpec is triggered by a GPI, the GPIEvent Parameter SHALL be sent
- before the ROSpecEvent Parameter signaling the start of the ROSpec.

- 2088 If the end of an ROSpec is triggered by a GPI, the GPIEvent Parameter SHALL be sent
- before the ROSpecEvent Parameter signaling the end of the ROSpec.
- 2090 If an ROSpec contains one or more AISpecs, the ROSpecEvent parameter signaling the
- 2091 end of an ROSpec SHALL be sent after the AISpecEvent Parameter signaling the end of
- the last AISpec within that ROSpec.
- 2093 If one ROSpec pre-empts another ROSpec, the ROSpecEvent parameter signaling the
- 2094 preemption of the first ROSpec SHALL be sent before the ROSpecEvent parameter
- signaling the start of the next ROSpec.
- 2096 Tag data received during an ROSpec execution SHALL be sent between the
- 2097 ROSpecEvent parameter signaling the start of the ROSpec and the ROSpecEvent
- 2098 parameter signaling the end or preemption of the ROSpec if the ROReportTrigger is not
- set to 'None'.
- 2100 Tag data received during an AISpec execution SHALL be sent before the AISpecEvent
- 2101 Parameter signaling the end of the AISpec if the ROReportTrigger is not 'None' or 'end
- 2102 of RO Spec'
- 2103 Tag data received during the time on a channel SHALL be sent after the HoppingEvent
- 2104 parameter that announced this channel and before the next HoppingEvent parameter
- when the ROReportTrigger is not 'None' and N=1.

2106 **13.2.6.2** HoppingEvent Parameter

- 2107 A Reader reports this event every time it hops frequency.
- 2108 Compliance requirement: Compliant Readers and Clients SHALL implement this
- 2109 parameter.

HoppingEvent Parameter

HopTableID: Unsigned Short Integer

NextChannelIndex: Unsigned Short Integer. This is the one-based ChannelIndex of the next channel to which the Reader is going to change.

2110 **13.2.6.3 GPIEvent Parameter**

- A reader reports this event every time an enabled GPI changes GPIstate.
- 2112 **Compliance requirement**: Compliant Readers and Clients MAY implement this
- 2113 parameter.

GPIEvent Parameter

GPIPortNumber: Unsigned Short Integer

GPIEvent: Boolean – True/False.

- 2114 **13.2.6.4 ROSpecEvent Parameter**
- 2115 This parameter carries the ROSpec event details. The EventType could be start or end of
- 2116 the ROSpec.
- 2117 Compliance requirement: Compliant Readers and Clients SHALL implement this
- 2118 parameter.

ROSpecEvent Parameter

ROSpecID: Unsigned Integer. This is the ID of the ROSpec that started, ended or got preempted.

EventType: Integer

Possible Values:

Value	Definition
0	Start of ROSpec
1	End of ROSpec
2	Preemption of ROSpec

PreemptingROSpecID: Integer. This field is ignored when EventType != 2. This field carries the ID of the preempting ROSpec.

2119 **13.2.6.5 ReportBufferLevelWarningEvent Parameter**

- A Reader can warn the Client that the Reader's report buffer is filling up. A Client can
- 2121 act upon this warning by requesting report data from the Reader, thereby freeing the
- 2122 Reader's report memory resources.

ReportBufferLevelWarningEvent Parameter

ReportBufferPercentageFull: Integer

Possible Values: 0-100

2123

- 2124 Compliance requirement: Compliant Readers and Clients MAY implement this
- 2125 parameter. A Reader MAY send a report buffer level warning event whenever the
- 2126 Reader senses that its report memory resources are running short. The buffer level at
- which a warning is reported is Reader implementation dependent. A Client MAY act
- 2128 upon a report buffer level warning event by requesting report data from the Reader and
- thereby free report memory resources in the Reader.

2130 **13.2.6.6 ReportBufferOverflowErrorEvent Parameter**

- A Reader reports a buffer overflow event whenever report data is lost due to lack of
- 2132 memory resources.

$Report Buffer Overflow Error Event\ Parameter$

- 2133 Compliance requirement: Compliant Readers and Clients SHALL implement this
- 2134 parameter. A Reader SHALL report a buffer overflow event whenever report data is lost
- 2135 due to lack of memory resources.

2136 **13.2.6.7** ReaderExceptionEvent Parameter

- 2137 The reader exception status event notifies the client that an unexpected event has
- 2138 occurred on the reader. Optional parameters provide more detail to the client as to the
- 2139 nature and scope of the event.
- 2140 Compliance requirement: Compliant Readers and Clients MAY implement this
- 2141 parameter.

ReaderExceptionEvent Parameter

ROSpecID: <ROSpecID Parameter> [Optional]

SpecIndex: <Spec Index Parameter> [Optional]

InventoryParameterSpecID: <InventoryParameterSpecID Parameter> [Optional]

AntennaID: <AntennaID Parameter> [Optional]

AccessSpecID: <AccessSpecID Parameter> [Optional]

OpSpecID: <OpSpecID Parameter> [Optional]

Message: UTF-8 String

Custom Extension Point List: List of <custom Parameter> [Optional]

2142 *13.2.6.7.1 OpSpecID Parameter*

2143 Compliance requirement: Compliant Readers and Clients MAY implement this

2144 parameter.

OpSpecID Parameter

OpSpecId: Unsigned Short Integer. 0 is illegal.

2145 **13.2.6.8 RFSurveyEvent Parameter**

2146 Compliance requirement: Compliant Readers and Clients MAY implement this

2147 parameter.

RFSurveyEvent Parameter

ROSpecID: Unsigned Integer. The identifier of the ROSpec that contains the RFSurveySpec.

SpecIndex: Unsigned Short Integer. The index of the spec in the ROSpec.

EventType: Integer

Possible Values:

Value	Definition
0	Start of RFSurvey
1	End of RESurvey

- 2148 **13.2.6.9 AlSpecEvent Parameter**
- This parameter carries the AISpec event details. The EventType is the end of the AISpec.
- When reporting the end event, the AirProtocolSingulationDetails MAY be reported if it is
- supported by the Reader and EventType of 7 has been enabled (Section 13.2.5.1).
- 2152 Compliance requirement: Compliant Readers and Clients SHALL implement this
- 2153 parameter.

AISpecEvent Parameter

ROSpecID: Unsigned Integer. The identifier of the ROSpec that contains the AISpec.

SpecIndex: Unsigned Short Integer. The index of the spec in the ROSpec.

EventType: Integer

Possible Values:

Value Definition
---0 End of AISpec

AirProtocolSingulationDetails: LLRP parameter [Optional]

Possible Values:

Each air protocol's AirProtocolSingulationDetails parameter is expressed as a different LLRP Parameter. The air protocol specific AirProtocolSingulationDetails LLRP Parameters are defined in section 15.1. This field is the AirProtocolSingulationDetails LLRP Parameter corresponding to the air protocol referenced by the ProtocolID of the InventoryParameterSpec upon whose execution completion this event report was generated.

2154 **13.2.6.10** AntennaEvent Parameter

- 2155 This event is generated when the Reader detects that an antenna is connected or
- 2156 disconnected.
- 2157 **Compliance requirement**: Compliant Readers and Clients MAY implement this parameter.

Antenna Event Parameter

AntennaID: Unsigned Short Integer

EventType: Integer

Possible Values:

Value Definition
---- 0 Antenna disconnected
1 Antenna connected

2159 13.2.6.11 ConnectionAttemptEvent Parameter

- 2160 This status report parameter establishes Reader connection status when the Client or
- 2161 Reader initiates a connection. See section 18.1, TCP Transport, for more details
- regarding the use of this report.
- 2163 Compliance requirement: Compliant Readers and Clients SHALL implement this
- 2164 parameter.

2165 **13.2.6.12 ConnectionCloseEvent Parameter**

- This status report parameter informs the Client that, unsolicited by the Client, the Reader
- 2167 will close the connection between the Reader and Client. Before the Reader closes a
- 2168 connection with the Client that is not solicited by the Client, the Reader SHALL first
- 2169 attempt to send a READER EVENT NOTIFICATION containing this parameter to the
- 2170 Client.
- 2171 Once the Reader sends this event to the Client, the Reader SHALL close the connection
- 2172 to the Client. This is also to say that, once the Reader sends this event, the Reader
- 2173 SHALL send no additional messages to the Client and the Reader SHALL ignore any
- 2174 messages received from the Client until another new connection is established.
- 2175 Compliance requirement: Compliant Readers and Clients SHALL implement this
- 2176 parameter.

ConnectionCloseEvent Parameter

2177

2178

14 Errors

- 2179 This section describes the errors that are solely based on LLRP protocol message parsing.
- 2180 The Reader SHALL discard the message if there is at least one error in the message, or
- 2181 cannot be fully processed. In addition, no portion of the message containing an error
- 2182 SHALL be executed by the Reader. In case the message has one or more errors, the
- 2183 Reader SHALL return at least one error parameter for one of the errors. The Reader
- 2184 MAY return more than one error parameter, one for each error. The errors are conveyed
- using a combination of 'generic error codes', a pointer to the culprit parameter/field, and
- a description of the error encoded as a string of UTF-8 characters.

- 2187 Typically the errors in the LLRP defined messages are conveyed inside of the responses
- from the Reader. However, in cases where the message received by the Reader contains
- an unsupported message type, or a CUSTOM MESSAGE with unsupported parameters
- or fields, the Reader SHALL respond with the ERROR MESSAGE.
- When a Reader or Client receives a command or notification with a version that is not
- supported, the receiver SHALL send an ERROR MESSAGE in reply consisting of: A
- version that is the same as the received message, the message ID that matches the
- 2194 received message, and an LLRPStatusParameter with the ErrorCode set to
- 2195 M Unsupported Version. This message SHALL contain no sub-parameters (such as Field
- 2196 Error, Parameter Error).
- 2197 Readers and Clients SHALL not respond to an ERROR MESSAGE.

14.1 Messages

2199 **14.1.1 ERROR_MESSAGE**

- 2200 This message is issued by the Reader to the Client, and it contains the LLRPStatus
- parameter that describes the error in the message.
- 2202 Compliance requirement: Compliant Readers and Clients SHALL implement this
- 2203 message.

2198

ERROR MESSAGE

Error: <LLRPStatus Parameter>

14.2 Parameters

- 2205 First, the error codes are presented, and then later, error parameters are presented that
- identify the culprit field in the message.

2207 **14.2.1 LLRP Status Codes**

- 2208 Status can be a success or one of the error conditions. This section lists a set of generic
- error conditions that, in combination with the identifier of the culprit field, conveys the
- 2210 error condition. The codes are broken into four scopes: message, parameter, field and
- device. The device code indicates that the error is in the Reader device rather than the
- message, parameter or field.

2213

StatusCode	Name	Scope	Description
0	M_Success	Message	This code SHALL indicate that the
			message was received and
			processed successfully.
100	M_ParameterError		This code SHALL indicate that an
			error occurred with a parameter of
			this message.

101	M FieldError		This code SHALL indicate that an
101	M_FleidElloi		
			error occurred with a field of this
102) () () () () () () () () () (message.
102	M_UnexpectedParameter		This code SHALL indicate that an
			unexpected parameter was
			received with this message.
103	M_MissingParameter		This code SHALL indicate that a
			required parameter was missing
			from this message.
104	M_DuplicateParameter		This code SHALL indicate that a
			parameter, for which there must
			only be one instance at the Reader,
			was seen more than once in this
			message.
105	M OverflowParameter		This code SHALL indicate that the
	_		maximum number of instances of
			the parameter has been exceeded
			at the Reader.
106	M OverflowField		This code SHALL indicate that the
100	inicid		maximum number of instances of
			the field has been exceeded at the
			Reader.
107	M Unknown Parameter		This code SHALL indicate that an
107	M_UnknownParameter		
			unknown parameter was received
108	M. Halmann Field		in the message. This code SHALL indicate that the
108	M_UnknownField		
			field is unknown or not found at
100	NOTE A DE		the Reader.
109	M_UnsupportedMessage		This code SHALL indicate that an
			unsupported message type was
	12.2		received.
110	M_UnsupportedVersion		This code SHALL indicate that the
			LLRP version in the received
			message is not supported by the
			Reader.
111	M_UnsupportedParameter		This code MAY indicate that the
			Parameter in the received message
			is not supported by the Reader.
200	P_ParameterError	Parameter	This code SHALL indicate that an
			error occurred with a parameter of
			this parameter.
201	P FieldError		This code SHALL indicate that an
	_		error occurred with a field of this
			parameter.
202	P UnexpectedParameter		This code SHALL indicate that an
	F		unexpected parameter was
			minipotton parameter was

			received with this message.
203	P MissingParameter		This code SHALL indicate that a
			required parameter was missing
			from this parameter.
204	P_DuplicateParameter		This code SHALL indicate that a
			parameter, for which there must
			only be one instance, was seen
			more than once in this parameter.
205	P_OverflowParameter		This code SHALL indicate that the
			maximum number of instances of
			the parameter has been exceeded
			at the Reader.
206	P_OverflowField		This code SHALL indicate that the
			maximum number of instances of
			the field has been exceeded at the
			Reader.
207	P_UnknownParameter		This code SHALL indicate that an
			unknown parameter was received
200	D 11.1 E: 11		with this message.
208	P_UnknownField		This code SHALL indicate that the
			field is unknown or not found at
200	D. Ungumented Dorometer		the Reader. This code SHALL indicate that an
209	P_UnsupportedParameter		
			unsupported parameter was received.
300	A Invalid	Field	This code SHALL indicate that the
300	71_IIIvana	Ficiu	field value was considered invalid
			for a non specific reason. An
			example is a message with invalid
			SpecID for a ROSpec or
			AccessSpec.
301	A_OutOfRange		This code SHALL indicate that the
			field value did not fall within an
			acceptable range.
401	R_DeviceError	Reader	This code MAY indicate that there
			is a problem on the Reader rather
			than with a message, parameter, or
			field.

2214 **14.2.2 LLRPStatus Parameter**

2215 **Compliance requirement**: Compliant Readers and Clients SHALL implement this parameter.

LLRPStatus Parameter

StatusCode: Integer.

Possible Values:

See the error code table (section 14.2.1) for possible values within the Message, Parameter or Field scope.

FieldError: <FieldError Parameter> [Optional]

ParameterError: <ParameterError Parameter> [Optional]

ErrorDescription: UTF-8 String

2217 **14.2.2.1** FieldError Parameter

2218 **Compliance requirement**: Compliant Readers and Clients SHALL implement this

2219 parameter.

FieldError Parameter

FieldNum: Integer. Field number for which the error applies. The fields are numbered after the order in which they appear in the parameter or message body.

Possible Values:

0-65535

ErrorCode: Integer.

Possible Values:

See the error code table (section 14.2.1) for possible values within the Argument scope.

2220 **14.2.2.2** ParameterError Parameter

2221 Compliance requirement: Compliant Readers and Clients SHALL implement this

2222 parameter.

ParameterError Parameter

Parameter Type: Integer. The parameter type that caused this error.

Possible Values:

0 - 1023

ErrorCode: Integer.

Possible Values:

See the error code table (section 14.2.1) for possible values within the Parameter scope.

FieldError: <FieldError Parameter> [Optional]

ParameterError: <ParameterError Parameter> [Optional]

2223

15 Air Protocol Specific Parameters

- For each air protocol supported by LLRP, the following subsection, 15.1, provides a table
- 2226 cross-referencing LLRP parameters and their corresponding air protocol specific
- 2227 parameters. All LLRP air protocol specific parameters are specified in the next
- 2228 subsection, 15.2.

2229 15.1 LLRP Air Protocol Cross-Reference Tables

- 2230 Within this section there is a separate subsection for each air protocol specified by LLRP.
- 2231 Each air protocol subsection includes a table cross-referencing LLRP parameters and
- their corresponding air protocol specific parameters.
- Support for a new air protocol can be added to LLRP by adding new subsections to this
- 2234 section e.g., 15.1.2 and 15.1.3.

2235 15.1.1 Class-1 Generation-2 (C1G2) Air Protocol

- 2236 The Class-1 Generation-2 (C1G2) Air Protocol is specified by the EPCglobal Class-1
- 2237 Generation-2 UHF RFID Protocol v1.1.0 specification.
- 2238 The following table cross-references LLRP parameters to C1G2 air protocol specific
- 2239 parameters.

LLRP Parameter (Section #)	C1G2 Parameter (Section #)
AirProtocolLLRPCapabilities (9.2.3)	C1G2LLRPCapabilities 15.2.1.1.1
UHF_RFModeTable (9.2.4.1)	UHFC1G2RFModeTable (15.2.1.1.2)
AirProtocolInventoryCommandSettings (12.2.6)	C1G2InventoryCommand (15.2.1.2.1)
TagSpec (11.2.1.2)	C1G2TagSpec (15.2.1.3.1)
OpSpec (11.2.1.2)	C1G2OpSpec (15.2.1.3.2)
AirProtocolOpSpecList (11.2.2)	C1G2OpSpec (15.2.1.3.2)
AirProtocolSpecificEPCMemorySelector (13.2.1.1)	C1G2EPCMemorySelector (15.2.1.5.1)
AirProtocolTagData (13.2.3)	C1G2PC and C1G2CRC (15.2.1.5.2, 15.2.1.5.3)
AirProtocolSingulationDetails (13.2.6.9)	C1G2SingulationDetails (15.2.1.5.4)
Op Spec Results (13.2.3)	C1G2OpSpecResult (15.2.1.5.5)

15.2 LLRP Air Protocol Specific Parameters

- Within this section there is a separate subsection for each air protocol specified by LLRP.
- 2242 Each air protocol subsection includes a definition for each air protocol specific
- 2243 parameter. Section 15.1 above cross-references LLRP parameters to the air protocol
- specific parameters specified in this section.
- Support for a new air protocol can be added to LLRP by adding new subsections to this
- 2246 section e.g., 15.2.2 and 15.2.3.

2247 15.2.1 Class-1 Generation-2 (C1G2) Air Protocol

- 2248 The Class-1 Generation-2 (C1G2) Air Protocol is specified by EPCglobal Class-1
- 2249 Generation-2 UHF RFID Protocol v1.1.0 specification.
- 2250 The following subsections specify LLRP air protocol specific parameters. These
- subsections are partitioned to correlate with major sections of the LLRP specification:
- Reader Device Capabilities
- Inventory Operation
- Access Operation
- Reader Device Configuration
- 2256 Reports

2257 **15.2.1.1** Reader Device Capabilities

- 2258 This section of air protocol specific parameters corresponds to LLRP parameters
- specified in section 9.

2260 15.2.1.1.1 C1G2LLRPCapabilities Parameter

- 2261 Compliance requirement: Compliant Readers and Clients SHALL implement this
- parameter. Readers MAY support BlockErase, and MAY support BlockWrite. Readers
- 2263 SHALL support at least one select filter per query.

C1G2LLRPCapabilities Parameter

CanSupportBlockErase: Boolean CanSupportBlockWrite: Boolean

MaxNumSelectFiltersPerQuery: Unsigned Short Integer. If set to zero, it indicates

there is no maximum limit.

2264 15.2.1.1.2 UHFC1G2RFModeTable Parameter

- This parameter carries the set of C1G2 RF modes that the Reader is capable of operating.
- 2266 Compliance requirement: Compliant Readers and Clients SHALL implement this
- parameter.

UHFC1G2RFModeTable Parameter

UHFC1G2RFModeSet: List of <UHFC1G2RFModeTableEntry Parameter>

2268 15.2.1.1.2.1 UHFC1G2RFModeTableEntry Parameter

- 2269 This parameter carries the information for each UHFC1G2 RF mode. A mode that has
- been tested for conformance by the EPCGlobal Hardware Action Group's Testing and
- 2271 Conformance (HAG T&C) group, is indicated using a conformance flag.
- 2272 Compliance requirement: Compliant Readers and Clients SHALL implement this
- parameter.

UHFC1G2RFModeTableEntry Parameter

Mode identifier: Unsigned Integer. This is a Reader defined identifier that the client may use to set the Gen2 operating parameters.

DR Value: Integer. Divide ratio.

Possible Values:

Value	DR
0	8
1	64/3

BDR Value: Integer. Backscatter data rate in bps.

Possible Values:

40000 - 640000 bps

M value: Integer. Modulation.

Possible Values:

Value	M	
0	FMC	
1	2	
2	4	
3	8	

Forward link modulation: Integer

Possible Values:

Value	Modulation
0	PR-ASK
1	SSB-ASK
2	DSB-ASK

PIE Value: Integer. One thousand times the ratio of data-0 symbol length and data-1 symbol length in pulse-interval encoding. The C1G2 spec specifies a ratio range of 1.5 – 2.0. (see section 6.3.1.2.4 in [C1G2]).

Possible Values:

1500-2000

MinTariValue: Integer. Minimum Tari time in nanoseconds (see section 6.3.1.2.4 in [C1G2])

Possible Values:

6250-25000

MaxTariValue: Integer. Maximum Tari time in nanoseconds. (see section 6.3.1.2.4 in [C1G2]).

Possible Values:

6250-25000

StepTariValue: Integer. Tari Step size in nanoseconds.(see section 6.3.1.2.4 in [C1G2])

Possible Values:

0 - 18750 nsec

Spectral Mask Indicator: Integer. Spectral mask characteristics of the mode. The Reader SHALL advertise this value if and only if the spectral mask value is valid for all the Tari steps in the range.

Possible Values:

Value	Modulation
0	Unknown
1	SI - Meets [C1G2] Single-Interrogator Mode Mask
2	MI - Meets [C1G2] Multi-Interrogator Mode Mask
3	DI - Meets [C1G2] Dense-Interrogator Mode Mask

EPC HAG T&C Conformance: Boolean. This flag indicates if the Reader vendor has received the certification for the parameter sets specified in this mode. The Reader SHALL set this flag to true only if the Reader vendor has received EPCGlobal conformance for this mode as specified in EPCGlobal Testing and Conformance.

15.2.1.2 Inventory Operation

- 2275 This section of air protocol specific parameters corresponds to LLRP parameters
- specified in section 10.

2277 15.2.1.2.1 C1G2InventoryCommand Parameter

- 2278 This parameter defines the C1G2 inventory-specific settings to be used during a
- particular C1G2 inventory operation. This comprises of C1G2Filter Parameter, C1G2RF
- 2280 Parameter and C1G2Singulation Parameter. It is not necessary that the Filter, RF Control
- and Singulation Control Parameters be specified in each and every inventory command.
- 2282 They are optional parameters. If not specified, the default values in the Reader are used
- during the inventory operation. If multiple C1G2Filter parameters are encapsulated by the
- 2284 Client in the C1G2InventoryCommand parameter, the ordering of the filter parameters
- determine the order of C1G2 air-protocol commands (e.g., Select command) generated by
- the Reader.

- The TagInventoryStateAware flag is used to determine how to process all the C1G2Filter
- 2288 and C1G2Singulation parameters in this command. At a functional level, if the Client is
- 2289 managing the tag states during an inventory operation, it would set that flag to true and
- pass the appropriate fields in the C1G2 Filter and C1G2 Singulation parameters. If a
- 2291 reader set CanDoTagInventoryStateAwareSingulation to False in LLRPCapabilities
- 2292 (section 9.2.2), it SHALL ignore the TagInventoryStateAware flag.
- 2293 Compliance requirement: Compliant Readers and Clients SHALL implement this
- 2294 parameter.

C1G2InventoryCommand Parameter

TagInventoryStateAware: Boolean

C1G2 Filter: List of <C1G2Filter Parameter> [if absent, use default]

C1G2 RF: <C1G2RFControl Parameter> [if absent, use default]

C1G2 Singulation Control: <C1G2SingulationControl Parameter> [if absent, use

default]

2303

2304

2305

2306

2307

2308

2309

2310

Custom Extension Point List: List of <Custom Parameter> (optional)

- 2295 **15.2.1.2.1.1** C1G2Filter Parameter
- This parameter carries information specific to C1G2 filter (in particular, the parameters
- for the select command) operation, and are optionally sent with each inventory command
- from the Client to the Reader. This sets up the target tag population that gets inventoried.
- For an inventory operation with multiple filters, multiple instances of filter parameters
- are sent. A filter parameter contains the following fields:
- Target tag mask: This contains the information for the tag memory data pattern used for the select operation.
 - T: This value is set if the Client is interested in only a truncated portion of the tag to be backscattered by the tag. The portion that gets backscattered includes the portion of the tag ID following the mask. This bit has to be set only in the last filter-spec.
 - TagInventoryStateAwareFilterAction: This is used if the TagInventoryStateAware flag is set to true in the InventoryParameterSpec.
 - TagInventoryStateUnawareFilterAction: This is used if the TagInventoryStateAware flag is set to false in the InventoryParameterSpec.
- Compliance requirement: Compliant Readers and Clients SHALL implement this parameter.

C1G2Filter Parameter

Target Tag Mask: <C1G2TagInventoryMask Parameter>

T: Integer

Possible Values:

Value	Truncate action
0	Unspecified: The Reader decides what truncate action to take.
1 2	Do not truncate Truncate

TagInventoryStateAwareAction: C1G2TagInventoryStateAwareFilterAction Parameter (optional)

TagInventoryStateUnawareAction: C1G2TagInventoryStateUnawareFilterAction Parameter (optional)

- 2313 15.2.1.2.1.1.1 C1G2TagInventoryMask Parameter
- 2314 **Compliance requirement**: Compliant Readers and Clients SHALL implement this parameter.

C1G2TagInventoryMask Parameter

MB: Integer. C1G2 Tag memory bank.

Possible Values:

1-3. The mask used for the C1G2 select command applies only to EPC, TID or User memory, and not to Reserved memory (MB 0).

Pointer: Unsigned Short Integer. The first (msb) bit location of the specified memory bank against which to compare the TagMask.

TagMask: Bit array. The pattern against which to compare.

- 2316 15.2.1.2.1.1.2 C1G2TagInventoryStateAwareFilterAction Parameter
- This parameter is used by the Client to manage the tag states during an inventory
- 2318 operation. In order to use this parameter during inventory, the TagInventoryStateAware
- flag is set to true in the InventoryParameterSpec. This parameter contains:
- Target: This value indicates which flag in the tag to modify whether the SL flag or its inventoried flag for a particular session.
 - Action describes the action for matching and non-matching tags. The actions are specific about the tag-inventory states e.g., do nothing, assert or deassert SL, assign inventoried S0/S1/S2/S3 to A or B.
- Compliance requirement: Compliant Readers and Clients MAY implement this parameter. Readers that do not support tag inventory state aware singulation SHALL set CanDoTagInventoryStateAwareSingulation to false in LLRPCapabilities.

C1G2TagInventoryStateAwareFilterAction Parameter

Target: Integer *Possible Values*:

2322

2323

2324

Value Definition

0	SL
1	Inventoried state for session S0
2	Inventoried state for session S1
3	Inventoried state for session S2
4	Inventoried state for session S3
Action : Integer	
Possible Values:	
Value	Definition
0	Matching tags: assert SL or inventoried state \rightarrow A. Non-matching tags: deassert SL or inventoried state \rightarrow B.
1	Matching tags: assert SL or inventoried state \Rightarrow A. Non-matching tags: do nothing
2	Matching tags: do nothing Non-matching tags: deassert SL or inventoried state → B
3	Matching tags: negate SL or $(A \rightarrow B, B \rightarrow A)$ Non-matching tags: do nothing
4	Matching tags: deassert SL or inventoried state → B Non-matching tags: assert SL or inventoried state → A
5	Matching tags: deassert SL or inventoried state >> B Non-matching tags: do nothing
6	Matching tags: do nothing Non-matching tags: assert SL or inventoried state → A
7	Matching tags: do nothing Non-matching tags: negate SL or (A→B, B→A)

15.2.1.2.1.1.3 C1G2TagInventoryStateUnawareFilterAction Parameter

This parameter is used by the Client if it does not want to manage the tag states during an inventory operation. Using this parameter, the Client instructs the Reader about the tags that should and should not participate in the inventory action. In order to use this parameter during inventory, the TagInventoryStateAware flag is set to false in the InventoryParameterSpec. This parameter contains:

• Action describes the action for matching and non-matching tags. However, the action is simply specifying whether matching or non-matching tags partake in this inventory. The Reader is expected to handle the tag inventory states to facilitate this.

In this parameter, Action=Select means search for pattern in Inventory, and Action=Unselect means do not search for pattern in Inventory.

2340 **Compliance requirement**: Compliant Readers and Clients SHALL implement this parameter.

C1G2TagInventoryStateUnawareFilterAction Parameter

Action: Integer

2328

2329

2330

23312332

2333

2334

2335

2336

2337

Possible Values:			
Value	Matching Tags	Non-matching Tags	
0	Select	Unselect	
1	Select	Do nothing	
2	Do nothing	Unselect	
3	Unselect	Do nothing	
4	Unselect	Select	
5	Do nothing	Select	

2342 **15.2.1.2.1.2 C1G2RF** Control Parameter

- This Parameter carries the settings relevant to RF forward and reverse link control in the C1G2 air protocol. This is basically the C1G2 RF Mode and the Tari value to use for the
- inventory operation.
- 2346 **Compliance requirement**: Compliant Readers and Clients SHALL implement this parameter.

C1G2RFControl Parameter

ModeIndex: Unsigned Integer. This is an index into the UHFC1G2RFModeTable.

Tari: Integer. Value of Tari to use for this mode specified in nsec. This is specified if the mode selected has a Tari range. If the selected mode has a range, and the Tari is set to zero, the Reader implementation picks up any Tari value within the range. If the selected mode has a range, and the specified Tari is out of that range and is not set to zero, an error message is generated.

Possible Values:

0 or 6250-25000 nsec

2348 15.2.1.2.1.3 C1G2SingulationControl Parameter

- This C1G2SingulationControl Parameter provides controls particular to the singulation process in the C1G2 air protocol. The singulation process is started using a Query
- 2350 process in the C1G2 air protocol. The singulation process is started using a Query command in the C1G2 protocol. The Query command describes the session number, tag
- 2352 state, the start Q value to use, and the RF link parameters. The RF link parameters are
- 2352 state, the start Q value to use, and the RF link parameters. The RF link parameters are
- 2353 specified using the C1G2RFControl Parameter (see section 15.2.1.2.1.2). This
- 2354 Singulation Parameter specifies the session, tag state and description of the target
- singulation environment. The following attributes are specified to provide guidance to the
- 2356 Reader for the singulation algorithm:

2359

2360

- Tag transit time: This is the measure of expected tag mobility in the field of view of the antenna where this inventory operation is getting executed.
 - Tag population: This is the expected tag population in the field of view of the antenna.
- In addition, the Singulation Parameter allows setting of the following:
- Session ID: This is the C1G2 session number that the tags use to update the inventory state upon successful singulation.

- TagInventoryStateAwareSingulationAction: This is used if the TagInventoryStateAware flag is set to true in the InventoryParameterSpec.
 - O I: This is the inventoried state of the target tag population in the selected session. Only tags that match the session state participate in the inventory round. If the Ignore value is specified, the Reader ignores this field, and its up to the Reader implementation to determine the value of I used in the inventory round.
 - S: This is the state of the SL flag in the tag. Only tags that match that tag state participate in the inventory round. If the Ignore value is specified, the Reader ignores this field, and its up to the Reader implementation to determine the value of S used in the inventory round.
- If a reader sets CanDoTagInventoryStateAwareSingulation to False in LLRPCapabilities (section 9.2.2), it SHALL ignore the TagInventoryStateAwareSingulationAction field.
- 2377 **Compliance requirement**: Compliant Readers and Clients SHALL implement this parameter.

C1G2SingulationControl Parameter

Session: Integer. Session number to use for the inventory operation.

Possible Values:

0-3

2366

2367

2368

23692370

2371

23722373

2374

Tag population: Unsigned Short Integer. An estimate of the tag population in view of the RF field of the antenna.

Tag transit time: Unsigned Integer. An estimate of the time a tag will typically remain in the RF field of the antenna specified in milliseconds.

TagInventoryStateAwareSingulationAction:

<C1G2TagInventoryStateAwareSingulationAction Parameter> (optional)

- 2379 15.2.1.2.1.3.1 C1G2TagInventoryStateAwareSingulationAction Parameter
- 2380 Compliance requirement: Compliant Readers and Clients MAY implement this
- parameter. Readers that do not support tag inventory state aware singulation SHALL set
- 2382 CanDoTagInventoryStateAwareSingulation to false in LLRPCapabilities.

C1G2TagInventoryStateAwareSingulationAction Parameter

I: Integer

Possible Values:

Value Definition
---- 0 State A
1 State B

S: Integer

Possible Values:	
Value	Definition
0	SL
1	~SL

2383 **15.2.1.3 Access Operation**

- 2384 This section of air protocol specific parameters corresponds to LLRP parameters
- 2385 specified in section 11.

2386 15.2.1.3.1 C1G2TagSpec Parameter

- 2387 This parameter describes the target tag population on which certain operations have to be
- 2388 performed. This Parameter is similar to the selection C1G2Filter Parameter described
- 2389 earlier. However, because these tags are stored in the Reader's memory and ternary
- comparisons are to be allowed for, each bit i in the target tag is represented using 2 bits -
- bit i in mask, and bit i in tag pattern. If bit i in the mask is zero, then bit i of the target tag
- is a don't care (X); if bit i in the mask is one, then bit i of the target tag is bit i of the tag
- pattern. For example, "all tags" is specified using a mask length of zero.
- 2394 This parameter can carry up to two tag patterns. If more than one pattern is present, a
- Boolean AND is implied. Each tag pattern has a match or a non-match flag, allowing (A
- and B,!A and B, !A and !B, A and !B), where A and B are the tag patterns.
- 2397 The tagSpec contains:
- TagPattern1
- TagPattern2
- 2400 **Compliance requirement**: Compliant Readers and Clients SHALL implement this parameter.

C1G2TagSpec Parameter

TagPattern1: <C1G2TargetTag Parameter>

TagPattern2: <C1G2TargetTag Parameter> [optional]

2402 15.2.1.3.1.1 C1G2TargetTag Parameter

- 2403 If Length is zero, this pattern will match all tags regardless of MB, pointer, mask and
- 2404 data
- 2405 Compliance requirement: Compliant Readers and Clients SHALL implement this
- parameter.

C1G2TargetTag Parameter

MB: Integer. Memory bank.

Possible Values: 0-3.

Pointer: Unsigned Short Integer. The address of the first (msb) bit against which to apply

the Tag Mask and compare with the value.

TagMask: Bit array
TagData: Bit array
Match: Boolean

2407 *15.2.1.3.2 C1G2 OpSpec Parameters*

- 2408 This section describes the C1G2 specific OpSpec parameters that are sent as part of the
- 2409 AccessSpec. Each OpSpec parameter has an OpSpecID that is used when reporting
- results of the operation.

2411 15.2.1.3.2.1 C1G2Read Parameter

- MB is the memory bank to use. WordPtr is the starting word address. WordCount is the
- 2413 number of 16-bit words to be read. Following is text reproduced from the C1G2
- 2414 specification regarding WordCount=0. [If WordCount = 0, the tag backscatters the
- 2415 contents of the chosen memory bank starting at WordPtr and ending at the end of the
- bank, unless MB = 1, in which case the Tag shall backscatter the EPC memory contents
- starting at WordPtr and ending at the length of the EPC specified by the first 5 bits of the
- 2418 PC if WordPtr lies within the EPC, and shall backscatter the EPC memory contents
- starting at WordPtr and ending at the end of EPC memory if WordPtr lies outside the
- 2420 EPC.]
- Access Password is the password used by the Reader to transition the tag to the secure
- state so that it can read protected tag memory regions. For example, the Tag's Reserved
- 2423 memory is locked but not permalocked, meaning that the Reader must issue the access
- password and transition the Tag to the secured state before performing the read operation.
- 2425 Compliance requirement: Compliant Readers and Clients SHALL implement this
- 2426 parameter.

C1G2Read Parameter

OpSpecID: Unsigned Short Integer

MB: Integer. Memory bank.

Possible Values: 0-3

WordPtr: Unsigned Short Integer. The word addresss of the first word to read from the

chosen memory bank.

WordCount: Unsigned Short Integer **AccessPassword**: Unsigned Integer

2427 **15.2.1.3.2.2** C1G2Write Parameter

- 2428 MB is the memory bank to use. WordPtr is the starting word address. Write Data is the
- 2429 data to be written to the tag. Word Count is the number of words to be written.
- 2430 Depending on the word count, the Reader may have to execute multiple C1G2 air

- 2431 protocol Write commands. Access Password is the password used by the Reader to
- 2432 transition the tag to the secure state so that it can write to protected tag memory regions.
- 2433 Compliance requirement: Compliant Readers and Clients SHALL implement this
- 2434 parameter.

C1G2Write Parameter

OpSpecID: Unsigned Short Integer

MB: Integer. Memory bank.

Possible Values: 0-3

WordPtr: Unsigned Short Integer. The word addresss of the first word to be written to the

chosen memory bank.

Write Data: Short array. The data to write to the chosen memory bank.

AccessPassword: Unsigned Integer

- 2435 15.2.1.3.2.3 C1G2Kill Parameter
- 2436 Kill Password is the value of the kill password to be used or set.
- 2437 Compliance requirement: Compliant Readers and Clients SHALL implement this
- 2438 parameter.

C1G2Kill Parameter

OpSpecID: Unsigned Short Integer **Kill Password**: Unsigned Integer

- 2439 15.2.1.3.2.4 C1G2Lock Parameter
- 2440 This parameter contains the definition of the access privilege updates
- 2441 (read/write/permalock) to be performed in various locations of the memory. The five data
- 2442 fields for which we can define access control using the lock command are: Kill Password,
- 2443 Access Password, EPC memory, TID memory and User memory. The access privilege
- Access 1 assword, ETC memory, 11D memory and Osci memory. The access privilege
- 2444 updates are expressed as a list of C1G2LockPayload Parameters, one for each memory
- 2445 location.
- 2446 The Access Password provides the password to enter the *secured* state. A Reader can
- 2447 perform a lock operation on a tag only if the tag is in the *secured* state. The tag enters the
- secured state only using the Access Password (if a non-zero value).
- 2449 Compliance requirement: Compliant Readers and Clients SHALL implement this
- parameter.

C1G2Lock Parameter

OpSpecID: Unsigned Short Integer

LockCommandPayloadList: List of <C1G2LockPayload Parameter>

Access Password: Unsigned Integer

- 2451 15.2.1.3.2.4.1 C1G2LockPayload Parameter
- 2452 This parameter contains the definition of the access privilege updates
- 2453 (read/write/permalock) to be performed for a single location of the tag memory. The five
- 2454 data fields for which we can define access control using the lock command are: Kill
- Password, Access Password, EPC memory, TID memory and User memory.
- 2456 **Compliance requirement**: Compliant Readers and Clients SHALL implement this parameter.
 - C1G2LockPayload Parameter

On Cros ID . Ungion of Chart Intercon

OpSpecID: Unsigned Short Integer

Privilege: Integer. Value indicates the access privilege to be applied.

Possible Values:

Value	Access Privilege
0	Read/Write
1	Permalock
2	Permaunlock
3	Unlock

DataField: Unsigned Integer. Value indicates to which data field the access privilege will be applied.

Possible Values:

Value	Field
0	Kill Password
1	Access Password
2	EPC Memory
3	TID Memory
4	User Memory

- 2458 15.2.1.3.2.5 C1G2BlockErase Parameter
- MB is the memory bank to use. WordPtr is the starting word address. Word Count is the
- number of 16-bit words to be read. Access Password is the password used by the Reader
- 2461 to transition the tag to the secure state so that it can erase protected tag memory regions.
- 2462 Compliance requirement: Compliant Readers and Clients MAY implement this
- 2463 parameter. Readers that do not support C1G2BlockErase SHALL set
- 2464 CanSupportBlockErase to false in C1G2LLRPCapabilities. If such a Reader receives an
- 2465 ADD ACCESSSPEC with an AccessSpec that contained this OpSpec parameter, the
- 2466 Reader SHALL return an error for that message and not add the AccessSpec.

C1G2BlockErase Parameter

OpSpecID: Unsigned Short Integer

MB: Integer. Memory bank.

Possible Values: 0-3

WordPtr: Unsigned Short Integer. Word address of first word to be erased.

Word Count: Unsigned Short Integer. Number of words to erase.

Access Password: Unsigned Integer

2467 15.2.1.3.2.6 C1G2BlockWrite Parameter

- MB is the memory bank to use. WordPtr is the starting word address. Word Count is the
- 2469 number of 16-bit words to be written. Depending on the word count, the Reader may
- 2470 have to execute multiple C1G2 air protocol block write commands. Write Data is the data
- 2471 to be written to the tag. Access Password is the password used by the Reader to transition
- the tag to the secure state so that it can write to protected tag memory regions.
- 2473 Compliance requirement: Compliant Readers and Clients MAY implement this
- 2474 parameter. Readers that do not support C1G2BlockWrite SHALL set
- 2475 CanSupportBlockWrite to false in C1G2LLRPCapabilities. If such a Reader receives an
- 2476 ADD ACCESSSPEC with an AccessSpec that contained this OpSpec parameter, the
- 2477 Reader SHALL return an error for that message and not add the AccessSpec.

C1G2BlockWrite Parameter

OpSpecID: Unsigned Short Integer

MB: Integer. Memory bank.

Possible Values: 0-3

WordPtr: Unsigned Short Integer. Word address of first word to be written.

Write Data: Short array

Access Password: Unsigned Integer

2478 **15.2.1.4 Reader Device Configuration**

- 2479 This section of air protocol specific parameters corresponds to LLRP parameters
- 2480 specified in section 12. The only air protocol specific parameter i
- 2481 AirProtocolInventoryCommandSettings parameter in the AntennaConfiguration (section
- 2482 12.2.6). The C1G2 specific InventoryCommand is already defined in section 15.2.1.2.1.

2483 **15.2.1.5** Reports

- 2484 This section of air protocol specific parameters corresponds to LLRP parameters
- specified in section 13.2.1.1.

2486 15.2.1.5.1 C1G2EPCMemorySelector Parameter

- 2487 This parameter is used to determine what contents are of interest in the C1G2EPC
- 2488 memory bank for reporting. If enableCRC and enablePC is set to false, only the EPC is
- returned in the RO Report. If enablePC is set to true, the PC bits and the EPC are returned
- in the RO Report. If enablePC and enableCRC is set to true, the EPC, PC bits and CRC
- are returned in the RO Report.

2492 Compliance requirement: Compliant Readers and Clients SHALL implement this

parameter.

C1G2EPCMemorySelector

enablePC: Boolean enableCRC: Boolean

2494 15.2.1.5.2 C1G2PC Parameter

2495 Compliance requirement: Compliant Readers and Clients SHALL implement this

2496 parameter.

C1G2PC Parameter

PC bits: Unsigned Short Integer

2497 *15.2.1.5.3 C1G2CRC Parameter*

2498 Compliance requirement: Compliant Readers and Clients SHALL implement this

2499 parameter.

C1G2CRC Parameter

CRC: Unsigned Short Integer

2500 15.2.1.5.4 C1G2SingulationDetails Parameter

2501 **Compliance requirement**: Compliant Readers and Clients MAY implement this

2502 parameter.

C1G2SingulationDetails Parameter

NumCollisionSlots: Unsigned Short Integer. The number of slots detected as collided over the duration of this report.

NumEmptySlots: Unsigned Short Integer. The number of slots detected as empty over the duration of this report.

2503 **15.2.1.5.5 C1G2 OpSpec Results**

2504 15.2.1.5.5.1 C1G2ReadOpSpecResult Parameter

2505 **Compliance requirement**: Compliant Readers and Clients SHALL implement this

2506 parameter.

C1G2ReadOpSpecResult Parameter

OpSpecID: Unsigned Short Integer

ReadData: Short Array. The data read from the RFID tag.

Result: Integer

Possible Values:	
Value	Definition
0	Success
1	Non-specific tag error
2	No response from tag
3	Non-specific reader error

2507 15.2.1.5.5.2 C1G2WriteOpSpecResult Parameter

Compliance requirement: Compliant Readers and Clients SHALL implement this parameter.

C1G2WriteOpSpecResult Parameter

OpSpecID: Unsigned Short Integer

NumWordsWritten: Unsigned Short Integer. The number of words written as a result of this OpSpec. If the number of words written is not equal to the length of the data pattern to write, the Result below SHALL be non-zero.

Result: Integer

Possible Values:

Value	Definition
0	Success
1	Tag memory overrun error
2	Tag memory locked error
3	Insufficient power to perform memory-write operation
4	Non-specific tag error
5	No response from tag
6	Non-specific reader error

2510 15.2.1.5.5.3 C1G2KillOpSpecResult Parameter

2511 **Compliance requirement**: Compliant Readers and Clients SHALL implement this

2512 parameter.

2508

2509

C1G2KillOpSpecResult Parameter

OpSpecID: Unsigned Short Integer

Result: Integer

Possible Values:

- ,	
Value	Definition
0	Success
1	Zero kill password error
2	Insufficient power to perform kill
	operation
3	Non-specific tag error
4	No response from tag
5	Non-specific reader error

- 2513 15.2.1.5.5.4 C1G2LockOpSpecResult Parameter
- 2514 Compliance requirement: Compliant Readers and Clients SHALL implement this
- 2515 parameter.

C1G2LockOpSpecResult Parameter

OpSpecID: Unsigned Short Integer

Result: Integer

Possible Values:

vaiues.	
Value	Definition
0	Success
1	Insufficient power to perform lock operation
2	Non-specific tag error
3	No response from tag
4	Non-specific reader error

2516 15.2.1.5.5.5 C1G2BlockEraseOpSpecResult Parameter

- 2517 Compliance requirement: Compliant Readers and Clients MAY implement this
- 2518 parameter. Readers that do not support C1G2 Block Erase SHALL set
- 2519 CanSupportBlockErase to false in C1G2LLRPCapabilities. If such a Reader receives an
- 2520 ADD_ACCESSSPEC with an AccessSpec that contains this OpSpec parameter, the
- 2521 Reader SHALL return an error for that message and not add the AccessSpec.

C1G2BlockEraseOpSpecResult Parameter

OpSpecID: Unsigned Short Integer

Result: Integer

Possible Values:

Value	Definition
0	Success
1	Tag memory overrun error
2	Tag memory locked error
3	Insufficient power to perform block erase operation
4	Non-specific tag error
5	No response from tag
6	Non-specific reader error

2522 15.2.1.5.5.6 C1G2BlockWriteOpSpecResult Parameter

- 2523 Compliance requirement: Compliant Readers and Clients MAY implement this
- 2524 parameter. Readers that do not support C1G2 Block Write SHALL set
- 2525 CanSupportBlockWrite to false in C1G2LLRPCapabilities. If such a Reader receives an
- 2526 ADD_ACCESSSPEC with an AccessSpec that contains this OpSpec parameter, the
- 2527 Reader SHALL return an error for that message and not add the AccessSpec.

C1G2BlockWriteOpSpecResult Parameter

OpSpecID: Unsigned Short Integer NumWordsWritten: Unsigned Short Integer **Result**: Integer Possible Values: Value Definition ____ _____ \cap Success 1 Tag memory overrun error 2 Tag memory locked error 3 Insufficient power to perform memory-write operation 4 Non-specific tag error 5 No response from tag Non-specific reader error

2528 16 Binary Encoding for LLRP

This section contains the specific formats and operations for the binary encoding of the Low Level Reader Protocol. All fields and parameters must be encoded in the order shown in the diagrams in this section. This section does not contain information that has been generalized in the main body of the document. Refer to sections 8-15 for the description of the messages and the parameters and fields in the messages.

The binary encoding is based on a stream of octets. Each octet represents 8 bits of information. Octets within the data stream are serialized according to the particular transport mechanism over which this binding is carried. Octet numbering shown in this section is in network order. For example, in Figure 12, the first octet that a LLRP endpoint receives contains Rsvd, Ver and 2 bits of Message type.

25382539

2534

2535

25362537

0										1										2										3	
0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1
	Rsvd Ver Message Type															Message Length [31:16]															
	Message Length [15:0]															Message ID[31:16]															
	Message ID[15:0]																														
														Me	ssag	e Va	lue														

2540 Figure 12: Network Order

Figure 13 illustrates the bit order inside the fields.

2542

2	1	0	2	1	0	9	8	7	6	5	4	3	2	1	0	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16
Rsvd Ver Message Type															Me	ssag	e Le	ngth	[31	:16]											

2543 Figure 13: Bit Order in Fields

2544 Integer numbers SHALL be encoded in network byte order with the most significant byte

of the integer being sent first (big-Endian). Bit arrays are aligned to the most significant

bit. Bit arrays are padded to an octet boundary. Pad bits SHALL be ignored by the

2547 Reader and Client.

- 2548 The length of all messages within the binary encoding SHALL be multiples of octets.
- 2549 This means all parameters within the binary encoding SHALL be multiples of octets.
- 2550 This includes any custom or vendor specific parameter. All the messages and parameters
- in this section have been padded with zero to ensure that the length is a multiple of octets.

Notations

2552

- 2553 Inside a message or a parameter,
- If a parameter X is denoted simply as X, it means that X is mandatory and appears once in the message.
- If a parameter X is denoted as X (0-n), it means that X is optional in the message, and it can appear multiple times in the message.
- If a parameter X is denoted as X (0-1), it means that X is optional in the message and that it can appear at most once in the message.
- If a parameter X is denoted as X (1-n), it means that X is mandatory and can appear multiple times in the message.

2562 Negative Numbers

Negative numbers are represented using two complement notation.

2564 **16.1 Messages**

25	65	,																														
	0										1										2										3	
	0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1
]	Rsvd Ver Message Type															Message Length [31:16]															
		Message Length [15:0]																			N	1ess	age I	D[3	1:16	5]						
		Message ID[15:0]																														
	Message V														e Va	alue																
$2\overline{5}$	66)																														

Reserved bits: 3 bits

The reserved bits are reserved for future extensions. All reserved bits in messages SHALL be set to 0 in outgoing messages.

Ver: 3 hits

2568

2569

2570 2571 2572

2573

2574

2577

2579

2580

2581

The version of LLRP. Implementations of LLRP based on this specification are using the value 0x1. Other values are reserved for future use.

2575 Message Type: 10 bits 2576 The type of LLRP

The type of LLRP message being carried in the message.

2578 Message Length: 32 bits

This value represents the size of the entire message in octets starting from bit offset 0 of the first word. Therefore, if the Message Value field is zero-length, the Length field will be set to 10.

Message ID: 32 bits

2583 2584 2585	As stated earlier, the communications between the Client and the Reader are primarily of a request-response type - requests/commands from the Client to the Reader, and responses from the Reader to the Client. In order to facilitate multiple outstanding commands/requests from the Client, LLRP uses a
2586 2587 2588	Message sequence number in each message. The Message sequence number is used to correlate a response with the original request. This sequence number is local to the LLRP channel.
2589 2590	Message Value: variable length Dependent on the Message Type.

16.1.1 **GET_READER_CAPABILITIES** 2591

2592

0									1										2										3	
0 1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1
Rsv	Rsvd Ver Message Type =1															Message Length [31:16]														
	Message Length [15:0]															Message ID[31:16]														
	Message ID[15:0]															RequestedData														
	Custom Parameter															ter ((0-n)						_							
2502																														

2593 2594

See Section 9.1.1.

2595

GET_READER_CAPABILITIES_RESPONSE 16.1.2 2596

2597

,																															
0										1										2										3	
0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1
]	Rsvd Ver Message Type = 11 Message Length [31:16] Message Length [15:0] Message ID[31:16]																														
	Message Length [15:0] Message ID[31:16]																														
	Message Length [15:0] Message ID[31:16] Message ID[15:0] LLRPStatus Parameter																														
													LL	RPS	Statu	s Pa	rame	eter													
										(Gene	eralI	Devi	ceCa	ıpab	ilitie	s Pa	ıram	eter	(0-1))										
												LLR	PCa	ipab	ilitie	s Pa	rame	eter	(0-1))											
											Re	gula	tory	Cap	abili	ties	Para	met	er (0	-1)											
										A	irPro	otoc	olLI	RPO	Capa	bilit	ies I	Parai	nete	r (0-	1)										
													Cus	stom	Par	amet	ter (0-n)													

2598 2599 2600

See Section 9.1.2.

16.1.3 ADD_ROSPEC 2601

2602

2002	_																														
0										1										2										3	
0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1
	Rsvo	ŀ		Ver				N	1ess	age '	Туре	e = 2	20								Mes	ssag	e Le	ngth	[31	:16]					
							e Le														N	Jess	age :	ID[3	1:16	6]					
					1	Mess	sage	ID[15:0]																					
													L	205	pec I	Dara	mete	r													
													Г	ردن	pcc i	ara	iiicic	/I													

2603 2604 2605

See section 10.1.1.

16.1.4 ADD_ROSPEC_RESPONSE

0										1										2										3	
0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1
	Rsvo	i		Ver				N	/less	age '	Гуре	e = 3	30								Mes	ssage	e Le	ngth	[31	:16]					
					Me	ssag	e Le	engtl	h [15	5:0]											N	1ess	age]	ID[3	1:16	6]					
					1	Mess	sage	ID[15:0]																					
													LL	RPS	tatu	s Pai	rame	eter													

2609 See section 10.1.2.

16.1.5 DELETE_ROSPEC

	-																														
0										1										2										3	
0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1
	Rsvo	i		Ver				N	/less	age '	Туре	e = 2	21		Message Length [31:16]																
					Me	essag	ge Le	engtl	h [15	5:0]											N	Лess	age	ID[3	31:16	6]					
					1	Mess	sage	ID[15:0]]	ROS	pecI	D[3	1:16]					
						ROS	Spec	ID[1	[5:0]																						

See section 10.1.3.

16.1.6 DELETE_ROSPEC_RESPONSE

0										1										2										3	
0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1
	Rsvo	i		Ver				N	Aess	age	Тур	e = 3	1								Me	ssage	e Le	ngth	[31	:16]					
					Me	ssag	e Le	engtl	n [15	5:0]											N	/less	age	ID[3	31:16	6]					
	Message Length [15:0]																														
	Message ID[15:0]																														
	Message ID[15:0] LLRPStatus Pa														s Pai	rame	eter														
						Mess	sage	ID[15:0				LL	RPS	tatu	s Pa	rame	eter													
						Mess	sage	ID[15:0				LL	RPS	statu	s Pa	rame	eter													

See section 10.1.4.

16.1.7 START_ROSPEC

		•																														
Ī	0										1										2										3	
Ī	0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1
]	Rsvo	i		Ver				N	/less	age '	Гуре	= 2	22								Me	ssag	e Le	ngth	[31	:16]					
Ī	Rsvd Ver Message Type = 22 Message Length [31:16] Message Length [15:0] Message ID[31:16]																															
Ī						ľ	Mess	sage	ID[15:0]]	ROS	pecI	D[3	1:16]					
Ī							ROS	Spec	ID[1	5:0]																						
Ī																																
Ī																																

See section 10.1.5.

2625

16.1.8 START_ROSPEC_RESPONSE 2626

2627

0										1										2										3	
0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1
	Rsvd Ver Message Type = 32																				Mes	ssag	e Lei	ngth	[31	:16]					
					Me	ssag	e Le	engtl	n [15	5:0]											N	1ess	age l	ID[3	1:16	5]					
					1	Mess	sage	ID[15:0]																					
													LL	RPS	tatu	s Pa	rame	eter													

2628 2629 See section 10.1.6.

2630

16.1.9 STOP_ROSPEC 2631

0										1										2										3	
0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1
	Rsv	d		Ver				N	1ess	age [Гуре	e = 2	23								Mes	ssage	e Le	ngth	[31	:16]					
					Me	ssag	ge Le	ngtl	ı [15	[0:5											N	/less	age :	ID[3	1:16	5]					
					1	Mess	sage	ID[15:0]											I	ROS	pecI	D[3	1:16]					
						ROS	Spec	ID[1	5:0]																						

2632

2633 See section 10.1.7.

2634

16.1.10 STOP_ROSPEC_RESPONSE 2635

				_			_	_	_			_			_						_			_	_		_				
0										1										2										3	
0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1
	Rsvo	d		Ver		Message Type = 33																									
				Message Length [15:0] Message ID[31:16]																											
	Message Length [15:0] Message ID[31:16] Message ID[15:0]																														
													LL	RPS	tatu	s Pa	rame	eter													

2636 2637 2638

See section 10.1.8.

16.1.11 **ENABLE_ROSPEC** 2639

0										1										2										3	
0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1
	Rsvo	ŀ		Ver				N	1ess	age [Гуре	pe = 24 Message Length [31:16]																			
					Me	ssag	e Le	engtl	n [15	[0:											N	Лess	age !	ID[3	1:16	5]					
					1	Mess	sage	ID[15:0]											I	ROS	pecI	D[3	1:16]					
						ROS	Spec	ID[1	5:0]																						

2641 See section 10.1.9.

2642

ENABLE_ROSPEC_RESPONSE 16.1.12 2643

0										1										2										3	
0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1
	Rsv	d		Ver				N	1ess	age '	Гуре	e = 3	4								Mes	ssag	e Le	ngth	[31	:16]					
					Me	ssag	e Le	engtl	n [15	5:0]											N	Iess	age :	ID[3	31:16	5]					
					I	Mess	sage	ID[15:0]																					
													LL	RPS	tatu	s Pa	rame	eter													

2644

2645 2646 See section 10.1.10.

DISABLE_ROSPEC 16.1.13 2647

0										1										2										3	
0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1
	Rsvo	1		Ver				N	1ess	age '	Гуре	= 2	25								Mes	ssag	e Le	ngth	[31	:16]					
					Me	ssag	e Le	ngtl	n [15	5:0]											N	Iess	age I	ID[3	1:16	[[
					1	Mess	sage	ID[15:0]											I	ROS	pecI	D[3	1:16]					
						ROS	Spec	ID[1	5:0]																						

2648

2649 See section 10.1.11.

2650

DISABLE_ROSPEC_RESPONSE 16.1.14 2651

										_				_																	
0										1										2										3	
0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1
	Rsvo	1		Ver				N	1ess	age '	Гуре	= 3	5								Mes	sag	e Le	ngth	[31	:16]					
					Me	ssag	e Le	ngtl	ı [15	5:0]											N	1ess	age I	ID[3	1:16	5]					
					I	Mess	sage	ID[15:0]																					
													LL	RPS	tatu	s Pa	rame	eter													

2652

2653 See section 10.1.12.

2654

16.1.15 **GET_ROSPECS** 2655

200	U																														
0										1										2										3	
0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1
	Rsv	d		Ver				N	1ess	age '	Гуре	= 2	26								Me	ssage	e Le	ngth	[31	:16]					
					Me	ssag	e Le	engtl	ı [15	5:0]											N	/less	age I	ID[3	1:16	5]					
					I	Mess	sage	ID[15:0	1																					

2657 2658 Sce section 10.1.13. 2660 16.1.16 GET_ROSPECS_RESPONSE 2661 0 1 2 3 4 5 6 7 8 9 0 0 1 2 3 4 5 6 7 8 9 0 0 1 2 3 4 5 6 7 8 9 0 0 1 2 3 4 5 6 7 8 9 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0																														
2658 See section 10.1.13. 2660																														
	16	5.1.1	6		Gl	ΕT	F	RC	SI	PE	CS	3_ F	RES	PC	NS	E														
0									1																					
See Section 10.1.13. See Section 10.1.13.		1																												
KSV	va	,		Mess	age	e I <i>e</i>					pe -	- 30																		
										_											IVICS	age	11)	71.10	<u> </u>					
												I	LRP	Statu	ıs Paı	rame	eter													
												R	OSpe	ec Pa	rame	ter ((0-n))												
2665 2666	16	5.1. 1	17		ΑI	DE)_/	40	CC	ES	SS	SPE	C					1					1			1	1	ī		
2665 2666 0									1										_	_				<u> </u>		7	0			1
2665 2666 0 0 1	2	3	4				8	9	1000)]		2 3		5	6	7	8	9	_	1						7	8	9		1
2665 2666 0 0 1	2	3	4 /er	5 (6	7	8 N	9 Mes	1 0 0 ssage	e Ty		2 3		5	6	7	8	9	_	1 M	essag	e Le	ngtl	ı [31	:16]	7	8	9		1
2665 2666 0 0 1	2	3	4 /er	5 (Mess	6 sage	7 e Le	8 Nengt	9 Mes	10 0 ssage 15:0	e Ty		2 3		5	6	7	8	9	_	1 M	essag	e Le	ngtl	ı [31	:16]	7	8	9		1
2665 2666 0 0 1	2	3	4 /er	5 (Mess	6 sage	7 e Le	8 Nengt	9 Mes	10 0 ssage 15:0	e Ty		2 3 3 = 40	5 4				•	9	_	1 M	essag	e Le	ngtl	ı [31	:16]	7	8	9		1
2665 2666 0 0 1	2	3	4 /er	5 (Mess	6 sage	7 e Le	8 Nengt	9 Mes	10 0 ssage 15:0	e Ty		2 3 3 = 40	5 4				•	9	_	1 M	essag	e Le	ngtl	ı [31	:16]	7	8	9		1
2665 2666 0 0 1 Rsv	2	3	4 /er	5 (Mess	6 sage	7 e Le	8 Nengt	9 Mes	10 0 ssage 15:0	e Ty		2 3 3 = 40	5 4				•	9	_	1 M	essag	e Le	ngtl	ı [31	:16]	7	8	9		1
2665 2666 0 0 1 Rsv 2667 2668 2669	2 vd	3 Sect	4 Ver	5 Mess M	6 sage	7 Pee Lee League	8 Nengti ID[9 9 Mes h [15:	10 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	e Ty	pe =	2 3 3 = 40	Acces	ssSpe	c Par	rame	eter		_	1 M	essag	e Le	ngtl	ı [31	:16]	7	8	9		1
2665 2666 0 0 1 Rsv 2667 2668 2669 2670 2671	2 vd	3 Sect	4 Ver	5 Mess M	6 sage	7 Pee Lee League	8 Nengti ID[9 9 Mes h [15:	10 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	e Ty	pe =	2 3 3 = 40	Acces	ssSpe	c Par	rame	eter			M	essag	e Le	ngtl	ı [31	:16]	7	8	9	0	1
2665 2666 0 0 1 Rsv 2667 2668 2669 2670 2671 0	See 16	3 3 Sect	4 Ver	Messs M	age essa	7 Per Leage DC	8 Nengt ID[9 9 Mess h [15:	1	ES	pe =	2 3 3 5 5 FE	Acces	_RE	c Par	rame	NS	E		Me	Mess	e Lee Lee Lee Lee Lee Lee Lee Lee Lee L	ngtl ID[3	1 [31]	:16]				3	
2665 2666 0 0 1 Rsv 2667 2668 2669 2670 2671 0 0 1	2 vd See	3 Sect	4 //er // // // // // // // // // // // // //	Messs M	6 sage	7 Pee Lee League	8 Nengti ID[9 9 Mess h [15:	11	ES	pe =	2 3 = 40 A	Acces	_RE	c Par	rame	eter			0 1 M	Mess Mess 2	e Lee Lee Lee Lee Lee Lee Lee Lee Lee L	ngth ID[3	1 [31] 31:16	:16] 6]	7	8	9	0	1
2665 2666 0 0 1 Rsv 2667 2668 2669 2670 2671 0	2 vd See	3 Sect	4 //er	Messs M	sageessa	7 e Le age	8 Nengti ID[9 9 Mes	1	ES	pe =	2 3 = 40 A	Acces	_RE	c Par	rame	NS	E		0 1 M	Mess	e Le Sage	ngtl ID[3	1 [31] 31:10 5 1 [31]	:16] 6] 6] 6 6 :16]				3	

LLRPStatus Parameter

2672 2673 2674 See Section 11.1.2.

16.1.19 DELETE_ACCESSSPEC 2675

2676

0										1										2										3	
0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1
	Rsvo	d		Ver				N	1ess	age [Гуре	= 4	1								Mes	ssage	e Le	ngth	[31	:16]					
					Me	ssag	e Le	ngtl	n [15	5:0]											N	Aess.	age	ID[3	1:16	5]					
					1	Mess	sage	ID[15:0]											A	cces	sSpe	cId[31:1	6]					
					A	cces	sSp	ecId	[15:0	0]																					

2677 2678 See Section 11.1.3.

2679

DELETE_ACCESSSPEC_RESPONSE 16.1.20 2680

2681

200	1																														
0										1										2										3	
0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1
	Rsv	d		Ver				N	1ess	age '	Туре	e = 5	1								Me	ssag	e Le	ngth	[31	:16]					
					Me	ssag	e Le	engtl	n [15	5:0]											N	Лess	age]	ID[3	1:16	6]					
					1	Mess	sage	ID[15:0]																					
													LL	RPS	Statu	s Pa	rame	eter													

 $2\overline{682}$ 2683

See Section 11.1.4.

2684

16.1.21 **ENABLE_ACCESSSPEC** 2685

2686

0										1										2										3	
0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1
	Rsvo	i		Ver				N	/less	age '	Гуре	e = 4	-2								Me	ssage	e Le	ngth	[31	:16]					
					Me	ssag	e Le	engtl	h [15	5:0]											N	/less	age :	ID[3	1:16	6]					
					1	Mess	sage	ID[15:0]											A	cces	sSpe	cId[31:1	6]					
					A	cces	sSp	ecId	[15:0	0]																					

2687

2688 See Section 11.1.5.

2689

16.1.22 ENABLE_ACCESSSPEC_RESPONSE 2690

	_																														
0										1										2										3	
0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1
	Rsvo	d		Ver				N	1ess	age '	Гуре	e = 5	52								Me	ssag	e Le	ngth	[31	:16]					
					Me	essag	ge Le	engtl	n [15	5:0]											N	Лess	age	ID[3	31:16	5]					
					I	Mess	sage	ID[15:0]																					
													LL	RPS	tatu	s Pa	rame	eter													

See Section 11.1.6.

16.1.23 DISABLE_ACCESSSPEC

2	696	-)																														
	0										1										2										3	
	0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1
]	Rsvo	i		Ver				N	1ess	age '	Тур	e = 4	13								Mes	ssag	e Le	ngth	[31	:16]					
						Me	ssag	e Le	engtl	n [15	5:0]											N	1 ess	age	ID[3	1:16	5]					
						1	Mess	sage	ID[15:0]											A	cces	sSpe	cId[31:1	6]					
						A	cces	sSp	ecId	[15:	0]																					

2698 See Section 11.1.7.

16.1.24 DISABLE_ACCESSSPEC_RESPONSE

270	1																														
0										1										2										3	
0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1
	Rsv	d		Ver				N	1ess	age '	Гуре	= 5	3								Mes	ssage	e Le	ngth	[31	:16]					
					Me	ssag	e Le	engtl	n [15	5:0]											N	1ess	age]	[D[3	1:16	5]					
					1	Mess	sage	ID[15:0]																					
													LL	RPS	tatu	s Pa	rame	eter													

See Section 11.1.8.

16.1.25 GET_ACCESSSPECS

4/0	,0																															
0	1										1										2										3	
0	1		2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1
	Rs	vd			Ver				N	1ess	age '	Гуре	e = 4	4								Mes	sag	e Le	ngth	[31	:16]					
						Me	ssag	e Le	ngtl	n [15	5:0]											N	1ess	age I	ID[3	1:16	6]					
						I	Mess	sage	ID[15:0]																					
																																I

708 See Section 11.1.9.

2710 16.1.26 GET_ACCESSSPECS_RESPONSE

_																																
	0										1										2										3	
Ī	0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1
Ī]	Rsvc	i		Ver				N	1ess	age '	Гуре	e = 5	4								Mes	ssag	e Le	ngth	[31	:16]					

																1														
																					N	1ess	age	ID[3	31:16	5				
					M	essa	age	ושנ	15:0	<u>'] </u>			LI	RPS	Statu	l s Pai	rame	eter												
												A	Acce	ssSp	ec P	aran	neter	: (0-1	1)											
Rsvd Ver																														
271. 271.	3								_	DE	. 01		о т	•																
	_	1	6. 1	.27		CI	LIE	=N	'-	KE	:Ql	JE	51	_0	P															
										1																				
			3			6	7				1			4	5	6	7	8	9	0	1					<u> </u>	7	8	9	0 1
	Rs	vd		Ver			. Т.				Тур	e = 4	15																	
						_															N	/less	age .	ID[3	1:16)				
					171	CSSC	age	וןענו	13.0	<u>'</u>						İ														
													Tag	Repo	ortDa	ata P	aran	nete	r											
Message ID[15:0]																														
271	<u> </u>																													
2 <u>72</u>	0	1	6.1	.28		CI	LIE	EN ⁻	Τ_		Ql	JE:	ST	_0	P_	RE	SF	PO	NS											3
			3			6	7				1			4	5	6	7	8	9		1						7	8	9	0 1
	Rsv	vd		Ver							Тур	e = 5	55																	
						_			_												N	/less	age .	ID[3	1:16	5]				
					IVI	CSS	age	ושנו	13.0	<u>']</u>		Clie	ntRe	eque	stRe	spon	ise P	'aran	neter											
1	1	- 1		1																										
272	1				11_	<u> </u>							1																	
272; 272;	2 3 4						ΕT	R	REI	PO	RT	-	•																	1
272; 272; 272; 0	2 3 4 5	1	6.1	.29		GI				1	RT									2										3
272. 272. 272. 272. 0 0	2 3 4 5 1	1 2	6.1	. 29	5 (GI	ET	8	9	1 0	1	2	3	4	5	6	7	8	9	2 0	1 Mc	2	3	4	5	6	7	8	9	3 0 1
272. 272. 272. 272. 0 0	2 3 4 5	1 2	6.1	.29	5 (GI	7	8 N	9 Iess	1 0 age	1			4	5	6	7	8	9			ssag	e Le	ngth	[31	:16]	7	8	9	
272. 272. 272. 272. 0 0	2 3 4 5 1	1 2	6.1	. 29	5 (Mess	GI 5	7	8 N	9 less 1 [1;	1 0 age 5:0]	1	2		4	5	6	7	8	9			ssag	e Le		[31	:16]	7	8	9	

See Section 13.1.1.

2727 2728

16.1.30 RO_ACCESS_REPORT 2729

2730

0										1										2										3	
0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1
	Rsvo	1		Ver				N	Aess:	age '	Гурє	e = 6	1								Me	ssag	e Le	ngth	ı [31	:16]					
	Message Length [15:0] Message ID[31:16] Message ID[15:0]																														
					I	Mess	sage	ID[15:0]																					
										R	FSu	rvey	Rep	ortR	Серо	rtDa	ta P	aram	neter	. (0-1	1)										
													Cus	tom	Para	amet	er (0-n)													

2731

2732 See Section 13.1.2.

2733

16.1.31 **KEEPALIVE** 2734

2735

0										1										2										3	
0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1
	Rsvd Ver Message Type = 62																			Mes	ssag	e Le	ngth	[31	:16]						
		svd Ver Message Type = 62 Message Length [15:0]																			N	Лess	age	ID[3	31:16	5]					
					I	Mess	sage	ID[15:0]																					
	Message ID[15:0]																														

See Section 13.1.3.

2736 2737 2738

16.1.32 KEEPALIVE_ACK 2739

2740

212	<u>TU</u>																															
(0 1																2										3					
(0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6													7	8	9	0	1	2	3	4	5	6	7	8	9	0	1				
	R	Rsvd Ver Message Type = 72																				Mes	ssag	e Le	ngth	[31	:16]					
		Message Length [15:0]																			N	Лess	age	ID[3	1:16	5]						
						1	Mess	sage	ID[15:0]																					

2741 2742 See Section 13.1.4.

16.1.33 READER_EVENT_NOTIFICATION

0	1	2 3												
0 1 2 3 4 5	6 7 8 9 0 1 2 3 4 5	6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1												
Rsvd Ver	Message Type = 63	Message Length [31:16]												
Message Length [15:0] Message ID[31:16]														
Message Length [15:0] Message ID[31:16] Message ID[15:0]														
	ReaderEventNotif	cationData Parameter												
		 												
<u> </u>														

See Section 13.1.5.

16.1.34 ENABLE_EVENTS_AND_REPORTS

0																		2										3				
0	1		2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1
	Rsvd Ver Message Type = 64																				Mes	ssage	e Le	ngth	[31	:16]						
		Message Length [15:0]																				N	1ess	age]	ID[3	1:16	5]					
]	Mess	sage	ID[15:0]																					
	Message ID[15:0]																															

2751 See Section 13.1.6.

16.1.35 ERROR_MESSAGE

0	1													
0 1 2 3 4 5	6 7 8 9 0 1 2 3 4 5	6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1												
Rsvd Ver	Message Type = 100	Message Length [31:16]												
Message Length [15:0] Message ID[31:16]														
N	Message ID[15:0]													
	LLRPStatus	s Parameter												
2754														

See Section 14.1.1.

16.1.36 GET_READER_CONFIG

	0										1										2										3	
Ī	0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1
Ī	I	Rsvc	l		Ver				1	Mess	age	Тур	e = 2	2								Mes	ssage	e Le	ngth	[31:	:16]					
Ī						Μe	essag	ge Le	engt	h [15	5:0]											N	Лess	age :	ID[3]	1:16	5]					•

]	Mes	sage	ID[15:0]										Α	nten	ına I	D						
			Re	ques	tedD	ata									G	PIPo	rtNı	ım						G	POI	Portl	Num	[15:	8]	
		(GРО	Port	Nun	n[7:0)]																							
ſ		GPOPortNum[7:0] Custom Parameter (0-n)																												
Ī																														
2	7.5.0																													

See Section 12.1.1.

GET_READER_CONFIG_RESPONSE 16.1.37 2762

2763

2/03																															
0										1										2										3	
0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1
]	Rsvd			Ver				N	1ess	age [Гуре	= 1	2								Me	ssage	e Le	ngth	[31	:16]					
					Μŧ	essag	ge Le	engtl	n [15	5:0]											N	/less	age	ID[3	31:16	5]					
]	Mes	sage	ID[15:0	1																					
													LL	RPS	tatu	s Pai	rame	eter													
	Identification Parameter (0-1) AntennaProperties Parameter (0-n)																														
	AntennaProperties Parameter (0-n)																														
	AntennaConfiguration Parameter (0-n)																														
																					1)										
																Para															
											F					c Pa															
										LI										ter (0	-1)										
													_			Para				_											
											G		_		_	ite P		_													
																Para			_												$\neg \neg$
											F					s Pa		_	_												
															_	amet			(,	-)											
													- un				(1)													\neg

2764 2765 2766

See Section 12.1.2.

16.1.38 SET_READER_CONFIG 2767

2/00	,																														
0										1										2										3	
0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1
	Rsvo	i		Ver				N	Mess	age	Тур	e = 1	3								Mes	ssag	e Le	ngth	ı [31	:16]					
					Μe	essag	ge Le	engtl	h [15	[0:											N	1ess	age	ID[3]	31:16	5]					
	Message ID[15:0] R Reserved ReaderEventNotificationSpec Parameter (0-1)																														
	ReaderEventNotificationSpec Parameter (0-1)																														
	ReaderEventNotificationSpec Parameter (0-1) AntennaProperties Parameter (0-n) AntennaConfiguration Parameter (0-n)																														
											Ar	iteni	naCo	nfig	urat	ion l	Para	mete	er (0)-n)											
												RC	Rep	ortS	pec	Para	ımet	er (0)-1)												
											I	Ассе	ssR	epor	tSpe	c Pa	ram	eter	(0-1))											
												Ke	epal	iveS	pec	Para	met	er (0)-1)												
												GP	OW	riteI	Data	Para	ımet	er (()-n)												
											G	PIP	ortC	urre	ntSta	ite P	aran	nete	r (0-	n)											
											I	Even	tsAı	ndRe	eport	ts Pa	ıram	eter	(0-1)	(l)											
													Cus	tom	Para	ame	ter ((0-n)													

																	ĺ	
																, ,	ı	ĺ
																, ,	ı	ĺ
2760	<u> </u>									•								

Abbreviations

R-Reset To Factory Defaults

2772 2773

See section 12.1.3.

2774

SET_READER_CONFIG_RESPONSE 16.1.39 2775

2776

0																			2										3		
0	1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6															7	8	9	0	1	2	3	4	5	6	7	8	9	0	1	
	Rsv	Rsvd Ver Message Type = 13																			Mes	ssage	e Le	ngth	[31	:16]					
		Message Length [15:0]																			N	1ess	age	ID[3	1:16	5]					
]	Mess	sage	ID[15:0]																					
													LL	RPS	tatu	s Pa	rame	eter													

2777 2778 2779

See section 12.1.4.

16.1.40 **CLOSE_CONNECTION** 2780

2781

0										1										2										3	
0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1
	Rsvc	1		Ver				N	1ess	age [Гуре	e = 1	4								Mes	ssage	e Le	ngth	[31	:16]					
					Me	ssag	ge Le	engtl	h [15	5:0]											N	Лess	age :	ID[3	1:16	5]					
		Nessage Type = 14 Message Type = 14 Message Length [15:0] Message ID[15:0]																													

2782

2783 See section 12.1.5.

2784

CLOSE_CONNECTION_RESPONSE 16.1.41 2785

2786

2/0	U																														
0										1										2										3	
0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1
	Rsvo	<u>1</u>		Ver				1	Mess	sage	Тур	e = .	4								Mes	ssag	e Le	ngth	[31	:16]					
					Me	essag	ge Le	engtl	h [15	5:0]											N	Aess	age	ID[3	31:16	5]					
]	Mess	sage	ID[15:0]																					
													LL	RPS	Statu	s Pa	rame	eter													

2787 2788 See section 12.1.6.

2790 **16.1.42 CUSTOM_MESSAGE**

2791

0	1	2	3
0 1 2 3 4 5	6 7 8 9 0 1 2 3 4 5	6 7 8 9 0 1 2 3	4 5 6 7 8 9 0 1
Rsvd Ver	Message Type = 1023	Message Ler	ngth [31:16]
Me	essage Length [15:0]	Message I	ID[31:16]
I	Message ID[15:0]	Vendor Ident	tifier [31:16]
Ver	ndor Identifier [15:0]	Message Subtype	
	Vendor Spec	ified Payload	
2702			

2792 2793

See Section 8.1.

2794

2795

16.2 LLRP Parameters

LLRP parameters are defined in the following subsections with the exception that the air protocol specific LLRP parameters are defined in Section 16.3. The binary encoding of LLRP uses two different encodings of parameters: Type-length-value (TLV) encoded parameters, and Type-value (TV) encoded parameters. The TV encoding is only used for encoding parameters that are fixed-length, and are in Reports and Notifications from the Reader. The use of a compact encoding (i.e., TV) for the Reports and Notifications helps improve the network efficiency.

2803 16.2.1 TLV and TV Encoding of LLRP Parameter

The type of encoding (TLV or TV) is determined based on the value of bit 0 in the parameter header. All TLV-encoded Parameters SHALL have a 0 in bit 0 of the header.

2806 All TV-encoded Parameters SHALL have a 1 in bit 0 of the header.

2807 **16.2.1.1** TLV-Parameters

2808 LLRP TLV-Parameters have the following encoding structure.

0										1										2										3	
0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1
		Rese	rvec	l					Para	amet	ter T	ype										Para	mete	er Le	ngth	ì					
														Para	met	er V	alue														

2809 2810

2811 Reserved bits: 6 bits

The reserved bits are reserved for future extensions. All reserved bits SHALL be set to 0.

2812 2813

Parameter Type: 10 bits

This is the type of LLRP parameter being carried in the message. The parameter number space for the

- 2816 TLV-parameters is 128 2047. The number space 0-127 is reserved for TV-parameters.
- 2817 2818 Parameter Length: 16 bits

2838

2840

2851 2852

- This value represents the size of the entire parameter in bytes starting from bit offset 0 of the first word.
- Therefore, if the Parameter Value field is zero-length, the Parameter Length field will be set to 4.
- 28212822 Parameter Value: variable length
- Dependent on the Parameter Type.

2824 16.2.1.1.1 Encoding Guidelines for TLV-Parameters

- 2825 The following rules apply to TLV-Parameters:
 - Parameters may contain mandatory and optional fields.
- Parameter fields may be passed by value or by sub-parameter.
- Mandatory fields will always be present and optional fields may or may not be present.
- Mandatory fields of fixed length will be passed by value only, using the order, size and alignment defined in this document.
- A mandatory field of variable length must be passed by value if it is the only field, mandatory or optional, of variable length in that parameter.
- A parameter with multiple mandatory or optional fields of variable length must pass them as sub-parameters.
- A parameter containing a field of variable length being passed by value may not contain sub-parameters.
 - Optional fields will always be passed as sub-parameters.
- 2839 The following rules apply to sub-parameters:
 - Sub-parameters follow all parameter rules.
- A sub-parameter is a parameter that is encompassed within the length of a preceding parameter and adds to the dataset of the encapsulating parameter.

```
ParameterA-length-----+
2843
2844
             Data
2845
                   ParameterB-length---+
2846
                   Data <-+
                   ParameterC-length----+
2847
2848
                   Data
                        ParameterD-length---+
2849
2850
                         Data <-+ <-+
```

- Sub-parameters may be mandatory or optional.
- 2853 **16.2.1.2 TV-Parameters**
- 2854 LLRP TV-Parameters have the following encoding structure.

0										1										2										3	
0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1

1	F	arar	neter	Typ	oe .																									
							1						Para	amet	er V	'alue	;													
2855																														
2856 2857 2858 2859 2860 2861 2862 2863 2864	Par I	This TV-prame Depe	eter T is the baran eter V enden	e typneter alue alue ont on	e of s is e: va the	TLLI 1 – riab Para nca	127. le lei amete	The ngth er Ty	nur ype. Gui to T	nber <i>deli</i> V-1	ines Para	e 12	28-2 ters	047 'V-1	is re	eserv	ed f	or T	LV- _l	oara	mete	ers.			the					
2865 2866		•	TV	∕-Pa	aran	nete	ers c	ann	ot	con	tain	sul	o-pa	aran	nete	ers (TL	V 01	TV	∕-Pa	arar	nete	ers).							
2867	16	5.2 .	.2		G	en	era	al F	Pai	an	net	er	S																	
2868	16	5.2.2	2.1		U [.]	TC	Tim	est	tan	np I	Par	am	ete	er																
0									1										2										3	
0 1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1
	Res	erve	d					T	ype	= 12	28											Lei	ngth							
																[63:3														
												N	licro	seco	onds	[31:	υJ													
2869 2870	G -		etion	7.1	2 1 1	1 1	1			I	1		I	1	1	1	I	1	I		<u>I</u>	I	<u>I</u>	1	1	1	<u>I</u>	1	<u>I</u>	

2870 See Section

See Section 7.1.3.1.1.1.

16.2.2.2 Uptime Parameter

0										1										2										3	
0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1
		Rese	ervec	l					T	ype	= 12	29											Ler	igth							
						•							M	icros	Seco	nds	63:.	32]													
													M	licro	seco	nds	[31:	0]													

See section 7.1.3.1.1.2.

16.2.3 Reader Device Capabilities Parameters

16.2.3.1 GeneralDeviceCapabilities Parameter

0	1	
0 1 2 3 4 5	6 7 8 9 0 1 2 3 4 5	6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
Reserved	Type = 137	Length
MaxNu	mberOfAntennaSupported	C T Reserved
	Device manu	facturer name
	Model	l Name
Firm	wareVersionByteCount	
	Reader Firmware Version: V	Variable length UTF-8 String
	ReceiveSensitivityTab	leEntry Parameter (1-n)
	PerAntennaReceiveSensiti	ivityRange Parameter (0-n)
		ities Parameter
		ocol Parameter (1-n)

2881 See Section 9.2.1.

2882

Abbreviations

2883 2884 C-Can Set Antenna Properties2885 T - HasUTCClockCapability 2886

ReceiveSensitivityTableEntry Parameter 2887 16.2.3.1.1

0										1										2										3	
0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1
		Rese	ervec	1					T	ype	= 13	39											Len	gth							
							Inc	lex													Rece	eive	Sens	sitivi	ty V	⁷ alue	•				

2888 2889 2890

See Section 9.2.1.11.

PerAntennaReceiveSensitivityRange Parameter 2891 16.2.3.1.2

0								1										2										3	
0 1	2 3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1
	Reserved	i					T	ype	= 14	19											Ler	igth							
	0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 Reserved Type = 149 AntennaID ReceiveSensitivityIndexMax																	R	ecei	veSe	ensit	ivity	Inde	exM	in				
	AntennaID																												
	Access of Sensitivity indexival																												

2892

2893 See Section 9.2.1.22.

2894 16.2.3.1.3 PerAntennaAirProtocol Parameter

0										1										2										3	
0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1
		Rese	rvec	l					T	ype	= 14	10											Ler	igth							
																				Nu	mPr	otoc	ols								
	AntennaId																		•••						Pro	otoc	olID	#P			

See Section 9.2.1.33.

2897 16.2.3.1.4 GPIOCapabilities Parameter

0										1										2										3	
0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1
		Rese	ervec	l			•		T	ype	= 14	1	•					•	•		•	•	Ler	gth	•	•				•	
		7 3 4 5 6 7 8 9 0 1 7 3 4 5															N	Jum	GPO)s											

2899 See section 9.2.1.44.

16.2.3.2 LLRPCapabilities Parameter

0										1										2										3	
0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1
	I	Rese	ervec	1					T	ype	= 14	-2											Ler	igth							
C	R	S	T	Н	Re	serv	ed	N	1ax P	rior	ityL	evel	Supp	orte	ed					Cl	ient	Requ	iest(OpSp	ресТ	ime	out				
	•							•					N	Max]	Num	RO	Spec	S													
												1	Max1	Nun	Spe	csPe	rRO	Spe	c												
										M	[axN	uml	nve	ntory	Para	ame	terSp	oecs.	Per/	AISp	ec										
															umA																
												Max	κNui	пОр	Spec	esPe	rAcc	cesss	Spec	2											

Abbreviations

C – CanDoRFSurvey

R – CanReportBufferFillWarning

S-Supports Client Request Op Spec

T – CanDoTagInventoryStateAwareSingulation

H – SupportsEventAndReportHolding

MaxNumPriority – MaxNumPriorityLevelsSupported

See Section 9.2.2.

16.2.3.3 AirProtocolLLRPCapabilities Parameter

2914 See section 9.2.3.

There is no separate binary encoding for AirProtocolLLRPCapabilities. Each Air protocol's capabilities are expressed in a different LLRP Parameter. Refer to Section 16.3 for air protocol specific capability parameters. For example, the C1G2LLRPCapabilities Parameter (Section 16.3.1.1.1) carries the C1G2 air protocol capabilities.

16.2.3.4 RegulatoryCapabilities Parameter

0														
0 1 2 3 4 5	7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8													
Reserved	Type = 143	Length												
	Country Code	Communications Standard												
	UHFBandCapabili	ties Parameter (0-1)												

					I						1	Cu	iston	n Pai	ramte	er (0	-n)													
																														_
)22)23)24		e Sec							~																					
925	16	5.2.3	3.4.	1	U	HI	⁴ Ba	nd	Cap	pab	iliti	es i	Par	am	eter	•	ı		ı											
0	2	2		_			0	0	1	1	2	2		_			0	0	2	1		2		-		7	0	0	3	_
0 1	Pec	3 erve	4	5	6	7	8	9 T	0 ype	$\frac{1}{=1}$	14	3	4	5	6	7	8	9	0	1	2	3 Len	4	5	6	7	8	9	0	
	TCS	C1 V C1	u					1				wer	Leve	elTal	bleEi	ntrv	Para	met	er (l-n)		LCII	5111							_
													ıcyIr																	_
										Į	UHF	RFN	Mode	Tab	le Pa	ıram	eter	(1-n	1)											
																														_
929	16	.2.3.	4.1.	1 T	ran	smi	itPo	wer		elT	able	En	try]	Para	ame	ter			2										2	_
0 1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	_
)	U	/	0	-				3	4	5	U	/	o	7	U	1				3	U	/	o	7	U	
	Res	ervec	1					- 1	vne	= 14	4 7											ı en	ווועו							
	Kes	erve	1			In	dex	1	ype	= 14	45									Tr	ansı	Len nitPo		rVal	ue					_
	Res	erve	1			In	dex	1	ype	= 12	+5									Tr	ansı			rVal	ue					_
930		erved		9.2.	4.1.		dex	1	ype	= 12	43									Tr	ansı			rVal	ue					_ _ _
930	Sec 16	.2.3.	4.1.			1.		nfor	ma 1 0	tion	Par	ram 3	neter 4	5	6	7	8	9	2 0	Tr	ansı 2	nitPo	4	rVal	ue6	7	8	9	3 0	
930 931 932 933	Sec 16	.2.3.	4.1.	2 F	req	1.	ıcyIı	nfor	ma ¹	1 = 14	Pai 2 46	3	4	5					0			nitPo	4			7	8	9		
930 931 932 933 0 0 1	Sec 16	.2.3.	4.1.	2 F	req	1.	ıcyIı	nfor	ma 1 0	1 = 14	2 46	3	4 yHoj	5 pTab	ole P	aran	netei	: (0-1	0			nitPo	4			7	8	9		
930 931 932 933 0 0 1	Sec 16	.2.3.	4.1.	2 F	req	1.	ıcyIı	nfor	ma 1 0	1 = 14	2 46	3	4	5 pTab	ole P	aran	netei	: (0-1	0			nitPo	4			7	8	9		
930 931 932 933 0 0 1	Sec 16	.2.3.	4.1.	2 F	req	1.	ıcyIı	nfor	ma 1 0	1 = 14	2 46	3	4 yHoj	5 pTab	ole P	aran	netei	: (0-1	0			nitPo	4			7	8	9		
930 931 932 933 0 0 1 H 934 935 936 937 938 939	Second Se	3 ervec Re	4.1. 4 dd deserv	2 F 5 5 red 9.2.	pppii 4.1	1. uen 7	seyIi	nfor 9 T	opT	1 = 14 F	Par 2 446 Freque	3 enc.	4 yyHop dFree	5 pTab	ble P	aran	(0-1	(0-1	0 n)		2	3 Len	4 gth	5	6				3	
930 931 932 933 0 0 1 H 934 935 936 937 938 939	Sec. 16 Abb Sec. 16	3 ervec Re Dbrev	viation 4.1. 4 deserve	2 F 5 5 ed 9.2.	6 6 pppin 4.1.:	1. uen 7	ecyli 8	nfor 9 T	0 op T 1 0	### Table 1	Pan Pan 2 2 446	3 enc	4 yHopdFree	5 oTab quen	ole P	aran	netei	: (0-1	0 n)			3 Len	4 agth			7	8	9	0	
930 931 932 933 0 0 1 H 934 935 936 937 938 939	160 2 Ress	3 ervec Re	4.1. 4 dd sserv	2 F 5 red 9.2.	pppii 4.1	1. uen 7	seyIi	nfor 9 T	op7 1 0 ype	1	Pan Pan 2 2 446	3 encerized	4 yyHop dFree	5 pTab	ble P	aran	(0-1	(0-1	0 n)	1	2	3 Len	4 agth	5	6				3	

							Fr	eque	ency	#n							

NumHops: Number of entries in the List of Frequencies.

2943 2944

See Section 9.2.4.1.2.1.

2945 16.2.3.4.1.2.2 FixedFrequencyTable Parameter

0										1										2										3
0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0 1
		Rese	ervec	1					T	ype	= 14	8											Ler	igth						
						Nun	nFre	quei	ncies	3											F	requ	ency	/#1[í	31:1	6]				
	NumFrequencies Frequency#1[15:0]																													
	Frequency#n [15:0]																													

NumFrequencies: Number of entries in the List of Frequencies.

2947 2948

See Section 9.2.4.1.2.2.

2949

2950 **16.2.4 Reader Operations Parameters**

2951 **16.2.4.1 ROSpec Parameter**

0	1	
0 1 2 3 4 5 6 7	8 9 0 1 2 3 4 5	6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
Reserved	Type = 177	Length
	ROS	pecID
Priority	CurrentState	
	ROBoundaryS	Spec Parameter
	SpecParameter (1-r	n) [See notes below]
	ROReportSpec	Parameter (0-1)

2952

2953 Notes

Each SpecParameter can be one of the following types: AISpec Parameter or RFSurveySpec Parameter or

2955 Custom Parameter.

2956

2957 See Section 10.2.1.

2958

2959 16.2.4.1.1 ROBoundarySpec Parameter

0										1										2										3	
0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1
		Rese	ervec	1					T	ype	= 17	8											Ler	igth							
												RC	Spe	cSta	rtTri	gge	r Par	ame	eter												
ROSpecStartTrigger Parameter ROSpecStopTrigger Parameter																															

2960 2961 See Section 10.2.1.1. 2962

2963 16.2.4.1.1.1 ROSpecStartTrigger Parameter

0										1										2										3	
0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1
		Rese	ervec	l				•	T	ype	= 17	9	•	•	•				•		•		Ler	igth	•	•		•			
	ROS	Spec	Star	red Type = 179 artTriggerType																											
								-			Pe	riod	icTr	igge	rVal	ue P	aran	nete	r (0-	1)											
											(GPI	Γrigg	gerV	alue	Par	ame	ter (0-1)												
	GPITriggerValue Pa																•														

2964 2965

See Section 10.2.1.1.1.

2966

2967 16.2.4.1.1.1 PeriodicTriggerValue Parameter

0										1										2										3	
0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1
		Res	ervec	i					T	ype	= 18	0											Len	gth							
															Off	set															
															Per	iod															
												UTO	CTir	nesta	amp	Para	ımet	er ((0-1)												

2968 2969

2969 See Section 10.2.1.1.1.1.

2970

2971 16.2.4.1.1.1.2 GPITriggerValue Parameter

0										1										2										3	
0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1
	Reserved Type = 181																				Ler	ngth									
	GPIPortNum E															Е			Re	eserv	red					Tim	neou	t[31	:24]		
										Tin	neou	t [23	3:0]				•														

2972

2973 Abbreviations

2974 E – GPIEvent

2975

See section 10.2.1.1.1.2.

2976 2977

2978 **16.2.4.1.1.2 ROSpecStopTrigger Parameter**

0										1										2										3	
0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1
]	Rese	rvec	l					T	ype	= 18	2											Ler	igth							
	ROS	Spec	Stop	Trig	gerl	Гуре										D	urat	ionT	rigg	gerV	alue	[31:	8]								
I	Dura	tion	Trigg	gerV	alue	[7:0]																								
											(GPI.	Γrigg	gerV	alue	Par	ame	ter (0-1)												

2979 2980 See section 10.2.1.1.2. 2981 2982 16.2.4.2 **AISpec Parameter** 0 0 2 3 4 9 0 1 5 6 0 2 3 4 6 Reserved Type = 183Length AntennaCount AntennaID#1 AntennaID#n AISpecStopTrigger Parameter InventoryParameter Spec Parameter (1-n) Custom Parameter (0-n) 2983 2984 See section 10.2.2. 2985 2986 16.2.4.2.1 AISpecStopTrigger Parameter 0 9 0 1 0 0 2 3 4 5 8 4 5 8 9 3 4 5 9 0 6 6 Type = 184 Reserved Length AISpecStopTriggerType DurationTrigger[31:24] DurationTrigger[7:0] GPITriggerValue Parameter (0-1) TagObservationTrigger Parameter (0-1) 2987 2988 See section 10.2.2.1. 2989 2990 16.2.4.2.1.1 TagObservationTrigger Parameter 0 2 3 4 0 8 9 2 4 5 3 | 4 | 5 6 Reserved Type = 185Length TriggerType Reserved NumberOfTags NumberOfAttempts Timeout $2\overline{991}$ 2992 See section 10.2.2.1.1. 2993 2994 16.2.4.2.2 InventoryParameterSpec Parameter 0 2 3 4 5 0 3 4 1 6 Type = 186Reserved Length InventoryParameterSpecID ProtocolID AntennaConfigurationParameter (0-n)

							Cus	stom	Par	ame	ter (0-n)							
200	_	 -										-		L .	-				 _

See section 10.2.2.2.

2996 2997

RFSurveySpec Parameter 2998 16.2.4.3

0										1										2										3	
0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1
		Rese	ervec	1					T	ype	= 18	7											Len	ngth							
	AntennaID																			Sta	ırtFr	eque	ency	[31:	16]						
	StartFrequency[15:0]																			Er	ıdFr	eque	ncy	[31:1	[6]						
	11 11																														
											R.	FSu	rvey	Spec	Stop	Trig	gger	Para	amet	ter											
													Cus	stom	Para	amet	ter (0	0-n)													

2999

See Section 10.2.3.

3000 3001

RFSurveySpecStopTrigger Parameter 3002 16.2.4.3.1

0	1													
0 1 2 3 4 5 6 7	8 9 0 1 2 3 4 5	6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1												
Reserved	Type = 188	Length												
StopTriggerType	Duration [31:24]													
StopTriggerType Duration [31:24] Duration [7:0] N[31:8]														
N[7:0]														

3003

See Section 10.2.3.1.

3004 3005

16.2.5 Access Operation Parameters 3006

16.2.5.1 AccessSpec Parameter 3007

0										1										2										3	
0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1
]	Rese	ervec	i	•				Т	ype	= 20	7											Ler	igth							
														Ac	cess	Spec	cID														
	AccessSpecID AntennaId ProtocolId C Reserved																														
															ROS																
												Acc	essS	pecS	Stop	Γrigg	ger P	arar	neter	•											
												A	Acce	ssCo	mm	and	Para	met	er												
											1	Acc							(0-1))											
													Cus	stom	Par	ame	ter ((0-n)													

3008 3009 3010 Abbreviations

C – CurrentState

3011 See section 11.2.1. 3012

AccessSpecStopTrigger Parameter 3013 16.2.5.1.1

0										1										2										3	
0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1
									T	ype	= 20	8											Len	igth							
	Ac																														
																												•			

3014

3015 See Section 11.2.1.1.

3016

16.2.5.1.2 AccessCommand Parameter 3017

0										1										2										3	
0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1
]	Rese	rvec	i					T	ype	= 20	19											Ler	igth							
											T	agSp	oecP	aran	netei	:[Se	e no	tes t	oelov	w]											
											OpS	pec	Para	mete	er (1-	-n) [See	note	s be	low]											
													Cus	stom	Par	ame	ter (()-n)													

3018 3019

Notes

3020 TagSpecParameter is the air protocol specific tag spec parameter. For C1G2, it is C1G2TagSpec Parameter.

3021

3022 Each OpSpecParameter can be one of two types: Air protocol specific OpSpec (e.g., C1G2OpSpec 3023

Parameter) or ClientRequestOpSpec Parameter.

3024

3025 See Section 11.2.1.2.

16.2.5.1.3 ClientRequestOpSpec Parameter 3026

0										1										2										3	
0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1
		Rese	rved	l			•		T	ype	= 210)							•		•	•	Ler	igth	•		·			·	
	Reserved Type = 210 OpSpecID																														
202	7																													_	

3027

3028 See Section 11.2.1.2.1.

3029 16.2.5.1.3.1 ClientRequestResponse Parameter

30)30																														
	0									1										2										3	
	0	1	2	3	4	5	6	7	8	9 (1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1
	Reserved Type = 211 Length																														
	AccessSpecID																														
													I	EPCI	Data	Para	mete	er													
											Op	Spec	Para	mete	er (0	-n) [See	note	s bel	low]											
3)31																														

3032 Notes

Each OpSpecParameter is an Air protocol specific opspec (e.g., C1G2OpSpec Parameter).

3034

3035 See Section 11.2.2.

3036 **16.2.6 Configuration Parameters**

3037 16.2.6.1 LLRPConfigurationStateValue Parameter

3038

0										1										2										3	
0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1
	Reserved Type = 217																					Len	gth						•		
												LL	RPC	Confi	gura	ition	Stat	eVa	lue												

3039

3040 See section 12.2.1.

3041 **16.2.6.2 Identification Parameter**

0										1										2										3	
0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1
		Rese	rvec	1					T	ype	= 21	8			•						•		Ler	igth		•		•	•	•	
			IDT	ype										Е	yte(Cour	nt														
												R	Lead	er II)(Va	riab	le le	ngth	1)												

3042

3043 See Section 12.2.2.

3044 **16.2.6.3 GPOWriteData Parameter**

0										1										2										3	
0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1
	Reserved Type = 219															•			•		•	Ler	igth						•		
	Reserved Type = 219 GPO Port Number W															W			R	eser	ved										

3045

3046 Abbreviations

3047 W – GPO Data

3048

3049 See Section 12.2.3.

3050 **16.2.6.4 KeepaliveSpec Parameter**

0										1										2										3	
0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1
]	Rese	rvec	i					T	ype :	= 22	.0											Ler	igth							
	Ke	epal	erved Type = 220 Length liveTriggerType TimeInterval																												
		Ti	meI	nter	val																										

See Section 12.2.4.

16.2.6.5 Antenna Properties Parameter

0										1										2										3	
0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1
]	Rese	erve	1					T	ype :	= 22	1											Ler	ngth							
C	C Reserved Antenn														nnaI	d								Α	Antei	nnaC	3ain	[15:8	[]		
	1	Ante	nna	Gain	<u>1[7:0</u>]																									

Abbreviations

C – Antenna connected

3058 See Section 12.2.5.

16.2.6.6 AntennaConfiguration Parameter

									_																						
0										1										2										3	
0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1
		Rese	erve	1					T	ype :	= 22	22											Ler	igth							
						F	Ante	nnaI	d																						
												R	FRe	ceiv	er P	aran	neter	(0-	1)												
												RF	Trai	ısmi	tter	Para	met	er (0)-1)												
									Air	Prot	oco	lInv	ento	ryCo	omm	and	Setti	ngs	Para	met	er (0	-n)									

Notes: 3063 Each A

Each AirProtocolInventoryCommandSettingsParameter instance is an Air protocol specific Parameter (e.g.,

C1G2InventoryCommand Parameter).

See Section 12.2.6.

3068 16.2.6.7 RFReceiver Parameter

0										1										2										3	
0	1	. 2		3 4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1
		Res	serv	ed					T	ype	= 22	23											Ler	igth							
					R	ecei	ver S	Sens	itivi	ty																					

3070 See Section 12.2.6.1.

16.2.6.8 RFTransmitter Parameter

0										1										2										3	
0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1
]	Rese	rved	l					Ty	/pe =	= 22	4											Ler	ngth							
						Н	орТа	ableI	d													Ch	anne	elInc	dex						
						Tra	nsmi	itPov	wer																						

3073																										<u> </u>				
3074 3075	Se	e Se	ction	12.	2.6.2																									
3076	16	5.2.6	5.9 (GΡΙ	Po	rtC	urr	ent	Sta	te	Par	am	ete	er																
0	1 2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1
U	_	erve		3	U	/	0		ype	= 22		3	4	3	U	/	0	9	U	1			ngth		U	/	0	9	U	1
				1	G	PIPo	ortNi	ım			1	1			C			R	eserv	ed	ı		Ľ	ı	1	GPI	State	e		
3077																														
3078																														
3079 3080	Al	bre	viati		GPI	¬on:	fic																							
3080			,	C –	GFIG	JOII	ng																							
3082	Se	e Se	ction	12.	2.6.3																									
3083																														
3084	16	. 2 6	5.10		F	VAI	nte	Δnc	1Re	no	rte	Рa	ran	net	٥r															
0			10		_	· O.	107		1	PO		. u	. u.		· ·				2										3	
0	1 2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1
	Res	erve					1	Т	уре	= 22	26	1					1	1	ı		ı	Lei	ngth	ı	1					
Н		R	eserv	/ed																										
3085 3086 3087 3088 3089 3090			viati ction	Н –	Holo 2.6.4		ents/	AndF	Repo	rtsU	pon	Reco	onne	ect																
3091	1	6.2	.7		R	ep	or	tin	g F	ar	am	et	ers	6																
3092	14	() -	7.1 F	2 ∩∣	Ror)Or	tQn	.	Dai	ran	104	۵r																		
0	1(J. 4. I	.1 1	\ O	ı zek	JOI	ιορ	-	1 a	an	ieu	51 							2										3	
	1 2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1
	Res	erve		I					ype	= 23		_					,						ngth							
	RO	Repo	ortTr	igge	er								_		N															
										T	agR			ntent 1 Par					er											
												Cu	Ston	l Pai	ame	iei (U-II)													
3093							•							•	•		•	•				•	•	•	•		•			
3094 3095	Se	e Se	ction	13.	2.1.																									
3073																														
3096	10	5.2.	7.1.	1	T	agl	Rev	ort	Cor	iter	ıtSa	elec	tor	Pa	ran	net	er													
0		1	1			0-	- <i>F</i>	T	1		1	T .			.,				2										3	
9				1																1	1		1		1		1	1		

0 1 2 3 4 5	6 7 8 9 0 1 2 3 4 5	6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
Reserved	Type = 238	Length
R I P A C R	F L T S Reserved	
	AirProtocolSpecificEPCMemorySelect	torParameter (0-n) [See notes below]
2007		

3097 **Abbreviations**

3098

- 3099 R – EnableROSpecID
- 3100 I – EnableSpecIndex
- 3101 P – EnableInventoryParameterSpecID
- 3102 A – EnableAntennaID
- 3103 C – EnableChannelIndex
- 3104 R - EnablePeakRSSI
- 3105 F - EnableFirstSeenTimestamp
- 3106 L-Enable Last Seen Time stamp
- 3107 T-Enable Tag Seen Count
- 3108 S-EnableAccessSpecID
- 3109

3110

- **Notes:** 3111 Each instance of AirProtocolSpecificEPCMemorySelectorParameter is one of the air protocol specific
- 3112 selector parameters (e.g., C1G2EPCMemorySelector Parameter).
- 3113
- 3114 See section 13.2.1.1.

3115

16.2.7.2 **AccessReportSpec Parameter** 3116

0									1										2										3	
0	1	2 3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1
		Reserve						T	уре	= 23	39											Ler	igth							
	A	ccessRe	port	Trigg	ger																									

3117

3118 See section 13.2.2.

16.2.7.3 3119 TagReportData Parameter

0										1										2										3	
0	1	2	3	4	5	6	7	8	9	0	1	2	3 4	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1
	I	Rese	rved	i			•		Ту	pe :	= 24	0	•					•	•			•	Ler	ngth	•						
											EI	PCDat	aPaı	ram	neter	[Se	e no	tes l	belo	ow]											
												RO	Spe	ecII) Pa	ram	eter	(0-1)	.)												
												Sp	ecIn	dez	x Pai	ramo	eter	(0-1))												
										I	nver	ntoryP	aran	net	erSp	ecII	O Pa	ram	ete	r (0-1	.)										
	InventoryParameterSpecID Parameter (0-1) AntennaID Parameter (0-1)																														
AntennaID Parameter (0-1) PeakRSSI Parameter (0-1)																															
												Cha	nnel	Ind	lex P	araı	mete	er (0	-1)												
											First	Seen	Γime	esta	ımpl	JTC	Par	ame	eter	(0-1))										
										F	irstS	SeenT	mes	tan	npUj	ptim	ne Pa	aram	iete	er (0-	1)										
											Last	Seen	ime	esta	mpl	JTC	Par	ame	ter	(0-1))										
										L	astS	eenTi	mes	tan	որՍլ	ptim	ne Pa	aram	ete	er (0-	1)										
												Tags	Seen	Co	unt I	Para	met	er (0	-1))											
									Ai	rPro	otoco	olTagl	Data	Par	ame	ter ((0-n))[Se	e N	otes	belo	w]									
												Acc	essS	pec	ID F	Para	mete	er (0	-1)												

					Op	Spec	Res	sultP	aramet	er (0-	n) [S	ee n	otes	belo	ow]					
								Cus	stom Pa	rame	ter (0-n)								

- 3121 Notes:
- The EPCDataParameter is either the EPCData Parameter (Section 16.2.7.3.1) or EPC-96 Parameter
- (Section 16.2.7.3.2). The EPCData Parameter SHALL be used for encoding a non-96 bit EPC, whereas the
- EPC-96 Parameter SHALL be used for encoding a 96-bit EPC.

3125

- The AirProtocolTagDataParameter is one or more air protocol specific tag data parameters (e.g., C1G2PC and C1G2CRC). In the C1G2 case, each parameter, C1G2PC and C1G2CRC, is optional in the
- 3128 TagReportData Parameter.

3129

- 3130 OpSpecResultParameter: Either an air protocol specific OpSpec result parameter (e.g., C1G2OpSpecResult
- Parameter) or ClientRequestOpSpecResult Parameter.

3132

3133 See section 13.2.3.

3134 *16.2.7.3.1 EPCData Parameter*

0										1										2										3	
0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1
		Rese	ervec	i					Т	ype	= 24	-1											Ler	igth							
						EPG	CLe	ngth	Bits																						
															EI	PC															

3135

- 3136 EPCLengthBits: Number of bits in the EPC.
- 3137 See Section 13.2.3.2.

3138

3139 *16.2.7.3.2 EPC-96 Parameter (TV-Encoding)*

0		
0 1 2 3 4 5 6 7	8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	1
1 Type=13	EPC[95:72]	
	EPC[71:40]	
	EPC[39:8]	
EPC[7:0]		

 $3\overline{140}$

3141 See Section 13.2.3.2.

3142 16.2.7.3.3 ROSpecID Parameter (TV-Encoding)

							_						,				_														
0										1										2										3	
0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1
1			T	ype=	=9													ROS	Specl	ID[3	1:8]										
		RO	Spe	cID[7:0]																										

3143

3144 See Section 13.2.3.3.

3146 16.2.7.3.4 SpecIndex Parameter (TV-Encoding)

0										1										2										3	
0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1
1			Ty	уре=	14									S	pec	Inde	X														

3147

3148 See Section 13.2.3.4.

3149 16.2.7.3.5 InventoryParameterSpecID Parameter (TV-Encoding)

									-				_						•												
0										1										2										3	
0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1
1		•	1 y	pe=	10					•	•	I	nve	ntory	Para	amet	terSp	peclo		•	•		•								

3150

3151 See Section 13.2.3.5.

3152 16.2.7.3.6 AntennaID Parameter (TV-Encoding)

0										1										2										3	
0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1
1				ype=	=1									A	nte	nnaI	d														

3153

3154 See Section 13.2.3.6.

3155 16.2.7.3.7 PeakRSSI Parameter (TV-Encoding)

0										1										2										3	
0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1
1			Т	vpe=	=6					I	Peak	RSS	I																		

3156

3157 See Section 13.2.3.7.

3158 16.2.7.3.8 ChannelIndex Parameter (TV-Encoding)

0										1										2										3	
0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1
1				ype=	=7	•	•			•	•	•	•	Ch	anne	elInc	lex			•	•										

3159

3160 See Section 13.2.3.8.

3161 16.2.7.3.9 FirstSeenTimestampUTC Parameter (TV-Encoding)

0										1										2										3	
0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1
													M	icro	seco	nds	[39:	8]													
		Aicro	osec	onds	[7:0]																									

3162

3163 See Section 13.2.3.9.

3164 16.2.7.3.10 FirstSeenTimestampUptime Parameter (TV-Encoding)

					_	_				-					
0)			1					2					3	

0	1 2 3 4 5 6 7	8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0												
1 Type=3 Microseconds[63:40]														
		Microseconds [39:8]												
	Microseconds[7:0]													

3166 See Section 13.2.3.10.

3167 16.2.7.3.11 LastSeenTimestampUTC Parameter (TV-Encoding)

0										1									2						3	
0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 1 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 1 1 Type=4 Microseconds[63:40]															9	0	1									
1	0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0																									
													N.	licro	seco	onds	[39:8	3]								
		Micro	osec	onds	[7:0]																				

3168

3169 See Section 13.2.3.11.

3170 16.2.7.3.12 LastSeenTimestampUptime Parameter (TV-Encoding)

0										1										2										3	
0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1
1																															
													M	licro	seco	nds	[39:8	8]		_											
	N	Aicro	sec	onds	[7:0]																									

3171

3172 See Section 13.2.3.12.

3173 16.2.7.3.13 TagSeenCount Parameter (TV-Encoding)

	0										1										2										3	
	0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1
Ī	1			T	ype=	-8]	CagC	oun	t				•										
2	171																															

3174

3175 See Section 13.2.3.13.

3176 16.2.7.3.14 ClientRequestOpSpecResult Parameter (TV-Encoding)

0										1										2										3	
0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1
1			,	pe=	15									C)pSp	ecII)														
317	7																														

3178 See Section 13.2.3.14.

3179 16.2.7.3.15 AccessSpecID Parameter (TV-Encoding)

0									-	_					,				•													
0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1	0										1										')										3	
1 Type=16 AccessSpecID[31:8]	0	1	2	3	4	5	6	7		9	0	1	')	3	4	5	6	7		9	0	1	2	3	4	5	6	7	8	9	0	1
AccessSpecID[7:0]	71																															

3180

3181 See Section 13.2.3.15.

16.2.7.4 RFSurveyReportData Parameter 3184

_		\sim	_
٠,	1	v	4
٦.		$^{\sim}$	٦,

0										1										2										3	
0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1
		Res	erve	d					T	уре	= 24	-2											Ler	igth							
												I	ROS	pecI	D Pa	ıram	eter	(0-1)	l)												
												,	Spec	Inde	x Pa	ram	eter	(0-1))												
]	Freq	uenc	cyRS	SSIL	evel	Entr	у Ра	ram	eter	(1-n)										
													Cus	stom	Para	ame	ter (0	0-n)													
2100																															

3186 3187

See Section 13.2.3.15.

3188

FrequencyRSSILevelEntry Parameter 16.2.7.4.1 3189

3190

0										1										2										3	
0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1
	•	Rese	erve	i	•				T	ype	= 24	-3		•	•		•	•	•	•		•	Lei	ngth		•		•		•	
														F	requ	ienc	y														
														E	Band	widt	h														
		Av	verag	ge R	SSI					P	eak	RSS	SI																		
											Tir	nesta	amp	Para	met	er [S	ee n	otes	bel	ow]											
210																															

3191

3192 **Notes:**

TimestampParameter: Either UTCTimestamp Parameter or UptimeParameter.

3193 3194

3195 See section 13.2.4.1

3196

ReaderEventNotificationSpec Parameter 16.2.7.5 3197

3198

ノエノ	U																														
0										1										2										3	
0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1
		Rese	ervec	i					T	ype	= 24	4											Ler	igth							
											Ev	entl	Noti	ficat	ionS	tate	Para	met	er(1	-n)											
											_,	CIIII	1011	iicat	10110	tuto	ı uı		01(1	11)											
		1																													

3199

See Section 13.2.5.

3203 16.2.7.5.1 EventNotificationState Parameter

3204

0										1										2										3	
0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1
		Rese	ervec	i					T	ype	= 24	15		•									Ler	igth		•	•				
						F	even	tTyp	e							S			Re	eserv	red										

3205 3206

Abbreviations:

3207 S – NotificationState

3208

3209 See Section 13.2.5.1.

3210

3211 16.2.7.6 ReaderEventNotificationData Parameter

0										1										2										3	
0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1
		Rese	erve	d					T	ype =	= 24	6											Len	gth							•
											Tin	nest	amp	Para	mete	er [S	See n	otes	bel	ow]											
												Но	ppir	ngEv	ent i	Para	ımet	er (0)-1)												
													GPII																		
													OSpe																		
										Repo	ortB									eter (0-1)										
										Repo																					
										порс			Exc								<u> </u>										
													Surv	_					_												
													ISpe																		
																		_													
													ntenr																		
										(Con	nect	ion/	\tter	nptE	Even	t Pai	ame	eter ((0-1)											
											Co	nne	ction	Clo	seEv	ent	Para	met	er (0)-1)											
													Cus	stom	Para	ame	ter (0-n)													

3212

3213 Notes:

TimestampParameter: Either UTCTimestamp Parameter or Uptime Parameter.

3215

See section 13.2.6.

3216 3217

3218 *16.2.7.6.1 HoppingEvent Parameter*

0										1										2										3	
0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1
		Rese	erved	•					T	уре	= 24	17											Ler	igth							
						Н	орТа	able	ID												1	Next	Cha	nnel	Inde	X					
																•															

3219 3220

20 See section 13.2.6.2.

3222 16.2.7.6.2 **GPIEvent Parameter**

0										1										2										3	
0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1
		Rese	ervec	i	•				T	ype	= 24	18	•	•				•	•		•	•	Ler	gth			•	•		•	
						GPI	Por	tNur	nber							Е			R	eserv	ved										

3223 Abbreviations

3224 E – GPIEvent

3225 3226

See section 13.2.6.3.

3227

16.2.7.6.3 ROSpecEvent Parameter 3228

0	1	
0 1 2 3 4 5 6 7	8 9 0 1 2 3 4 5	6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
Reserved	Type = 249	Length
EventType		ROSpecID[31:8]
ROSpecID[7:0]		PreemptingROSpecID[31:8]
	PreemptingF	OSpecID[7:0]

3229

3230 See section 13.2.6.4.

3231

16.2.7.6.4 ReportBufferLevelWarningEvent Parameter 3232

0										1										2										3	
0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1
	I	Rese	rvec	1					T	ype	= 25	0											Ler	ngth							
Re	por	rtBu	fferI	Perc	entag	geFu	ı11																								

3233

See section 13.2.6.5.

3234 3235

ReportBufferOverflowErrorEvent Parameter 3236 16.2.7.6.5

							_		-			•																			
0										1										2										3	
0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1
		Rese	erve	d					T	ype	= 25	51											Len	igth							

3237 3238 3239

See section 13.2.6.6.

ReaderExceptionEvent Parameter 3240 16.2.7.6.6

0										1										2										3	
0	0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5													5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1	
	0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 Reserved Type = 252																					Ler	ngth								
				1	Mess	sage	Strii	ng B	vteC	Coun	nt																				

							M	essa	ge: V	Varia	able	leng	th U	TF-	8Stı	ing						
									ROS	pecI	D Pa	aram	eter	(0-1	l)							
									Spec	Inde	ex Pa	ıram	eter	(0-1))							
							Inve	ntor	yPar	ame	terSj	pecI	D Pa	ıram	eter	(0-1))					
									Ante	nnal	D Pa	aram	eter	(0-1)	l)							
								A	ccess	Spe	cID	Para	met	er (0	1)							
									OpS	pecI	D Pa	ıram	eter	(0-1))							
									Cus	stom	Par	ame	ter (0-n)								
3241											•											
3242	See	e Sect	ion 1	326	7																	

3244 16.2.7.6.6.1 OpSpecID Parameter (TV-Encoding)

(0										1										2										3	
(0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1
	1				pe=	17	•	•					•	•	(pSp	ecII)				•	•	•								
32	45																															

3246

See Section 13.2.5.7.1.

RFSurveyEvent Parameter 3247 *16.2.7.6.7*

0	1		3
0 1 2 3 4 5 6	7 8 9 0 1 2 3 4 5	6 7 8 9 0 1 2 3	4 5 6 7 8 9 0 1
Reserved	Type = 253	Ler	ngth
EventType		ROSpecID[31:8]	
ROSpecID[7:0]	SpecInd	ex[15:0]	

3248 3249

See Section 13.2.6.7.1.

3250 3251

16.2.7.6.8 AISpecEvent Parameter 3252

0			1									2										3	
0 1 2 3 4	6 7	8 9	0 1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1
Reserved		7	ype = 2	254									•		Ler	igth	•					•	
EventType										ROS	Spec	ID[3	31:8										
ROSpecID[7:)]					Spe	cInd	ex[1	5:0]														
		AirPro	tocolSi	ngula	tionI	Deta	ilsPa	ıram	eter	(0-1)) [S	ee n	otes	belo	w]								
											•												

3253

3254 See section 13.2.6.9.

3255 **Notes:**

3256

AirProtocolSingulationDetailsParameter is one of the air protocol specific singulation parameters (e.g.,

3258 C1G2SingulationDetails Parameter).

3259

16.2.7.6.9 AntennaEvent Parameter 3260

0										1										2										3	
0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1
		Rese	ervec	i				•	Т	ype	= 25	55	•	•					•				Ler	igth		•				•	
		F	Even	tTyp	oe .									A	Inter	nnaI	D														

See Section 13.2.6.10.

3263

3264 16.2.7.6.10 ConnectionAttemptEvent Parameter

0									1										2										3	
0 1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1
	Rese	erve	i					T	ype	= 25	6											Ler	igth							
						Sta	tus																							
2265																														

3265

3266 See Section 13.2.6.11.

3267

3268 16.2.7.6.11 ConnectionCloseEvent Parameter

0										1										2										3	
0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1
		Rese	ervec	i					T	ype	= 25	57											Len	gth							

3269 3270

See Section 13.2.6.12.

3271

3272 **16.2.8 LLRP Error Parameters**

3273 16.2.8.1 LLRPStatus Parameter

3274 0 2 3 6 7 8 9 0 1 2 3 4 5 6 7 8 0 2 3 4 5 6 Type = 287Length Reserved StatusCode Error Description ByteCount Error Description: Variable length UTF-8 String FieldError Parameter (0-1) ParameterError Parameter (0-1)

3275 3276

See Section 14.2.2.

3277

3278 *16.2.8.1.1 FieldError Parameter*

3	2/5	,																
	Λ						1					2	2				3	

0	1	2	3	4	5	6	7	8	9	0	1	2	3 4	5	6	7	8 9	0	1	2 3	4	5	6	7	8	9	0 1
		Rese	erve	d					T	ype	= 28	88								Le	ngth						
						I	Field	Nur	n											Erro	rCoc	le					

 $\frac{3\overline{280}}{3281}$

See section 14.2.2.1.

3282

3283 16.2.8.1.2 ParameterError Parameter

3	2	8	4	

	•																														
0										1										2										3	
0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1
		Rese	erve	1					T	ype	= 28	9											Len	igth							
						Par	ame	terT	ype													E	Error	Cod	e						
												F	Field	Err	or Pa	aram	eter	(0-1)	l)												
												Par	ame	ter E	Error	Par	amet	ter ((0-1)												

3285

3286 See Section 14.2.2.2.

3287

3288 **16.2.9** Custom Parameter

0										1										2										3	
0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1
		Rese	rvec	l					Т	ype	=102	.3	•	•	•			•]	Para	mete	er Le	ngth	1		•			
														7	/end	or I	D														
															Sub	type	;														
													Ver	ndor	Para	met	er Va	alue													

3289

3290 See Section 8.2.

3291

3292

16.3 Air Protocol Specific Parameters

- 3293 This section defines air protocol specific parameter encodings. There is a separate
- 3294 subsection here for each air protocol defined by LLRP. See section 15, in the LLRP
- 3295 abstract specification, for more information regarding air protocol specific parameters.

3296 16.3.1 Class-1 Generation-2 (C1G2) Protocol Parameters

- The Class-1 Generation-2 (C1G2) Air Protocol is specified by the EPCglobal Class-1
- 3298 Generation-2 UHF RFID Protocol v1.1.0 specification.
- 3299 The following subsections specify LLRP air protocol specific parameter encodings.
- These subsections are partitioned to correlate with subsections of section 16.2:
- Capabilities Parameters
- Reader Operations Parameters

- Access Operation Parameters

- Configuration Parameters

3305 - Reporting Parameters

3306 **16.3.1.1 Capabilities Parameters**

3307 This section of air protocol specific parameters corresponds to LLRP parameters

encodings specified in section 15.2.1.1.

3309 16.3.1.1.1 C1G2LLRPCapabilities Parameter

0										1										2										3	
0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1
		Rese	ervec	1					Т	ype	=32	7											Len	gth							
Е	W			Rese	erve	d						Ma	ιxΝι	ımS	elect	Filte	ersPe	erQu	ery												

 $\frac{3\overline{310}}{3311}$

Abbreviations

3312 E – CanSupportBlockErase 3313 W – CanSupportBlockWrite

3314

3315 See Section 15.2.1.1.1.

3316

3317 16.3.1.1.2 UHFC1G2RFModeTable Parameter

0									1										2										3	
0	1	2 3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1
]	Reserve	1					T	ype	= 32	28											Len	gth							
					•				UI	HFC	1G2	RFN	Aode	Tab	leEr	itry]	Para	mete	er (1-	-n)										

3318 3319

See Section 15.2.1.1.2.

3320

3321 16.3.1.1.2.1 UHFC1G2RFModeTableEntry Parameter

0										1										2										3	
0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1
	•	Res	erve	i	•		•	•	Т	ype	= 32	9	•						•		•	•	Ler	igth	•			•		•	
														Mo	de id	lenti	ifier														
R	C			Rese	erve	d					M	od							FI	LM							N	Л			
														В	DR	Valı	ıe														
														I	PIE V	/alu	e														
														Mi	nTa	riVa	lue														
														Ma	ıxTa	riVa	lue														
														Ste	рТа	riVa	lue														

3322

3323 Abbreviations

R - DR Value

M- Spectral Mask Indicator Mod – M value / Modulation FLM – Forward Link Modulation C – EPC HAG T&C Conformance See section 15.2.1.1.2.1. 16.3.1.2 **Reader Operations Parameters** This section of air protocol specific parameters corresponds to LLRP parameters encodings specified in section 15.2.1.2. C1G2InventoryCommand Parameter 16.3.1.2.1 3 4 8 9 Type = 330Reserved Length S Reserved C1G2Filter Parameter (0-n) C1G2RFControl Paremeter (0-1) C1G2SingulationControl Parameter (0-1) Custom Parameter (0-n) **Abbreviations** S-TagInventoryStateAwareSee Section 15.2.1.2.1 16.3.1.2.1.1 C1G2Filter Parameter 9 0 Reserved Type =331Length T Reserved C1G2TagInventoryMask Parameter C1G2TagInventoryStateAwareFilterAction Paremeter (0-1) C1G2TagInventoryStateUnawareFilterAction Parameter (0-1) See Section 15.2.1.2.1.1. 16.3.1.2.1.1.1 C1G2TagInventoryMask Parameter 9 0 Reserved Type = 332Length

Pointer[15:0]

Tag Mask

MB

Reserved

MaskBitCount[7:0]

MaskBitCount[15:8]

3347	7																														
3348 3349		See	sec	tion	15.2	.1.2.	1.1.	1.																							
3350)	16.	3.1	.2.1	.1.2	2 C	1G2	Tag	gInv	ent	ory	State	Aw	are	eFil	ter/	\cti	on	Para	ame	ter										
0										1										2										3	
0	1		3	4	5	6	7	8	9	0	1		3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1
		Rese							T	ype													Ler	ngth						Г	
			Tai	rget							Act	ion	1	- 1															<u> </u>		
3352 3353 3354	3			tion .2.1					gInv	/ent	ory	State	Una	aw	arel	Filte	erA	ctic	on P	'araı	met	er									
0										1										2										3	
0	1	2	3	4	-	-	7	8	0	0	1	2	3	4	5	_	7	8	9	0	1	2	3	4	5	6		8	9	0	1
		D	_	4	5	6	7	ð	9	U	1	2	5	4	3	6	/	·					3		_	U	7	O			
		Kese	ervec	i	3	0	/	8		ype			3	4	3	6	/							ngth		U	7	0			
		Rese	ervec)	0	/	8					<i>J</i>	4	3	6	/					2				U	1	0			
		Kese	ervec	i	3	0	/	8						4	3	6	/											0			
3355 3356 3357	6		Ac	i										4	3	6	/					2						0			
3356	5 7	See	Act	tion tion	15.2	.1.2.	.1.1.	3.	Т	уре	= 33			4	3	6	/					2						0			
3356 3357 3358	5 7	See 16.	Action Section 3.1.	tion tion	15.2 2 C	.1.2.	.1.1.í	3.	ıtro	ype I Pa	= 33	neter								2			Ler	ngth						3	
3356 3357 3 <u>358</u>	5 7	See 16.	Acres section 3.1.	tion 2.1.2	15.2	.1.2.	.1.1.	3.	ntro	1 Pa	= 33	neter		4	5	6	7	8	9	2 0	1	2	Ler 3	ngth 4	5	6	7	8	9	3 0	1
3356 3357 3358	6 7 8	See 16.	Acres section 3.1.	tion 2.1.2	15.2 2 C	2.1.2. 21G2	.1.1.í.	3. Cor	ntro 9 T	ype I Pa	= 33	neter							9		1		Ler 3 Ler	ngth 4					9		
3356 3357 3358	6 7 8	See 16.	Acres section 3.1.	tion 2.1.2	15.2 2 C	2.1.2. 21G2	.1.1.í	3. Cor	ntro 9 T	1 Pa	= 33	neter							9		1		Ler 3 Ler	ngth 4					9		1
3356 3357 3358	6 7 8	See 16.	Acres section 3.1.	tion 2.1.2	15.2 2 C	2.1.2. 21G2	.1.1.í.	3. Cor	ntro 9 T	1 Pa	= 33	neter							9		1		Ler 3 Ler	ngth 4					9		1
3356 3357 3358	6 7 8 1	See 16.	Acres section 3.1.	tion 2.1.2	15.2 2 C	2.1.2. 21G2	.1.1.í.	3. Cor	ntro 9 T	1 Pa	= 33	neter							9		1		Ler 3 Ler	ngth 4					9		1

3362 16.3.1.2.1.3 C1G2SingulationControl Parameter

0										1										2										3	
0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1
		Rese	rvec	1					Т	Гуре	=330	5											Ler	igth							
S	5		I	Rese	rved									Tag	gPop	ulat	ion								Tag	gTra	nsit	Гіте	e[31:	24]	
									Ta	gTra	nsiť	Γim	e[23	:0]																	
								C10	G2T	agIn	vent	oryS	tate	Awa	areSi	ngu	latio	nAc	tion	Para	amet	er (0)-1)	='							

Abbreviations: S-Session

3363 3364 3365 3366 3367 See section 15.2.1.2.1.3.

3369 16.3.1.2.1.3.1 C1G2TagInventoryStateAwareSingulationAction Parameter

0										1										2										3	
0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1
		Rese	ervec	l					T	ype	= 33	7											Len	igth							
I	S]	Rese	rvec	l																									

3370 3371

See section 15.2.1.2.1.3.1.

3372

3373 **16.3.1.3 Access Operation Parameters**

3374 This section of air protocol specific parameters corresponds to LLRP parameters

encodings specified in section 15.2.1.3.

3376 *16.3.1.3.1 C1G2TagSpec Parameter*

0										1										2										3	
0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1
		Rese	rved	l					T	ype	= 33	8											Ler	igth							
												(C1G	2Taı	get	ag I	Parai	nete	r												
												C10	G2T	arge	tTag	Par	amet	ter (0-1)												

3377 3378

See section 15.2.1.3.1.

3379

3380 16.3.1.3.1.1 C1G2TargetTag Parameter

3381																									
0				1										2										3	
0 1 2 3	3 4 5	6 7	8 9	0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1
Reserv	ed		7	Гуре	= 339	9	•	•		·		•	•				Len	gth			•	•			
MB M	Resv	rd							Poir	nter									M	[ask]	BitC	oun	t[15:	8]	
MaskB	tCount[7:	0]																							
								Т	ag N	Masl	K														
		DataBi	itCount																						
								7	Гаg l	Data	ı														

3382

3383 Abbreviations

M - Match.

3385 3386

See section 15.2.1.3.1.1.

3387

3388 16.3.1.3.2 C1G2 OpSpecs

3389 16.3.1.3.2.1 C1G2Read Parameter

3390

0										1										2										3	
0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1
]	Rese	rvec	i			•	•	T	ype	= 34	-1	•					•		•	•	•	Ler	ngth	•	•	•				
						(OpSp	pecI]	D												Ac	cessl	Pass	word	1[31	:16]					
					Ac	cess	Pass	swor	d[15	5:0]						M	ΙB			Rese	erve	d			1	Vorc	lPoi	nter[15:8	3]	
	7	Wor	dPo	inter	[7:0]								V	Vord	Cou	nt														

3391

3392 See section 15.2.1.3.2.2.

3393 16.3.1.3.2.2 C1G2Write Parameter

3394

0										1										2										3	
0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1
]	Rese	rvec	1					T	ype	= 34	12											Len	igth							
						(OpSp	pecI]	D												Acc	essI	Passv	word	1[31:	16]					
					Ac	cess	Pass	swor	d[15	5:0]						M	ΙB			Rese	rvec	l			V	Vord	Poir	nter[15:8]	
	7	Wor	dPo	inter	[7:0]							W	riteI	Data'	Wor	dCo	unt													
														V	Write	e Da	ta														
2 2 2																															

3395 3396 See section 15.2.1.3.2.2.

3397 16.3.1.3.2.3 C1G2Kill Parameter

0										1										2										3	
0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1
]	Rese	ervec	i					T	ype	= 34	.3											Ler	igth							
						(OpSp	ecIl	D												K	illPa	SSW	ord[31:1	6]					
					K	illP	assw	ord	[15:0	0]																					

3398

3399 See section 15.2.1.3.2.3.

3400 16.3.1.3.2.4 C1G2Lock Parameter

3401

0										1										2										3	
0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1
]	Rese	ervec	l					Т	ype	= 34	4												igth							
								pecII													Acc	essI	assv	word	1[31:	:16]					
					Ac	cess	Pass	swor	d[15	5:0]																					
											(C1G	2Lo	ckPa	ıyloa	ıd Pa	ıram	eter	(1-n	1)											

3403 See section 15.2.1.3.2.4.

3404

3405 16.3.1.3.2.4.1 C1G2LockPayload Parameter

3406

0									1										2										3	
0 1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1
	Rese	rved						T	ype	= 34	15											Len	igth							
	I	Privi	lege]	Data	Fiel	d																		

3407 3408

See section 15.2.1.3.2.4.1.

3409

3410 16.3.1.3.2.5 C1G2BlockErase Parameter

3411

0										1										2										3	
0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1
]	Rese	rvec	i					T	ype	= 34	-6											Lei	ngth							
						(OpS	pecI]	D												Ac	cessl	Pass	word	1[31	:16]					
					Αc	cess	sPass	swor	d[15	5:0]						N	ſΒ			Rese	erve	1			7	Word	dPoi	nter[15:8	3]	
	1	Wor	dPo	inter	[7:0]								V	Vord	Cou	nt														

3412 3413

See section 16.3.1.3.2.5.

3414

3415 16.3.1.3.2.6 C1G2BlockWrite Parameter

3416

0	1		
0 1 2 3 4 5 6 7	8 9 0 1 2 3 4 5	6 7 8 9 0 1 2 3	4 5 6 7 8 9 0 1
Reserved	Type = 347	Leng	gth
OpS	pecID	AccessPassw	vord[31:16]
AccessPas	sword[15:0]	MB Reserved	WordPointer[15:8]
WordPointer[7:0]	WriteData	WordCount	
	Write	e Data	
)417			

3417 3418

See section 15.2.1.3.2.6.

3419

3420 **16.3.1.4 Configuration Parameters**

- 3421 This section of air protocol specific parameters corresponds to LLRP parameters
- 3422 specified in Section 12.2. The only air protocol specific parameter is the
- 3423 AirProtocolInventoryCommandSettings parameter in the AntennaConfiguration (Section
- 3424 12.2.6). The C1G2 specific InventoryCommand is already defined in Section 16.3.1.2.1.

3426 **16.3.1.5** Reporting Parameters

3427 This section of air protocol specific parameters corresponds to LLRP parameters

encodings specified in section 15.2.1.5.

3429 16.3.1.5.1 C1G2EPCMemorySelector Parameter

34	30																															
()										1										2										3	
()	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1
]	Rese	rvec	l					T	уре	= 34	18											Len	igth							
	\mathbb{C}	P]	Rese	rvec	l																									
24	2 1	•						•	•	•					•	•			•	•								•				

3431 Abbreviations

3433

3434 C – EnableCRC 3435 P – EnablePCBits

3436

3437 See section 15.2.1.5.1.

3438

3439 *16.3.1.5.2 C1G2PC Parameter (TV-Encoding)*

0										1										2										3	
0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1
1			Ty	pe=	12										PC-	Bits															

3440

3441 See section 15.2.1.5.2.

3442 16.3.1.5.3 C1G2CRC Parameter (TV-Encoding)

																	_	-													
0										1										2										3	
0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1
1			Ty	/pe=	11										CF	RC															

3443

3444 See section 15.2.1.5.3.

3445 16.3.1.5.4 C1G2SingulationDetails Parameter (TV-Encoding)

0										1										2										3	
0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1
1			Ту	pe=	18								N	Jum(Colli	isior	Slot	S							Nu	mEr	npty	Slot	s[15		
	N	umE	mpt	ySlo	ts[7:	[0:																									1

3446

3447 See section 15.2.1.5.4.

3448 *16.3.1.5.5 C1G2 OpSpec Results*

3449 16.3.1.5.5.1 C1G2ReadOpSpecResult Parameter

0										1										2										3	
0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1
]	Rese	ervec	i					T	ype	= 34	19											Ler	igth							
			Re	sult										(OpSp	oecII	D							R	Read	Data	ıWo:	rdCo	ount	[15:8	8]

				ount[7:		_																					
													Reac	lData													
50																											
51 52				15.2.1.:																							
53	16.	3.1.	5.5.	2 C10	2W	rite	Op	Spec	Res	sult l	Par	am	eter			_			,				,	,			
0	_					_		1			_						2		_								3
0 1	2	3	4	5 6	7	8	9	0	1	2	3	4	5	6 7	8	9	0	1	2	3	4	5	6	7	8	9	0
	Rese		ı sult					Гуре	= 3:	50)nCr	ecID						Lei	ngth	Nur	~W	orda'	M/rit	tanl	15.0
Nı	ımW			ten[7:0	1								Just	Decid						Π		Ivui	11 VV (Jius	VVIII	LCII	15.6
110	11	J1 G15	,,111									<u> </u>	<u> </u>							 	 						
54 55	Sec	sec	tion	15.2.1.:	552																						
56	300	SCC	иоп	13.2.1	5.5.4																						
57	16	3.1.	5.5.	3 C10	2Ki	llOı	oSn	ecR	esu	lt Pa	ran	net	er														
0	T	•	•			- 1	P	1									2			T	T	Т					3
0 1	2	3	4	5 6	7	8	9	0	1	2	3	4	5	6	8	9		1	2	3	4	5	6	7	8	9	0
	Rese				1 '			Гуре	_				1 -	- 1		1		-			ngth		1	'			
		Re		1		T		- 1																			
		110	Suit		_							. (OpSp	oecID													
		110	Suit									(OpSı	pecID													
50			Suit										OpSı	becID													
	C-			15 2 1									OpSı	pecID													
59	Sec			15.2.1.:	5.5.3								OpSı	pecID													
59	See			15.2.1.:	5.5.3								OpS _I	pecID													
59 60		e sec	tion)pS	Spec	Res	ult P	ara			pecID													
59 60 61		e sec	tion	15.2.1.: 4 C1C)pS	Spec]	Res	ult P	ara			pecID			2										3
59 60 61	16	3.1.	tion 5.5.	4 C10	S2La	ock(1				ıme	ter		8	9	2 0	1	2				6	7	8	9	3 0
.59 .60 .61 0 1	16	3.1.	5.5.	4 C10		ock(9	1	1	2		ıme	ter		8	9		1	2	3		5	6	7	8	9	
59 60 61 0 1	16.	3.1. 3 ervee	5.5.	4 C10	S2La	ock(9	1 0	1	2		ame	ter 5		8	9		1	2	3	4	5	6	7	8	9	
.59 .60 .61 0 1	16.	3.1. 3 ervee	5.5.	4 C10	S2La	ock(9	1 0	1	2		ame	ter 5	6 7	8	9		1	2	3	4	5	6	7	8	9	
259 260 261 0 0 1	16.	3.1. 3 ervee	5.5.	4 C10	S2La	ock(9	1 0	1	2		ame	ter 5	6 7	8	9		1	2	3	4	5	6	7	8	9	
659 660 661 0 0 1	16.	3.1. 3 Prived Re	5.5. 4 1 sult	4 C10 5 6	62L 0	8	9	1 0	1	2		ame	ter 5	6 7	8	9		1	2	3	4	5	6	7	8	9	
659 660 661 0 1	16.	3.1. 3 Prived Re	5.5. 4 1 sult	4 C10	62L 0	8	9	1 0	1	2		ame	ter 5	6 7	8	9		1	2	3	4	5	6	7	8	9	
158 159 160 161 162 163 164	16.	3.1. 3 Prived Re	5.5. 4 1 sult	4 C10 5 6	62L 0	8	9	1 0	1	2		ame	ter 5	6 7	8	9		1	2	3	4	5	6	7	8	9	
659 660 661 0 1 662 663 664	16. 2 Rese	3.1. 3 ervee Re	5.5. 4 1 sult	5 6 15.2.1.:	7 5.5.4	8 8	9	1 0 Type	1 = 35	52	3	4 4	ter 5	6 7	8	9		1	2	3	4	5	6	7	8	9	
159 160 160 161 162 163 164 165	16. 2 Rese	3.1. 3 ervee Re	5.5. 4 1 sult	4 C10 5 6	7 5.5.4	8 8	9	1 0 Type	1 = 35	52	3	4 4	ter 5	6 7	8	9	0	1	2	3	4	5	6	7	8	9	0
.59 .60 .61 0 1 .62 .63 .64	16. 2 Ress	3.1. 3 ervec Re 3.1.	5.5. 4 11 sult tion 5.5.	4 C10 5 6 15.2.1.:	7 7 55.5.4	8	9 9 Era	1 0 Γype	1 = 3:	2 52 DecR	3	ame	ter 5 OpSi	6 7			2			3 Ler	4 angth	5					3
59 60 61 0 1 62 63 64 65 0 0 1	16. 2 Ress	3.1. 3 ervece sec	5.5. 4 11 sult tion 5.5. 4	5 6 15.2.1.:	7 7 55.5.4	8 8	Era 9	1 0 Γype	1	2 52 DecR	3	4 4	ter 5	6 7			2	1	2	3 Ler	4 4 ngth	5	6	7	8	9	0
61 0 0 1 62 63 64 65 0 0 1	16. 2 Ress	3.1. 3 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8	5.5. 4 11 sult 4 11	4 C10 5 6 15.2.1.:	7 7 55.5.4	8	Era 9	1 0 Γype	1	2 52 DecR	3	1 4 (1) (1) (1) (1) (1) (1) (1) (1) (1) (1)	ter 5 OpSi	6 7			2			3 Ler	4 angth	5					3
.659 .660 .61 0 0 1 .62 .63 .64	16. 2 Ress	3.1. 3 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8	5.5. 4 11 sult tion 5.5. 4	4 C10 5 6 15.2.1.:	7 7 55.5.4	8	Era 9	1 0 Γype	1	2 52 DecR	3	1 4 (1) (1) (1) (1) (1) (1) (1) (1) (1) (1)	ter 5 OpSi	6 7			2			3 Ler	4 4 ngth	5					3
61 0 0 1 62 63 64 65 0 0 1	16. 2 Ress	3.1. 3 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8	5.5. 4 11 sult 4 11	4 C10 5 6 15.2.1.:	7 7 55.5.4	8	Era 9	1 0 Γype	1	2 52 DecR	3	1 4 (1) (1) (1) (1) (1) (1) (1) (1) (1) (1)	ter 5 OpSi	6 7			2			3 Ler	4 4 ngth	5					3

3466 3467 See section 15.2.1.5.5.5.

3469 16.3.1.5.5.6 C1G2BlockWriteOpSpecResult Parameter

0										1										2										3	
0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1
		Rese	ervec	1					T	ype	= 35	54											Ler	ngth							
			Re	sult										(OpSp	oecII)								Nun	nWc	ordsV	Vritt	ten[]	[5:8]	
	Nu	mW	ords	Wri	tten[7:0]																									

3470

3471 See section 15.2.1.5.5.6.

16.4 Listing of Message and Parameter Types

3473 This section lists the parameter and message types used in the binary encoding.

3474 Table 4: Message Listing

Message Name	Type
GET_READER_CAPABILITIES	1
GET_READER_CAPABILITIES_RESPONSE	11
ADD_ROSPEC	20
ADD_ROSPEC_RESPONSE	30
DELETE_ROSPEC	21
DELETE_ROSPEC_RESPONSE	31
START_ROSPEC	22
START_ROSPEC_RESPONSE	32
STOP_ROSPEC	23
STOP_ROSPEC_RESPONSE	33
ENABLE_ROSPEC	24
ENABLE_ROSPEC_RESPONSE	34
DISABLE_ROSPEC	25
DISABLE_ROSPEC_RESPONSE	35
GET_ROSPECS	26
GET_ROSPECS_RESPONSE	36
ADD_ACCESSSPEC	40
ADD_ACCESSSPEC_RESPONSE	50
DELETE_ACCESSSPEC	41
DELETE_ACCESSSPEC_RESPONSE	51
ENABLE_ACCESSSPEC	42
ENABLE_ACCESSSPEC_RESPONSE	52

DISABLE_ACCESSSPEC	43
DISABLE_ACCESSSPEC_RESPONSE	53
GET_ACCESSSPECS	44
GET_ACCESSSPECS_RESPONSE	54
CLIENT_REQUEST_OP	45
CLIENT_REQUEST_OP_RESPONSE	55
GET_REPORT	60
RO_ACCESS_REPORT	61
KEEPALIVE	62
KEEPALIVE_ACK	72
READER_EVENT_NOTIFICATION	63
ENABLE_EVENTS_AND_REPORTS	64
ERROR_MESSAGE	100
GET_READER_CONFIG	2
GET_READER_CONFIG_RESPONSE	12
SET_READER_CONFIG	3
SET_READER_CONFIG_RESPONSE	13
CLOSE_CONNECTION	14
CLOSE_CONNECTION_RESPONSE	4
CUSTOM_MESSAGE	1023

3476 Table 5: Parameter Listing

Parameter Name	Type	TV-Encoded?
UTCTimeStamp	128	
Uptime	129	
GeneralDeviceCapabilities	137	
ReceiveSensitivityTableEntry	139	
PerAntennaAirProtocol	140	
GPIOCapabilities	141	
LLRPCapabilities	142	
RegulatoryCapabilities	143	
UHFBandCapabilities	144	
TransmitPowerLevelTableEntry	145	
FrequencyInformation	146	
FrequencyHopTable	147	

FixedFrequencyTable	148
PerAntennaReceiveSensitivityRange	149
ROSpec	177
ROBoundarySpec	178
ROSpecStartTrigger	179
PeriodicTriggerValue	180
GPITriggerValue	181
ROSpecStopTrigger	182
AISpec	183
AISpecStopTrigger	184
TagObservationTrigger	185
InventoryParameterSpec	186
RFSurveySpec	187
RFSurveySpecStopTrigger	188
AccessSpec	207
AccessSpecStopTrigger	208
AccessCommand	209
ClientRequestOpSpec	210
ClientRequestResponse	211
LLRPConfigurationStateValue	217
Identification	218
GPOWriteData	219
KeepaliveSpec	220
AntennaProperties	221
AntennaConfiguration	222
RFReceiver	223
RFTransmitter	224
GPIPortCurrentState	225
EventsAndReports	226
ROReportSpec	237
TagReportContentSelector	238
AccessReportSpec	239
TagReportData	240
EPCData	241
EPC-96	13 X

ROSpecID	9	X
SpecIndex	14	X
InventoryParameterSpecID	10	X
AntennaID	1	X
PeakRSSI	6	X
ChannelIndex	7	X
FirstSeenTimestampUTC	2	X
FirstSeenTimestampUptime	3	X
LastSeenTimestampUTC	4	X
LastSeenTimestampUptime	5	X
TagSeenCount	8	X
ClientRequestOpSpecResult	15	X
AccessSpecID	16	X
RFSurveyReportData	242	
FrequencyRSSILevelEntry	243	
ReaderEventNotificationSpec	244	
EventNotificationState	245	
ReaderEventNotificationData	246	
HoppingEvent	247	
GPIEvent	248	
ROSpecEvent	249	
ReportBufferLevelWarningEvent	250	
ReportBufferOverflowErrorEvent	251	
ReaderExceptionEvent	252	
OpSpecID	17	X
RFSurveyEvent	253	
AISpecEvent	254	
AntennaEvent	255	
ConnectionAttemptEvent	256	
ConnectionCloseEvent	257	
LLRPStatus	287	
FieldError	288	
ParameterError	289	
Custom	1023	
C1G2LLRPCapabilities	327	

UHFC1G2RFModeTable	328	
UHFC1G2RFModeTableEntry	329	
C1G2InventoryCommand	330	
C1G2Filter	331	
C1G2TagInventoryMask	332	
C1G2TagInventoryStateAwareFilterAction	333	
C1G2TagInventoryStateUnawareFilterAction	334	
C1G2RFControl	335	
C1G2SingulationControl	336	
C1G2TagInventoryStateAwareSingulationAction	337	
C1G2TagSpec	338	
C1G2TargetTag	339	
C1G2Read	341	
C1G2Write	342	
C1G2Kill	343	
C1G2Lock	344	
C1G2LockPayload	345	
C1G2BlockErase	346	
C1G2BlockWrite	347	
C1G2EPCMemorySelector	348	
C1G2PC	12	X
C1G2CRC	11	X
C1G2SingulationDetails	18	X
C1G2ReadOpSpecResult	349	
C1G2WriteOpSpecResult	350	
C1G2KillOpSpecResult	351	
C1G2LockOpSpecResult	352	
C1G2BlockEraseOpSpecResult	353	
C1G2BlockWriteOpSpecResult	354	

3478

34793480

3481

17 Transmitter Behavior of a Reader

A Reader SHALL enable its transmitter only under the following conditions:

• When an ROSpec is in the active state.

• Between a GET/SET_READER_CONFIG containing a RequestedData field with value 0 (All) or 2 (Antenna Properties) and the corresponding GET/SET_READER_CONFIG_RESPONSE.

18 Connection and Transport

- 3486 The Reader SHALL maintain LLRP configuration state during an LLRP connection.
- 3487 The Reader MAY maintain configuration or data state when a connection fails, or across
- 3488 LLRP connections.

3485

18.1 TCP Transport

- 3490 LLRP end-to-end communications based on TCP/IP connections SHALL be
- 3491 implemented in accordance with the requirements specified in this section. These
- requirements are defined as the LLRP *TCP Transport*.
- Readers SHALL be able to both initiate and accept LLRP TCP connections. Readers
- MAY be configured such that, at any given time, they only either initiate or accept an
- 3495 LLRP connection. If so, the mechanism for configuring a Reader to either initiate or
- accept an LLRP connection is not specified by LLRP.
- 3497 Clients SHALL be able both to initiate and accept LLRP TCP connections. Clients MAY
- 3498 be configured such that, at any given time, they only either initiate or accept an LLRP
- 3499 connection. If so, the mechanism for configuring a Client to either initiate or accept an
- 3500 LLRP connection is not specified by LLRP.
- 3501 For Readers and Clients, that are configured to accept connections, the default port is
- 3502 5084, as established by IANA (see http://www.iana.org/assignments/port-numbers), but
- other ports can be used.
- When a TCP connection (called the *established connection*) is initiated by either the
- Reader or the Client, the Reader SHALL reply with a status report message before
- 3506 communicating any other information. This report's status parameter
- 3507 ConnectionAttemptEvent, SHALL be set to indicate connection success (see section
- 3508 13.2.6.11). No other parameters may be contained within this message. The Client
- 3509 SHALL not send any information to the Reader until this status report message is
- 3510 received.
- 3511 Readers SHALL limit communications to a single established connection on a Reader IP
- 3512 address and TCP port. Readers MAY momentarily accept TCP connections (called
- 3513 momentary connections) in addition to the Reader's one established connection on a
- Reader IP address and TCP port. If a momentary connection is accepted, then the Reader
- 3515 SHALL send a status report message on the Reader's established connection. This
- 3516 report's status parameter, ConnectionAttemptEvent, SHALL be set to indicate that
- another connection was attempted (see section 13.2.6.11). If this action results in a TCP
- 3518 error, then the Reader MAY close the established connection and then treat the
- momentary connection as a new established connection. In this case, the Reader SHALL
- reply with a status report message on the newly created established connection, as
- 3521 specified above, indicating connection success.

If the established connection is not closed, then the Reader SHALL reply on the momentary connection with a status report message. This report's status parameter, ConnectionAttemptEvent, SHALL be set to indicate connection failure. The Reader SHALL use the appropriate connection failed status value as defined in section 13.2.6.11. Once the connection failure message is sent, the Reader SHALL close the momentary connection.

The following UML sequence diagrams illustrate different scenarios of a Reader and Client initiating TCP connections.

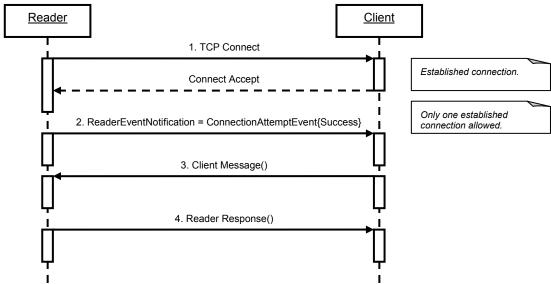
3530

3528

3529

3531

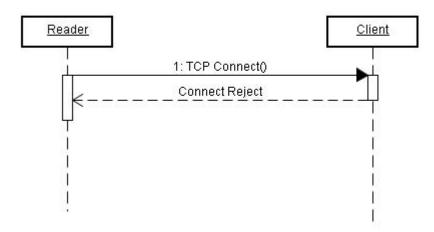
Reader Initiated Connection (normal case)



3532 I Figure 14: Reader

Figure 14: Reader Initiated Connection (Normal)

Reader Initiated Connection (exception case #1)



35353536

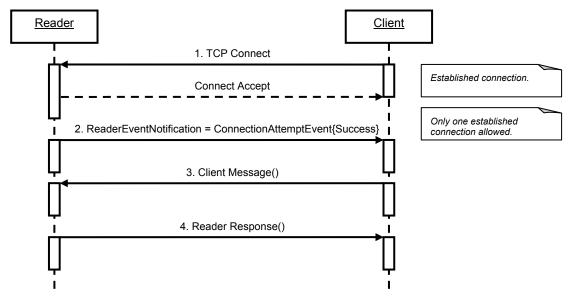
Figure 15: Reader Initiated Connection (Exception)

3537

3538

35393540

Client Initiated Connection (normal case)



3541 3542

Figure 16: Client Initiated Connection (Normal)

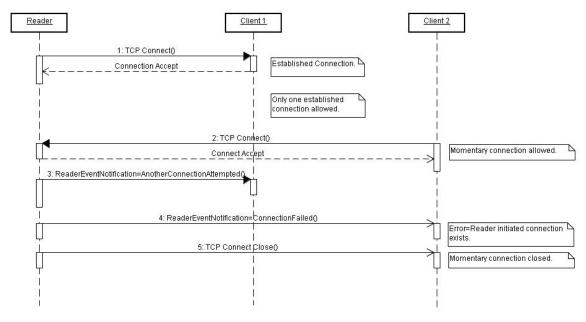
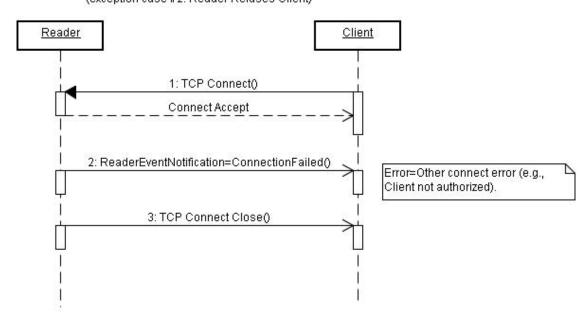


Figure 17: Client Initiated Connection (Exception #1)

Client Initiated Connection (exception case #2: Reader Refuses Client)

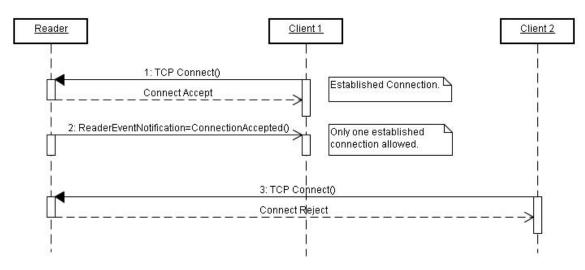


3546 3547

Figure 18: Client Initiated Connection (exception #2)

Client Initiated Connection

(exception case #3: Reader Refuses Another Connect)



3549 3550

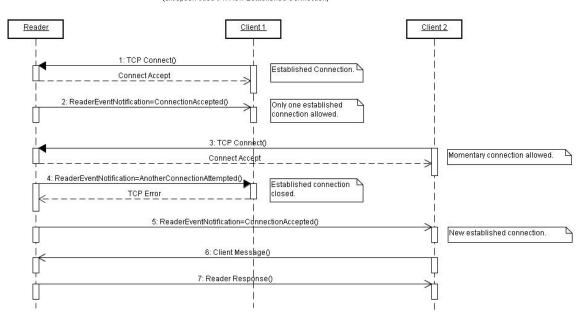
Figure 19: Client Initiated Connection (exception #3)

3551

3552

3553

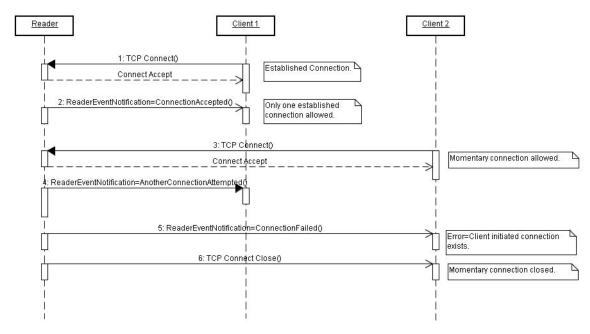
Client Initiated Connection
(exception case #4: New Established Connection)



3554 3555

Figure 20: Client Initiated Connection (exception #4)

Client Initiated Connection (exception case #5: Reader Refuses Connection with Explanation)

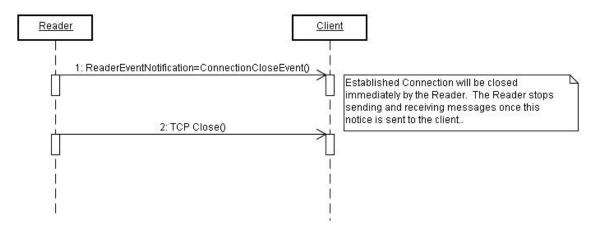


3557 3558

Figure 21: Client Initiated Connection (exception #5)

3559

Reader Initiated Close

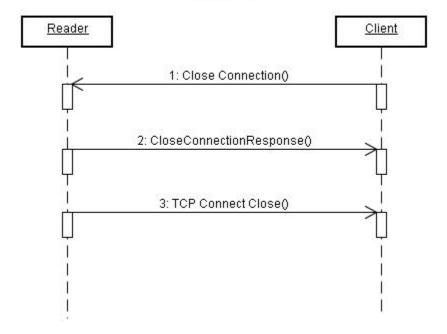


3560 3561

Figure 22: Reader Initiated Close

Client Initiated Close

(normal case)



3563 3564

Figure 23: Client Initiated Close (Normal)

3565

Client Initiated Close

(exception case #1: Reader Fails to Respond)

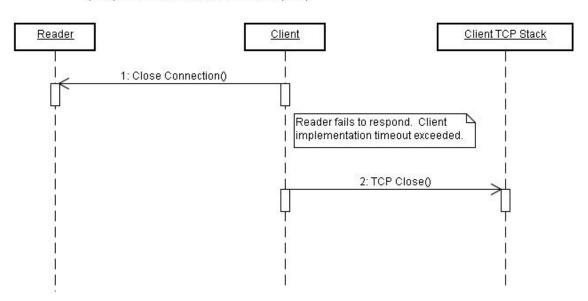


Figure 24: Client Initiated Close (Exception)

18.2 Security in TCP Transport

- 3569 This section describes the security aspects for LLRP connections running over a TCP
- 3570 transport binding. Refer to the previous section for any TCP connection related
- 3571 requirements.

3572 **18.2.1 Normative Section**

- 3573 The LLRP Client and LLRP Reader MAY implement TLS. The LLRP Client and LLRP
- 3574 Reader MAY use a different port for TLS LLRP connections and non-TLS LLRP
- 3575 connections.
- 3576 The LLRP Client MAY be capable of operating in a mixed deployment, where it
- 3577 communicates using TLS with a set of Readers and just plain TCP with a different set of
- 3578 Readers. In such mixed deployments, the LLRP Client MAY use different ports for TLS
- and non-TLS LLRP connections. The default port for TLS-LLRP connections is 5085, as
- established by IANA (see http://www.iana.org/assignments/port-numbers), but other
- ports can be used.
- 3582 The LLRP endpoint that initiates the TLS connection MAY be the same LLRP endpoint
- 3583 that initiated the underlying TCP connection.
- 3584 The LLRP endpoints SHALL use at least TLS1.0 [TLS10] and are recommended to use
- 3585 TLS1.1 [TLS11].
- 3586 If the Reader or Client uses X.509 certificates [X509] for authentication, the certificates
- 3587 SHALL be compliant with the EPCGlobal Security2 working group specification
- 3588 [SEC2].

3589 **18.2.2 Informative Section**

3590 **18.2.2.1 Overview of TLS**

- 3591 The TLS protocol provides privacy and data integrity between two authenticated
- 3592 communicating applications. TLS is a light weight transport protocol and has been
- proven to be reliable and secure by the use of millions of real users for many years. The
- 3594 strength of TLS can be chosen by the cipher suite negotiated by the two communicating
- parties through a flexible mechanism during the handshaking.
- 3596 TLS is particularly useful for TCP based applications. First, a TLS client initiates a
- 3597 connection with the TLS server. After a TLS connection is established, the applications
- can use the transport connection like an ordinary TCP connection, while having the added
- value that the data is protected and that both parties are mutually authenticated.
- 3600 For interoperability, a TLS client and server have to implement at least one common
- 3601 cipher suite. The credentials required for mutual authentication depend on the suite
- negotiated. For example, if the negotiated suite is using RSA for key exchange, then the
- server must own a server certificate (with private key) for RSA encryption purposes
- 3604 while the client must have a client certificate (with private key) for RSA signing
- purposes. Further, each side must have the root Certificate Authority (CA) certificates to

verify the certificates presented by the peers. TLS also requires each party to present the CA certificates (except the root) that directly and indirectly issue the certificate.

18.2.2.2 Threat Analysis for LLRP

- With TLS being used for Reader and Client communication, the following protections are provided, assuming that the credentials for the TLS client and server are not stolen:
 - Readers only talk to authorized LLRP Clients;
 - LLRP Clients only talk to authorized Readers;
 - No other party can read the LLRP messages (privacy protection) or inject/modify messages without being detected (integrity protection).
- Note that the strength of protection depends on the negotiated cipher suite.

18.2.2.3 Configuration Elements for TLS

- In order to use TLS for LLRP, the following information has to be configured and/or provisioned at each entity (Reader or Client):
 - **TLS enabled:** Yes or no. If TLS is not enabled, the rest of the information need not be configured and the LLRP endpoint (Reader or Client) SHALL use TCP directly.
 - TLS role: Whether the LLRP endpoint is playing the TLS client or the TLS server role. A TLS client initiates a TCP connection to jump start TLS handshaking. A TLS server passively listens on the TCP server port.
 - **Preferred list of cipher suites**: A TLS client proposes the list of cipher suites to the TLS server during TLS handshaking. The TLS server will pick one suite from the proposed list if it is also in the preferred list maintained by the server. In TLS, the order of suites in the proposed list has no significance. Also, it is up to the server's local policy to select when there are multiple choices.
 - Certificates and private keys: A TLS server needs a server certificate (with private key) for TLS server authentication. A TLS client needs a client certificate (with private key) for TLS client authentication. In each case, all the CA certificates (except the root) in the chain have to be available.
 - **Root CA certificates**: A TLS server needs to maintain the root CA certificate of the client certificate. This is used for verifying client certificates. A TLS client needs to maintain the root CA certificate of the server certificate. This is used for verifying server certificates.
 - List of authorized devices: Each TLS server MAY have a list of authorized TLS clients that can connect to it. Likewise, each TLS client MAY have a list of authorized TLS servers that it can connect to.

The configuration and/or provisioning of a LLRP endpoint is out of the scope of TLS and LLRP. Provisioning is important but does not affect the interoperability of LLRP. Vendors should have the flexibility to choose the most cost-effective ways (for provisioning and protecting provisioned credentials) based on designs, available technologies, potential threats, security requirements, and so on. This is a topic that should be addressed in DCI.

3648 18.2.2.4 Why different TLS server port?

3651

3652

3653 3654

3655

3656 3657

3658 3659

3660

3661 3662

3663

3664 3665

3666

3672

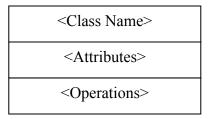
It is recommended that the TLS server should listen to a TCP port different from that for non-TLS mode for the following reasons:

- If one of the endpoints has to be deployed behind firewalls, IT managers are more willing to open a port they know only TLS traffic can pass through.
- Without using a different port, a non-TLS server may be confused by the TLS Client-Hello handshaking message.
- Without using a different port, a TLS server may be confused by the LLRP application message (non-TLS handshaking message).
- Without using a different port, for each new TCP connection, a server in a mixed environment (TLS and non-TLS) may have to wait a few moments to see if a Client-Hello message ever arrives from the client before it can conclude whether it is a TLS connection or not.
- Without using a different port, it is potentially harder to implement a hybrid server if the server relies on third-party libraries for handling TLS. This is because the server application has to read the first message from the client to know if it is a TLS connection. It may be difficult for the TLS library to take over a connection after the TLS Client-Hello message has been consumed.

However, if a deployment in totality is only TLS or only non-TLS, the LLRP endpoint can be configured only as a TLS server or non-TLS server exclusively, then there should be no problem using the same port, as long as a non-TLS server can ignore TLS handshaking messages from a TLS client and as long as a TLS server can ignore non-TLS handshaking messages from a non-TLS client.

19 (Informative) Object Model

- The Object Model (OM) presented in this section illustrates the data structures inherent in the LLRP specification and further described in section 5. These OM diagrams are based upon Unified Modeling Language (UML) notation (see www.uml.org). There are two kinds of LLRP data structures: 1) *messages* and 2) *data parameters*. Messages can be composed of data parameters. Data parameters can be further composed of other data parameters. A simple data element (i.e., a data element with no subcomponents) is called a *data field*.
- In the OM, both kinds of data structures are represented by UML class diagrams. Data fields are represented as class attributes.
- A UML class is defined as a collection of objects with common structure, common relationships, etc. A UML class is illustrated as a rectangle partitioned into three compartments as follows:



 The OM is used only to describe structure and therefore the *Operations* compartment is left empty for all OM classes.

There are three class relationship notations used in the OM:

- Association with one-way navigation.

This notation represents that one class includes a reference to another class (the arrowhead side). LLRP data structures reference each other via an identifier (e.g., ROSpecID).

A number or a range of numbers (e.g., 0..1) can appear on either side of the line. This is the multiplicity of the relationship (e.g., the number of instances of one class related to one instance of the other class). If no number appears on a side of the line, then a one is implied.

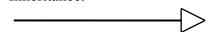
- Aggregation.



This notation represents that one class (the diamond side) includes another class embedded within it.

A number or a range of numbers (e.g., 0..1) can appear on either side of the line. This is the multiplicity of the relationship (e.g., the number of instances of one class related to one instance of the other class). If no number appears on a side of the line, then a one is implied.

- Inheritance.



This notation represents that one class is a superclass of another class known as the base class (the arrowhead side). A superclass includes all attributes and relationships of the base class plus additional features.

3713 **19.1 Capabilities**

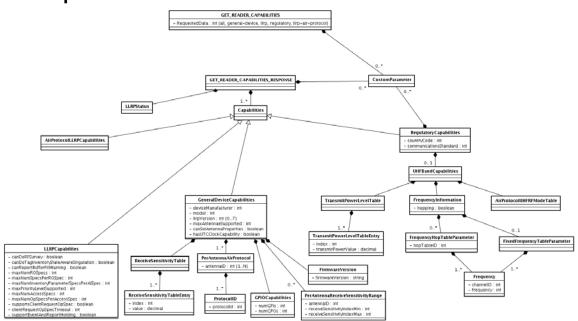


Figure 25: Capabilities

19.2 Configuration

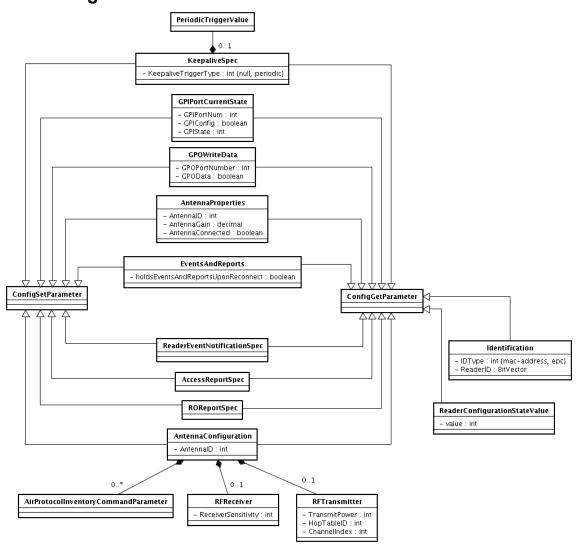
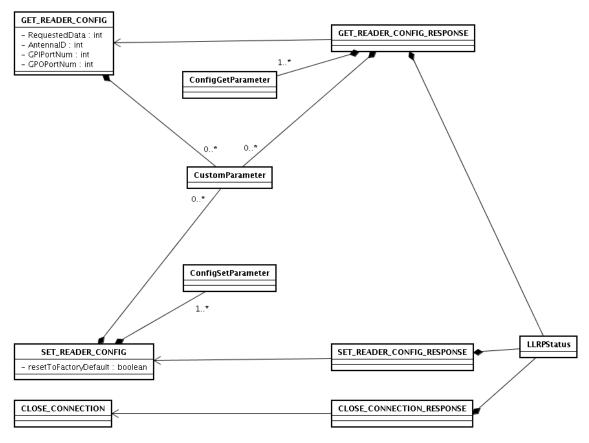
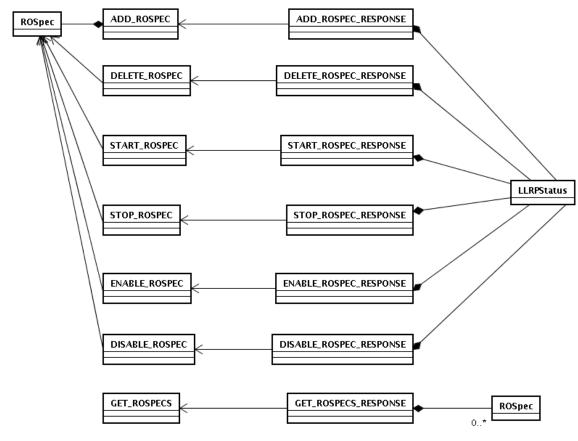


Figure 26: Configuration



3720 Figure 27: Configuration Commands

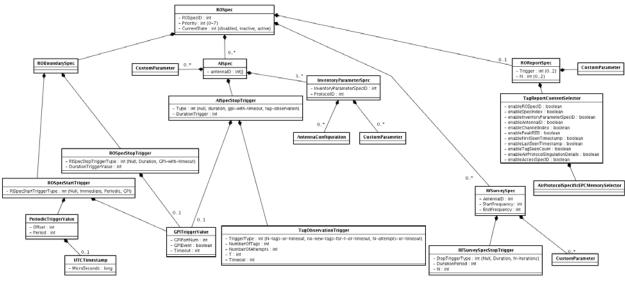
19.3 ROSpec



3723 Figure 28: RO Commands

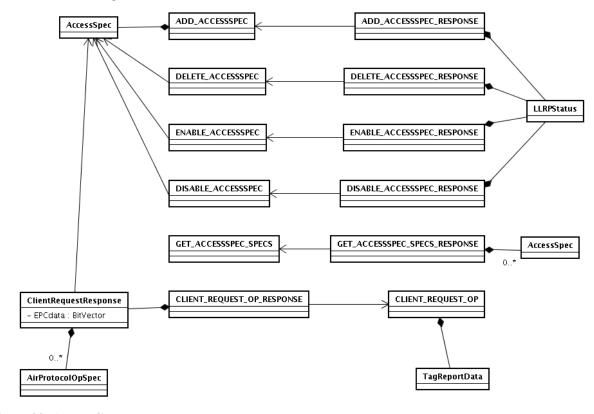
3722

3724



3725 Figure 29: ROSpec

3726 **19.4 AccessSpec**



3727

3728 Figure 30: Access Commands

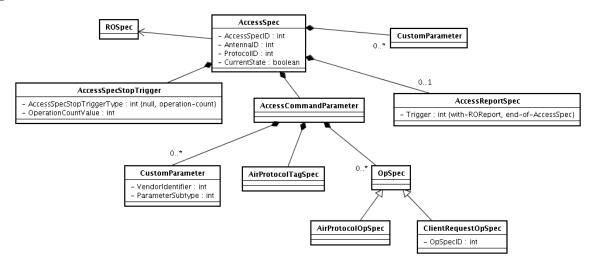
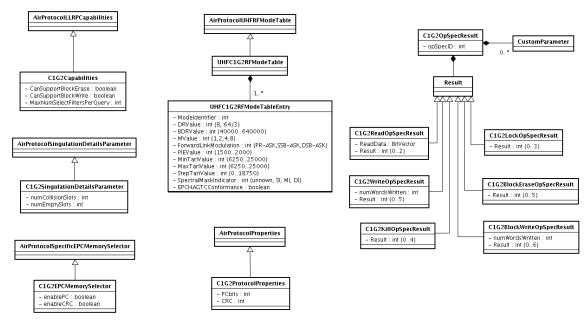


Figure 31: AccessSpec

19.5 C1G2 Parameters



3733 Figure 32: C1G2 Parameters

3732

37343735

3736

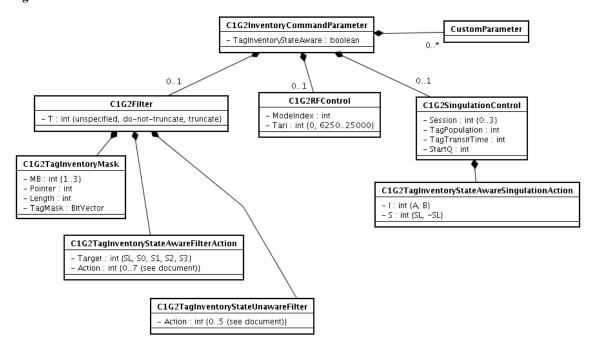
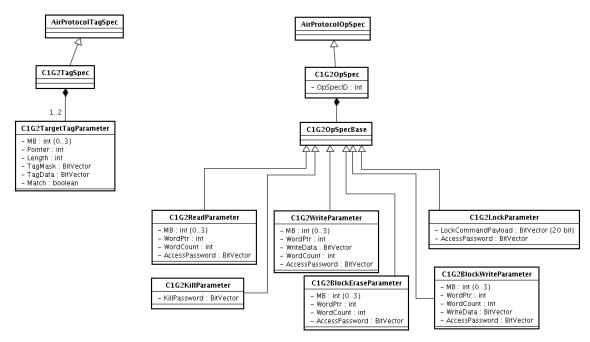


Figure 33: C1G2 Inventory Command

Copyright © 2005-2007 <u>EPCglobal</u>®, All Rights Reserved.



3738 Figure 34: C1G2 AccessSpec

3737

3739

3740 3741

19.6 Reporting and Notification

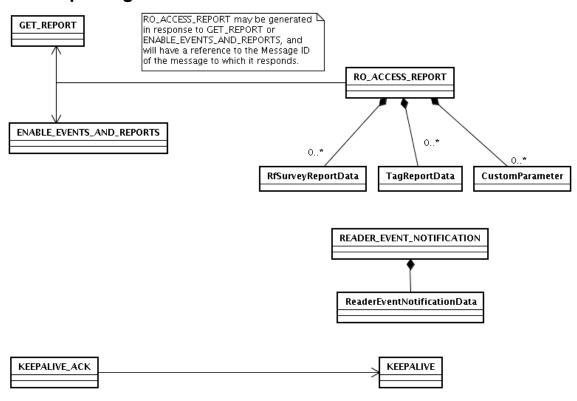
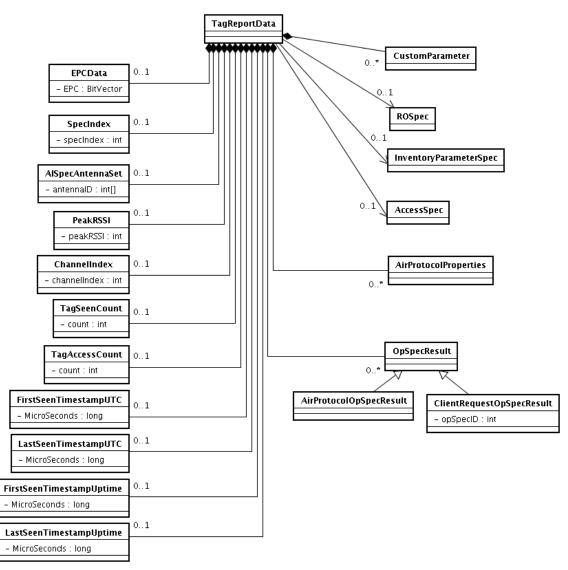
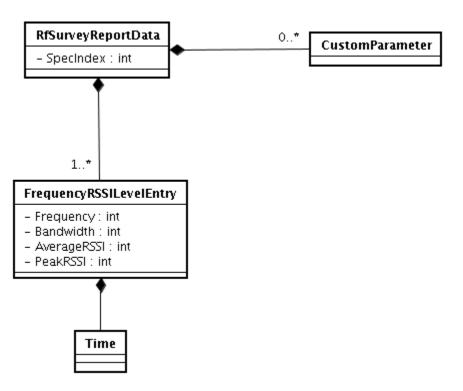


Figure 35: Reporting and Notification

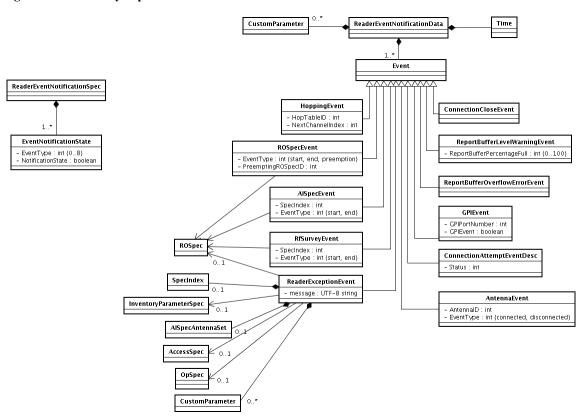


3743 Figure 36: TagReportData



37443745

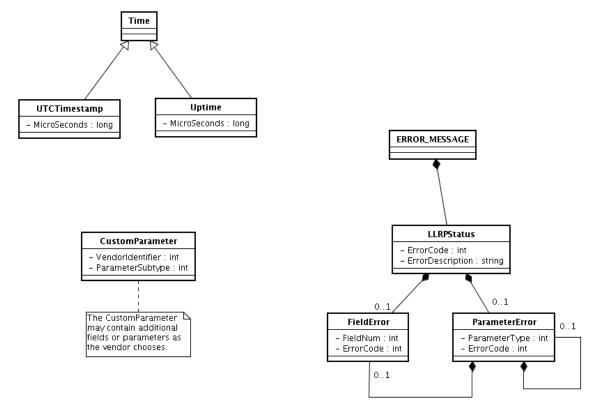
Figure 37: RFSurveyReportData



3746 3747

Figure 38: Reader Event Notification Data

19.7 General



3750 Fig

Figure 39: General Data

20 (Informative) TCP Keepalives

The TCP specification doesn't specify any specific handling of idle connections, where there is no data being transmitted by either end for a prolonged period of time. However, in some TCP implementations, there is an option called TCP-keepalive which may be turned on. If turned on, TCP-keepalive packets are sent only during periods of inactivity, on a configurable interval. If the connection is still valid, the other end responds with a segment containing an ack. If the connection is not valid the other end will reply with a connection reset (RST) and the connection is closed by this end.

Due to events like network failures, or Client failures, half connections may remain at the Reader because the TCP connection was not cleanly terminated. If the Reader doesn't implement TCP-keepalive, the only way to recover (i.e., reconnect to the Reader) may be to reboot the Reader.

However, there are Readers for which intermittent connectivity may be a normal mode of operation – e.g., mobile Readers, handheld Readers. When connectivity is lost for these devices, the use of TCP-keepalive acts negatively and closes the TCP session prematurely before the TCP session would have timed out. If keepalives were not used, the mobile Reader would just start sending LLRP messages as soon as the link layer is reestablished without requiring a re-establishment of the TCP session as long as the TCP session did not timeout.

3771	21	(Informative)) References

- 3772 **[ISODir2]** ISO, "Rules for the structure and drafting of International Standards (ISO/IEC
- Directives, Part 2, 2001, 4th edition)," July 2002.
- 3774 [C1G2] Class 1 Generation 2 UHF Air Interface Protocol Standard Version 1.0.9
- http://www.epcglobalinc.org/standards_technology/EPCglobal2UHFRFIDProtocolV1091
- 3776 <u>22005.pdf</u>
- 3777 [ALE 1.0] EPCglobal Application Level Events (ALE) 1.0 Specification
- 3778 http://www.epcglobalinc.org/standards technology/EPCglobal ApplicationALE Specifi
- 3779 cation v112-2005.pdf
- 3780 [Class0] 900 MHz Class 0 Radio Frequency (RF) Identification Tag Specification,
- 3781 http://www.epcglobalinc.org/standards technology/Secure/v1.0/UHF-class0.pdf
- 3782 [Class1] 860MHz -- 930 MHz Class 1 Radio Frequency (RF) Identification Tag Radio
- 3783 Frequency & Logical Communication Interface Specification.,
- 3784 http://www.epcglobalinc.org/standards_technology/Secure/v1.0/UHF-class1.pdf
- 3785 [ARC] EPCglobal Architecture Framework 1.0
- 3786 http://www.epcglobalinc.org/standards_technology/Final-epcglobal-arch-20050701.pdf
- 3787 [ISO3166] ISO, "Codes for the Representation of Names of Countries".
- 3788 http://www.iso.org/iso/en/prods-services/iso3166ma/index.html
- 3789 [UTC] IETF RFC 3339, "Date and Time on the Internet: Timestamps", July 2002.
- 3790 http://www.ietf.org/rfc/rfc3339.txt
- 3791 [EUI64] "Guidelines For 64-bit Global Identifier (EUI-64)",
- 3792 http://standards.ieee.org/db/oui/tutorials/EUI64.html
- 3793 [TLS11] IETF RFC 4346, "The Transport Layer Security (TLS) Protocol Version 1.1".
- 3794 http://www.ietf.org/rfc/rfc4346.txt
- 3795 [TLS10] IETF RFC 2246, "The TLS Protocol Version 1.0",
- 3796 http://www.ietf.org/rfc/rfc2246.txt
- 3797 [X509] ITU-T Recommendation X.509 (1997 E): Information Technology Open
- 3798 Systems Interconnection "The Directory Authentication Framework". 1988.
- 3799 [SEC2] EPCGlobal Certificate Profile,
- http://www.epcglobalinc.org/standards_technology/SAG%20Security%20Cert%20Profil
- 3801 e%20March%208%202006.pdf
- 3802 [UTF8] IETF RFC 3629, "UTF-8, a transformation format of ISO 10646", November
- 3803 2003. See also Annex D of ISO 10646-1:2000. http://www.ietf.org/rfc/rfc3629.txt
- 3804 **[HK]** OFTA 1049,
- 3805 http://www.ofta.gov.hk/en/standards/hktaspec/hkta1049.pdf#search=%22OFTA%201049
- 3806 %22

8807	[TW] DGT LP0002,
808	$\underline{http://www.dgt.gov.tw/English/Type-approval/8.4/LP0002/LP0002-940324.pdf}$
8809	[JPN] ARIB STD T89, http://www.arib.or.jp/english/html/overview/st_j.html
8810	[KOR] MIC Article 5-2, (Radio Equipment for RFID/USN): Technical Requirements
8811	for the radio equipment for passive RFID using the frequency range of 908.5~914MHz.
3812	

22 Acknowledgement of Contributors and Companies Opt'd-in during the Creation of this Standard (Informative)

Disclaimer

Whilst every effort has been made to ensure that this document and the information contained herein are correct, EPCglobal and any other party involved in the creation of the document hereby state that the document is provided on an "as is" basis without warranty, either expressed or implied, including but not limited to any warranty that the use of the information herein with not infringe any rights, of accuracy or fitness for purpose, and hereby disclaim any liability, direct or indirect, for damages or loss relating to the use of the document.

Below is a list of more active participants and contributors in the development of LLRP 1.0. This list does not acknowledge those who only monitored the process or those who chose not to have their name listed here. Active participants status was granted to those who generated emails, attended face-to-face meetings and conference calls that were associated with the development of this Standard.

First Name	Last Name	Company	Notable Role
Dave	Husak	Reva Systems	Co-Chair
Rob	Buck	Intermec	Co-Chair
Pattabhiraman	Krishna	Reva Systems	Editor
Mark	Frey	EPCglobal Inc.	Facilitator for WG
Software Team	at Impinj	Impinj	Minutes Recorder
Marc	Horowitz	BEA Systems	
Suresh	Bhaskaran	Intelleflex	
Daniel	Paley	Tagent Corp.	
Bud	Biswas	Polaris Networks	
Bob	O'Hara	Cisco	
Daniel	Bowman	Kimberly-Clark Corp	
Margaret	Wasserman	ThingMagic, LLC	
Arthur	Howarth	Cisco	
Richard	Bach	GlobeRanger	
Rick	Schuessler	Symbol Tech./Motorola	

Howard	Kapustein	Manhattan Associates
David	Missimer	Sirit
Darrel	Pinson	Symbol Technologies, Inc.
Matt	Poduska	Intermec
Steve	Lockhart	Sirit
David	Lavin	IBM
Lynn	Hingst	Intermec
John	Walter	Intermec
Soumya	Roy chowdhury	Polaris Networks
Martin	Jackson	Wal-Mart
Steve	Lin	Sirit
Bryan	Tracey	GlobeRanger
Scott	de Deug	IBM
Ted	Osinski	MET Labs
Scott	Barvick	Reva Systems
Manpreet	Singh	Symbol Technologies, Inc.
Heena	Nandu	Intelleflex
Gerhard	Gangl	7iD (formerly EOSS GmbH)
Bill	Bares	Intelleflex
Jim	Sykes	Savi Networks
Sudhir	Hasbe	Sirit
Albert	Lin	WJ Co.
Shigeya	Suzuki	Auto-ID Labs - Japan
Gay	Whitney	EPCglobal Inc.
Jim	Reed	MET Labs
Matthew	Harmon	Q.E.D. Systems
Ricardo	Labiaga	Sun Microsystems
Mark	Richardson	ThingMagic, LLC
David	Nesbitt	Vue Technology
Roger	Stewart	Applied Wireless (AWID)
Yukiko	Yumoto	Auto Id Lab Japan
Abel	Sanchez	Auto-ID Labs - MIT
John	Williams	Auto-ID Labs - MIT

Mark	Sompel	AWID	
Ken	Traub	BEA Systems	
Matt	Robshaw	France Telecom	
Wayne	Liu	Impinj	
Tareef	Al-Mahdawi	Intelleflex	
Joe	Kubler	Intermec	
John	Walter	Intermec	
Peter	Anderla	KCC	
John	Boulas	KCC	
John	Anderla	KCC	
Moon Suk	Kim	Metarights	
Chang Yeol	Lee	Metarights	
Jens	Kungl	Metro	
Isao	Kimata	NEC Corporation	
Satoshi	Kinoshita	NEC Corporation	
Hiroki	Tagato	NEC Corporation	
Sergio	Lobo	NXP Semiconductors	
Gregory	Grisco	Oracle Corporation	
Jahangir	Nakra	Procter & Gamble	
Trong	Le	Psion Teklogix Inc.	
Craig	Harmon	Q.E.D. Systems	
Peter	Spreadborough	Reva Systems	
Sudhir	Hasbe	Samsys	
Stephan	Haller	SAP	
Steve	Winkler	SAP	
Sengu	Elango	Savi	
Neal	Herman	Savi	
Don	Ahn	Savi Technology	
L. Julia	Zhu	Savi Technology	
Pankaj	Shukla	Symbol	
Jong	Park	Tibco	
Keith	Rider	Tyco / ADT	
Bob	Sawdye	Tyco / ADT	
David	Harty	VeriSign	
Richard	Campero	Vue Technology	

The following list in corporate alphabetical order contains all companies that were opt'd-in to the Reader Operations Working Group and have signed the EPCglobal IP Policy.

Company
(ETRI) Electronics and Telecommunications Research Institute
7iD (formerly EOSS GmbH)
Accenture
Acer Cybercenter Service Inc.
Altria Group, Inc./Kraft Foods
Applied Wireless (AWID)
Ark Tech Ltd
Auto-ID Labs - Cambridge
Auto-ID Labs - Japan
Auto-ID Labs - MIT
BEA Systems
Blackbay Ltd.
CAEN
Cisco
Convergence Sys Ltd
Dai Nippon Printing
Denso Wave Inc
ECO, Inc.
EPCglobal Inc.
FEIG Electronic
France Telecom
Fujitsu Ltd
GlobeRanger
GS1 Australia EAN
GS1 Germany (CCG)
GS1 Hong Kong
GS1 Japan
GS1 South Korea
GS1 Taiwan (EAN)

GS1 US
IBM
Impinj
Infineon Technologies NA Corp
Institute for Information Industry
Intelleflex
Intermec
Internet Initiative Japan, Inc.
Johnson & Johnson
Kimberly-Clark Corp
KL-NET
Korea Computer Servs, Ltd
LIT (Research Ctr for Logistics Info Tech)
Loftware, Inc.
Manhattan Associates
MET Labs
Metarights
Metro
Microelectronics Technology, Inc.
Mstar Semiconductor
NCR
NEC Corporation
NXP Semiconductors
OatSystems
ODIN Technologies
Omron
Oracle Corporation
Panda Int'l Transp Ltd
Pango Networks, Inc.
Paxar
PepsiCo
Polaris Networks
Procter & Gamble
Psion Teklogix Inc.
Q.E.D. Systems

Raining Data Corporation
RetailTech
Reva Systems
RFIP Ltd. (formerly Radio Freq Ident Ctr)
RFXCEL Corp
SAP
Savi Technology
Sirit
SOFTBANK TELECOM Corp. (Japan)
Supply Insight, Inc.
SyGade Solutions
Symbol Technologies, Inc.
T3C Incorporated
Tagent Corporation
TagSys
TEGO, Inc.
ThingMagic, LLC
Tibco
Toppan Printing Co
Toray International, Inc.
Tyco / ADT
Ussen Limited Company
VeriSign
Vocollect
Vue Technology
Wal-Mart
Wish Unity
Yuen Foong Yu Paper

3838