

OCF Device to Cloud Services Specification

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19

CONTENTS

20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60
61
62

| | | |
|--------|--|----|
| 1 | Scope | 1 |
| 2 | Normative references | 1 |
| 3 | Terms, definitions, and abbreviated terms | 2 |
| 3.1 | Terms and definitions | 2 |
| 3.2 | Abbreviated terms | 2 |
| 4 | Document conventions and organization | 3 |
| 4.1 | Conventions | 3 |
| 4.2 | Notation | 3 |
| 5 | Overview | 4 |
| 5.1 | Introduction | 4 |
| 5.2 | Architecture | 4 |
| 5.3 | Interaction Flow | 5 |
| 5.4 | Cloud Operational Flow | 6 |
| 5.4.1 | Pre-requisites and OCF Cloud User Account Creation | 7 |
| 5.4.2 | Mediator registration with the OCF Cloud | 7 |
| 5.4.3 | Device provisioning by the Mediator | 7 |
| 5.4.4 | Device Registration with the OCF Cloud | 7 |
| 5.4.5 | Connection with the OCF Cloud | 8 |
| 5.4.6 | Publishing Links to the OCF Cloud RD | 8 |
| 5.4.7 | Client to Server communication through the OCF Cloud | 8 |
| 5.4.8 | Refreshing connection with the OCF Cloud | 8 |
| 5.4.9 | Closing connection with the OCF Cloud | 8 |
| 5.4.10 | Deregistering from the OCF Cloud | 9 |
| 6 | Resource model | 11 |
| 6.1 | OCF Cloud Resource Directory | 11 |
| 6.1.1 | Indirect discovery for lookup of Resources | 11 |
| 6.1.2 | Resource Directory Definition | 11 |
| 6.1.3 | RD operational flows | 12 |
| 6.2 | CoAPCloudConf Resource | 17 |
| 6.2.1 | Introduction | 17 |
| 6.2.2 | Resource Definition | 17 |
| 6.2.3 | Error Handling | 18 |
| 7 | Network and connectivity | 19 |
| 8 | Functional interactions | 20 |
| 8.1 | Onboarding, Provisioning, and Configuration | 20 |
| 8.1.1 | Overview | 20 |
| 8.1.2 | Use of Mediator | 20 |
| 8.1.3 | Device Connection to the OCF Cloud | 23 |
| 8.1.4 | Device Registration with the OCF Cloud | 23 |
| 8.2 | Resource Publication | 24 |
| 8.3 | Client Registration with the OCF Cloud | 25 |

| | | | |
|----|---------------------|---|----|
| 63 | 8.4 | Resource Discovery | 25 |
| 64 | 8.5 | Device Deregistration from the OCF Cloud..... | 27 |
| 65 | 9 | Security | 27 |
| 66 | Annex A (normative) | Swagger2.0 definitions | 28 |
| 67 | A.1 | List of Resource Type definitions | 28 |
| 68 | A.2 | Resource directory resource | 28 |
| 69 | A.2.1 | Introduction | 28 |
| 70 | A.2.2 | Well-known URI | 28 |
| 71 | A.2.3 | Resource type | 28 |
| 72 | A.2.4 | OpenAPI 2.0 definition..... | 28 |
| 73 | A.2.5 | Property definition | 33 |
| 74 | A.2.6 | CRUDN behaviour | 33 |
| 75 | A.3 | CoAP Cloud Configuration Resource | 33 |
| 76 | A.3.1 | Introduction | 33 |
| 77 | A.3.2 | Example URI | 33 |
| 78 | A.3.3 | Resource type | 33 |
| 79 | A.3.4 | OpenAPI 2.0 definition..... | 33 |
| 80 | A.3.5 | Property definition | 37 |
| 81 | A.3.6 | CRUDN behaviour | 38 |
| 82 | | | |
| 83 | | | |

84
85
86
87
88
89
90
91
92
93
94
95
96
97
98

Figures

Figure 1 – OCF Cloud Architecture5

Figure 2 – OCF Cloud interaction model6

Figure 3 – Overall Operational State Machine 11

Figure 4 – Indirect discovery of Resources by via an RD 11

Figure 5 – RD discovery and RD supported query of Resources support..... 13

Figure 6 – Registration with OCF Cloud.....20

Figure 7 – Device Provisioning by the Mediator22

Figure 8 – Resource publication to the OCF Cloud.....25

Figure 9 – Resource discovery through OCF Cloud.....26

Figure 10 – Request routing through OCF Cloud.....27

Tables

| | |
|-----|--|
| 99 | |
| 100 | |
| 101 | Table 1 – OCF Cloud Interaction Flow6 |
| 102 | Table 2 – "oic.wk.rd" Resource Type definition 12 |
| 103 | Table 3 – "oic.wk.rd" Properties 12 |
| 104 | Table 4 – CoAPCloudConf Resource 17 |
| 105 | Table 5 – oic.r.coapcloudconf Resource Type definition..... 18 |
| 106 | Table 6 – Device to OCF Cloud Registration Flow.....20 |
| 107 | Table 7 – Device Provisioning by the Mediator23 |
| 108 | Table A.1 – Alphabetized list of resources28 |
| 109 | Table A-2 – The Property definitions of the Resource with type "rt" = "oic.wk.rd". 33 |
| 110 | Table A-3 – The CRUDN operations of the Resource with type "rt" = "oic.wk.rd"..... 33 |
| 111 | Table A.4 – The Property definitions of the Resource with type "rt" = "oic.r.coapcloudconf". .37 |
| 112 | Table A.5 – The CRUDN operations of the Resource with type "rt" = "oic.r.coapcloudconf"...38 |
| 113 | |

114 **1 Scope**

115 This document defines functional extensions to the capabilities defined in ISO/IEC 30118-1:2018
116 to meet the requirements of the OCF Cloud. This document specifies new Resource Types to
117 enable the functionality and any extensions to the existing capabilities defined in ISO/IEC 30118-
118 1:2018.

119 **2 Normative references**

120 The following documents are referred to in the text in such a way that some or all of their content
121 constitutes requirements of this document. For dated references, only the edition cited applies. For
122 undated references, the latest edition of the referenced document (including any amendments)
123 applies.

124 ISO/IEC 30118-1:2018 *Information technology -- Open Connectivity Foundation (OCF)*
125 *Specification -- Part 1: Core specification*
126 <https://www.iso.org/standard/53238.html>
127 Latest version available at: https://openconnectivity.org/specs/OCF_Core_Specification.pdf

128 ISO/IEC 30118-2:2018 *Information technology -- Open Connectivity Foundation (OCF)*
129 *Specification -- Part 2: Security specification*
130 <https://www.iso.org/standard/74239.html>
131 Latest version available at: https://openconnectivity.org/specs/OCF_Security_Specification.pdf

132 OCF Wi-Fi Easy Setup, *Open Connectivity Foundation Wi-Fi Easy Setup, Version 2.0.1*
133 Available at: https://openconnectivity.org/specs/OCF_Wi-Fi_Easy_Setup_Specification_v2.0.1.pdf
134 Latest version available at:
135 https://openconnectivity.org/specs/OCF_Wi-Fi_Easy_Setup_Specification.pdf

136 IETF RFC 6749, *The OAuth 2.0 Authorization Framework*, October 2012
137 <https://tools.ietf.org/html/rfc6749>

138 IETF RFC 6750, *The OAuth 2.0 Authorization Framework: Bearer Token Usage*, October 2012
139 <https://tools.ietf.org/html/rfc6750>

140 IETF RFC 8323, *CoAP (Constrained Application Protocol) over TCP, TLS, and WebSockets*,
141 February 2018
142 <https://tools.ietf.org/html/rfc8323>

143 OpenAPI specification, *fka Swagger RESTful API Documentation Specification*, Version 2.0
144 <https://github.com/OAI/OpenAPI-Specification/blob/master/versions/2.0.md>

145

146 **3 Terms, definitions, and abbreviated terms**

147 **3.1 Terms and definitions**

148 For the purposes of this document, the terms and definitions given in ISO/IEC 30118-1:2018 and
149 ISO/IEC 30118-2:2018 and the following apply.

150 ISO and IEC maintain terminological databases for use in standardization at the following
151 addresses:

- 152 – ISO Online browsing platform: available at <https://www.iso.org/obp>
- 153 – IEC Electropedia: available at <http://www.electropedia.org/>

154 **3.1.1**

155 **Cloud Provider**

156 entity or organization that hosts an OCF Cloud (3.1.2).

157 **3.1.2**

158 **OCF Cloud**

159 an OCF Cloud is not an OCF Device, but a logical entity that is owned by the Cloud Provider (3.1.1).
160 An OCF Cloud is authorised to communicate with a Device on behalf of the OCF Cloud User.

161 **3.1.3**

162 **Resource Directory**

163 a set of descriptions of Resources where the actual Resources are held on Servers external to the
164 entity hosting the Resource Directory (3.1.3), allowing lookups to be performed for those Resources

165 **3.2 Abbreviated terms**

166 **3.2.1**

167 **UX**

168 User Experience

169

170 **4 Document conventions and organization**

171 **4.1 Conventions**

172 In this document a number of terms, conditions, mechanisms, sequences, parameters, events,
173 states, or similar terms are printed with the first letter of each word in uppercase and the rest
174 lowercase (e.g., Network Architecture). Any lowercase uses of these words have the normal
175 technical English meaning.

176 **4.2 Notation**

177 In this document, features are described as required, recommended, allowed or DEPRECATED as
178 follows:

179 Required (or shall or mandatory)(M).

- 180 – These basic features shall be implemented to comply with Core Architecture. The phrases "shall
181 not", and "PROHIBITED" indicate behaviour that is prohibited, i.e. that if performed means the
182 implementation is not in compliance.

183 Recommended (or should)(S).

- 184 – These features add functionality supported by Core Architecture and should be implemented.
185 Recommended features take advantage of the capabilities Core Architecture, usually without
186 imposing major increase of complexity. Notice that for compliance testing, if a recommended
187 feature is implemented, it shall meet the specified requirements to be in compliance with these
188 guidelines. Some recommended features could become requirements in the future. The phrase
189 "should not" indicates behaviour that is permitted but not recommended.

190 Allowed (may or allowed)(O).

- 191 – These features are neither required nor recommended by Core Architecture, but if the feature
192 is implemented, it shall meet the specified requirements to be in compliance with these
193 guidelines.

194 DEPRECATED.

- 195 – Although these features are still described in this document, they should not be implemented
196 except for backward compatibility. The occurrence of a deprecated feature during operation of
197 an implementation compliant with the current document has no effect on the implementation's
198 operation and does not produce any error conditions. Backward compatibility may require that
199 a feature is implemented and functions as specified but it shall never be used by
200 implementations compliant with this document.

201 Conditionally allowed (CA)

- 202 – The definition or behaviour depends on a condition. If the specified condition is met, then the
203 definition or behaviour is allowed, otherwise it is not allowed.

204 Conditionally required (CR)

- 205 – The definition or behaviour depends on a condition. If the specified condition is met, then the
206 definition or behaviour is required. Otherwise the definition or behaviour is allowed as default
207 unless specifically defined as not allowed.

208

209 Strings that are to be taken literally are enclosed in "double quotes".

210 Words that are emphasized are printed in italic.

211 **5 Overview**

212 **5.1 Introduction**

213 An OCF Cloud extends the use of CoAP to enable a Device to interact with a cloud by utilizing
214 following features

- 215 – CoAP over TCP protocol defined in ISO/IEC 30118-1:2018
- 216 – The requirements within this document including those for a Resource Directory
- 217 – Security requirements and SVRs defined within the ISO/IEC 30118-2:2018

218 Devices which are not within a single local network may interact with each other using CoAP over
219 TCP (see ISO/IEC 30118-1:2018) via an OCF Cloud. At any point in time, a Device is configured
220 to use at most one OCF Cloud. The OCF Cloud groups Devices that belong to same OCF Cloud
221 User under an OCF Cloud created User ID. All the Devices registered to the OCF Cloud and
222 belonging to the same User ID can communicate with each other subject to the Device(s)
223 authorising the OCF Cloud in the ACE2 policies.

224 Annex A specifies the Resource Type definitions using the schema defined in the
225 OpenAPI specification as the API definition language that shall be followed by an OCF Device
226 realizing the Resources specified in this document.

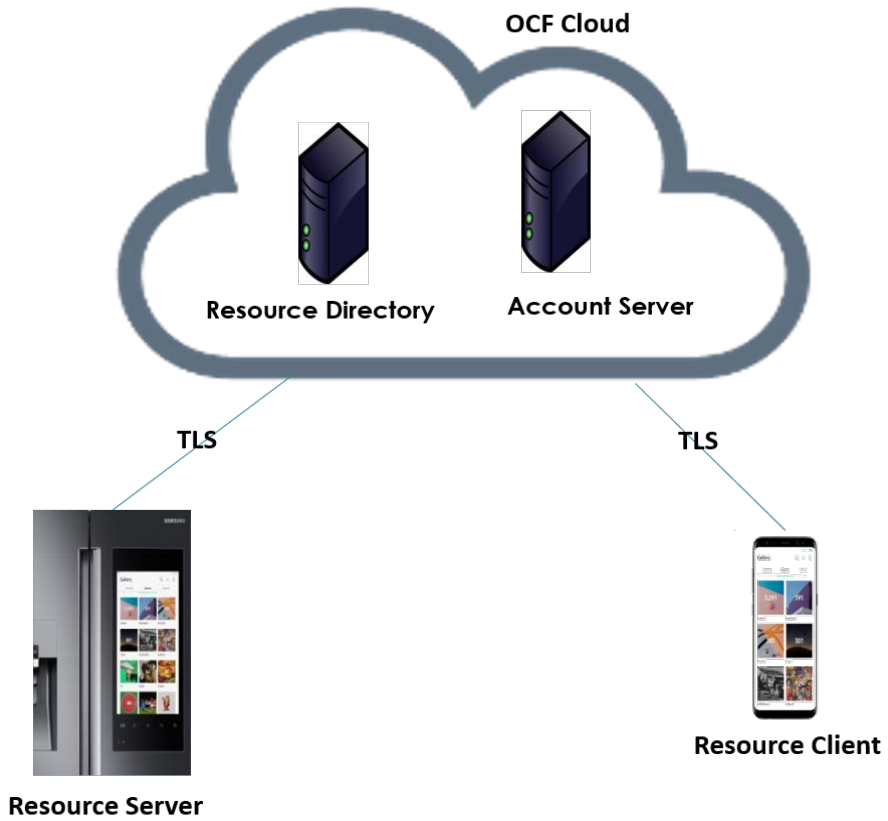
227 Note that an OCF Cloud is not an OCF Device, but a logical entity that is owned by the Cloud
228 Provider. An OCF Cloud is authorized to communicate with a Device by the OCF Cloud User

229 **5.2 Architecture**

230 The OCF Cloud is a logical entity to which an OCF Device communicates via a persistent TLS
231 connection. It encapsulates two functions:

- 232 – an account server function which is a logical entity that handles Device registration, Access
233 Token validation and handles sign-in and token-refresh requests from the Device. An OCF
234 Cloud User creates offline an account on the account server (by means of the mediator). The
235 account server is then also used to register the Devices (Clients and Servers) per account.
236 Note that all accounts are fully separated, e.g. logging into account A does not give access to
237 Devices registered to account B.
- 238 – a Resource Directory as defined by this document. The Resource Directory exposes Resource
239 information published by Devices. A Client, when discovering Devices, receives a response
240 from the Resource Directory on behalf of the Device. With information included in the response
241 from the Resource Directory, the Client may connect to the Device via the OCF Cloud.

242 This is illustrated in Figure 1.



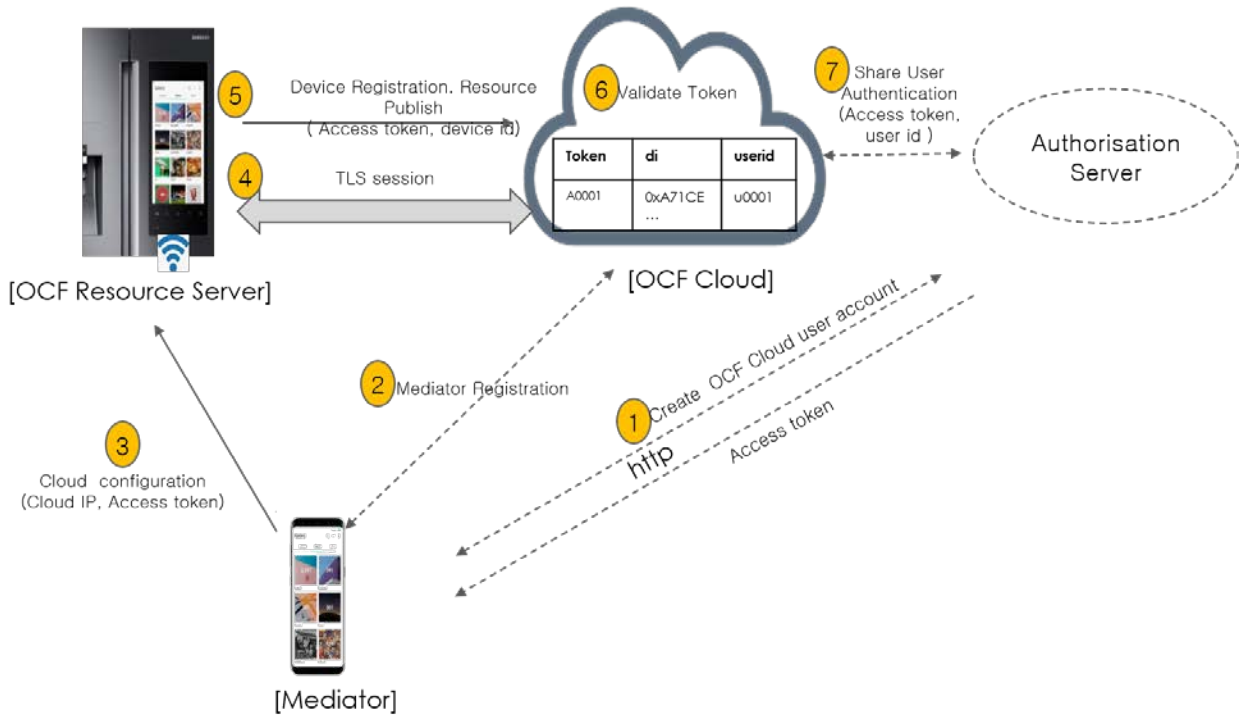
243

244

Figure 1 – OCF Cloud Architecture

245 **5.3 Interaction Flow**

246 This clause describes how the elements with the overall OCF Cloud interact. Figure 2 provides an
 247 overall introduction, Table 1 provides additional context to the elements in the flow.



248

249

Figure 2 – OCF Cloud interaction model

250

251

Table 1 – OCF Cloud Interaction Flow

| Steps | Description |
|-------|--|
| 1 | The Mediator obtains an Access Token for the OCF Cloud User from an Authorisation Provider |
| 2 | The Mediator registers with the OCF Cloud |
| 3 | The Mediator provisions "oic.r.coapcloudconf" on the Device with an Access Token, the URL of the OCF Cloud, the identity (UUID) of the OCF Cloud, and optionally an Authorisation Provider Name. |
| 4, 5 | The Device establishes a TLS session to the OCF Cloud and subsequently registers with the OCF Cloud |
| 6, 7 | The OCF Cloud validates the registration request and authorises the Access Token. Returning information to the Device in the "uid" of the OCF Cloud User and the expiration information of the Access Token. |

252

253 In the case where the OCF Cloud also acts as the Authorisation Server step 1 from Table 1 may
 254 be between the Mediator and the OCF Cloud in which case step 7 is not required.

255 **5.4 Cloud Operational Flow**

256 The sub-clauses listed provide an informative overview of the flow which results on a Device being
 257 registered with an OCF Cloud and Client interaction with that Device. The clauses provide
 258 references to the applicable clauses within this document and other documents that provide
 259 normative details.

260 The flow consists of the following high-level steps:

- 261 – Pre-requisites and OCF Cloud User account creation (see 5.4.1)
- 262 – Mediator registration with the OCF Cloud (see 5.4.2)
- 263 – Device provisioning by the Mediator (see 5.4.3)
- 264 – Device registration with the OCF Cloud (see 5.4.4)
- 265 – Device connection with the OCF Cloud (see 5.4.5)
- 266 – Devices Publishing Links to the OCF Cloud RD (see 5.4.6)
- 267 – Client to Server communication through the OCF Cloud (see 5.4.7)
- 268 – Device refreshing connection with the OCF Cloud (see 5.4.8)
- 269 – Device closing connection with the OCF Cloud (see 5.4.9)
- 270 – Device de-registering from the OCF Cloud (see 5.4.10)

271 **5.4.1 Pre-requisites and OCF Cloud User Account Creation**

272 The OCF Cloud User has a Device that they want to hook up to the OCF Cloud so that they can
273 access it remotely.

274 The Device is onboarded to the OCF Network as defined in ISO/IEC 30118-2:2018.

275 The OCF Cloud User makes use of a Mediator to provision the Device. A Mediator is a logical
276 function that may be on the OCF Cloud User's personal device (e.g. phone) or elsewhere. The
277 Mediator is configured with or through some out of band process to obtain the URL of the OCF
278 Cloud (e.g. the Mediator may be an application from the Cloud Provider).

279 The OCF Cloud User has access credentials for authenticating the OCF Cloud User to the
280 Authorisation Provider (i.e. user name/password or similar)

281 **5.4.2 Mediator registration with the OCF Cloud**

282 See 8.1.2.2, 8.1.2.3.

283 Via some trigger (e.g. a UX or other out of bounds mechanism), the Mediator authenticates the
284 OCF Cloud User to the Authorisation Provider and requests Access Token from an Authorisation
285 Provider.

286 The Mediator registers by providing its Access Token to the OCF Cloud which verifies the token
287 and creates a User ID with which the Mediator is associated. All instances of a Mediator for the
288 same OCF Cloud User will be associated with the same User ID. Similarly, this same User ID may
289 be used to assign multiple Devices to the same OCF Cloud User

290 **5.4.3 Device provisioning by the Mediator**

291 See 8.1.2.3; see also ISO/IEC 30118-2:2018 clause 7.5.2

292 The Mediator connects to the Device through normal OCF processes. The Mediator then requests
293 an Access Token from the OCF Cloud for the Device being provisioned. The Mediator updates the
294 "oic.r.coapcloudconf" Resource on the Device with the Access Token received from the OCF Cloud,
295 the OCF Cloud URI, and the OCF Cloud UUID. The Mediator may also provide the Auth Provider
296 Name. Note that this Access Token may only be used one time for the initial Device Registration
297 with the OCF Cloud.

298 **5.4.4 Device Registration with the OCF Cloud.**

299 See 8.1.3 and 8.1.4; see also ISO/IEC 30118-2:2018 clauses 10.5, 13.11, 13.12

300 On configuration of the "oic.r.coapcloudconf" Resource by the Mediator, the Device establishes a
301 TLS connection with the OCF Cloud using the URI that was provisioned, and the Device's
302 manufacturer certificate and the trust anchor certificate(s) for OCF Cloud certificate validation, both
303 of which were installed by the Device manufacturer. The combination of the Device's manufacturer
304 certificate and OCF Cloud User's Access Token ensures the interactions between the OCF Cloud
305 and OCF Devices are within the OCF Cloud User's domain.

306 To register with the OCF Cloud, the Device then sends an UPDATE operation to the Account
307 Resource on the OCF Cloud which includes the Access Token that was provisioned in the
308 "oic.r.coapcloudconf" Resource. Note that the OCF Cloud maintains a unique instance of the
309 Account Resource for every Device.

310 If the UPDATE is successfully validated, then the OCF Cloud provides an UPDATE response that
311 may provide updated values for the Access Token and details on the lifetime (expiration) of that
312 Token. The OCF Cloud also includes the User ID to which the Device is associated. All values
313 returned are stored securely on the Device. The returned Access Token is not written to the
314 "oic.r.coapcloudconf" Resource.

315 The Device is now registered with the OCF Cloud.

316 **5.4.5 Connection with the OCF Cloud**

317 See 8.1.4, see also ISO/IEC 30118-2:2018 clause 13.12

318 In order to enable passing data between the Device and the OCF Cloud, the Device sends an
319 UPDATE request to the Session Resource; once validated, the OCF Cloud sends a response
320 message that includes the remaining lifetime of the associated Access Token. The Device now has
321 an active connection and can exchange data.

322 **5.4.6 Publishing Links to the OCF Cloud RD**

323 See 8.2; see also ISO/IEC 30118-2:2018 clause 10.5, ISO/IEC 30118-1:2018 clause 11.3.6.

324 Once the TLS connection has been established to the OCF Cloud the Device exposes its Resources
325 in the Resource Directory in the OCF Cloud so that they may be seen/accessed remotely.

326 **5.4.7 Client to Server communication through the OCF Cloud**

327 See 8.3, 8.4; see also ISO/IEC 30118-2:2018 clause 10.5.

328 As for a Server, Clients follow this same process and register with the OCF Cloud.

329 The OCF Cloud allows communication between all of an OCF Cloud User's Devices based on the
330 fact that they have the same User ID.

331 When the Client attempts CRUDN actions on the Links hosted by the OCF Cloud, the OCF Cloud
332 forwards those requests to the Device. The Device responds to the OCF Cloud which then proxies
333 the response to the Client (i.e. Client -> OCF Cloud -> Device -> OCF Cloud -> Client).

334 **5.4.8 Refreshing connection with the OCF Cloud**

335 See ISO/IEC 30118-2:2018 clause 13.13.

336 When (or before) the Access Token expires, the Device refreshes its token by sending an UPDATE
337 request to the Token Refresh Resource.

338 **5.4.9 Closing connection with the OCF Cloud**

339 See ISO/IEC 30118-2:2018 clause 13.12.

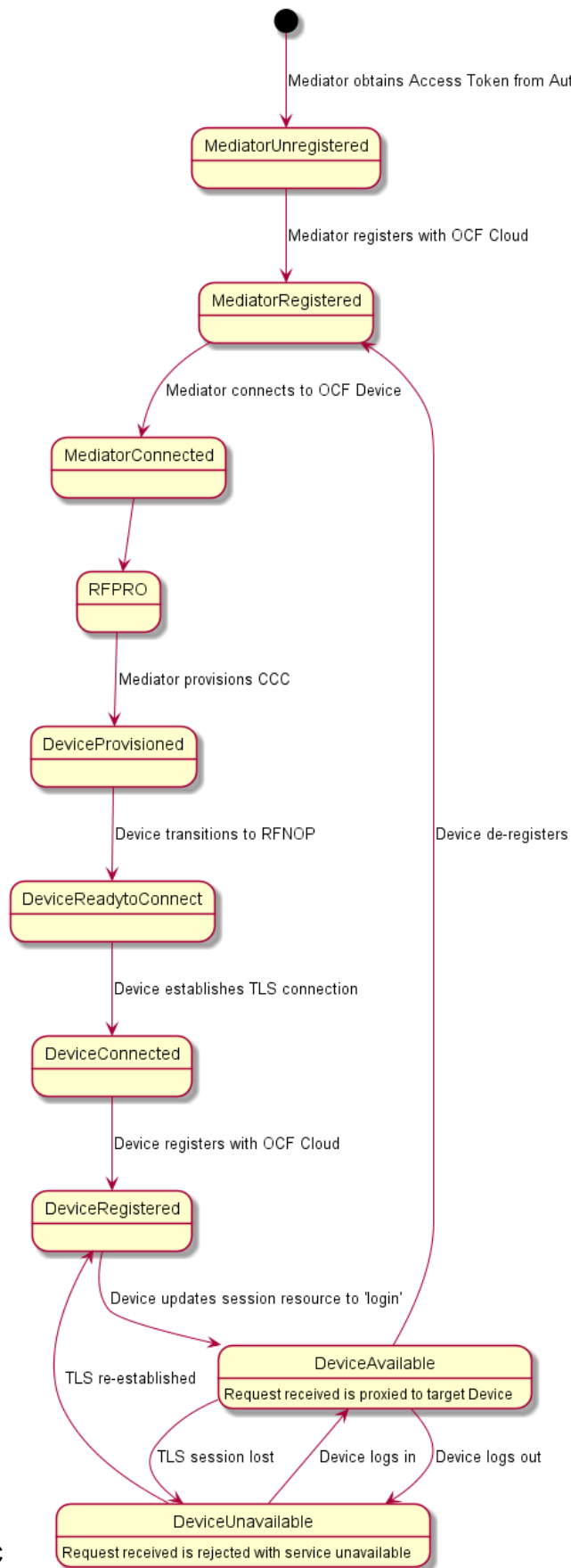
340 To log out of the OCF Cloud the Device sends an UPDATE request to the Session Resource
341 indicating a "login" status of "false". This does not delete or remove any of the Device Registration
342 information. The Device may log back into the OCF Cloud at any point prior to expiration of the
343 Access Token.

344 **5.4.10 Deregistering from the OCF Cloud**

345 See 8.5; see also ISO/IEC 30118-2:2018 clause 13.10.

346 To deregister with the OCF Cloud, the Device sends a DELETE request message to the Account
347 Resource including its Access Token. The OCF Cloud sends a response message confirming that
348 the Device has been deregistered.

349 To connect to the OCF Cloud again, the Device has to re-follow the flow starting with Mediator
350 provisioning (see clause 5.4.3). Figure 3 captures the state machine that is described by the
351 informative operation flow provided in clause 5.4.



353 **Figure 3 – Overall Operational State Machine**

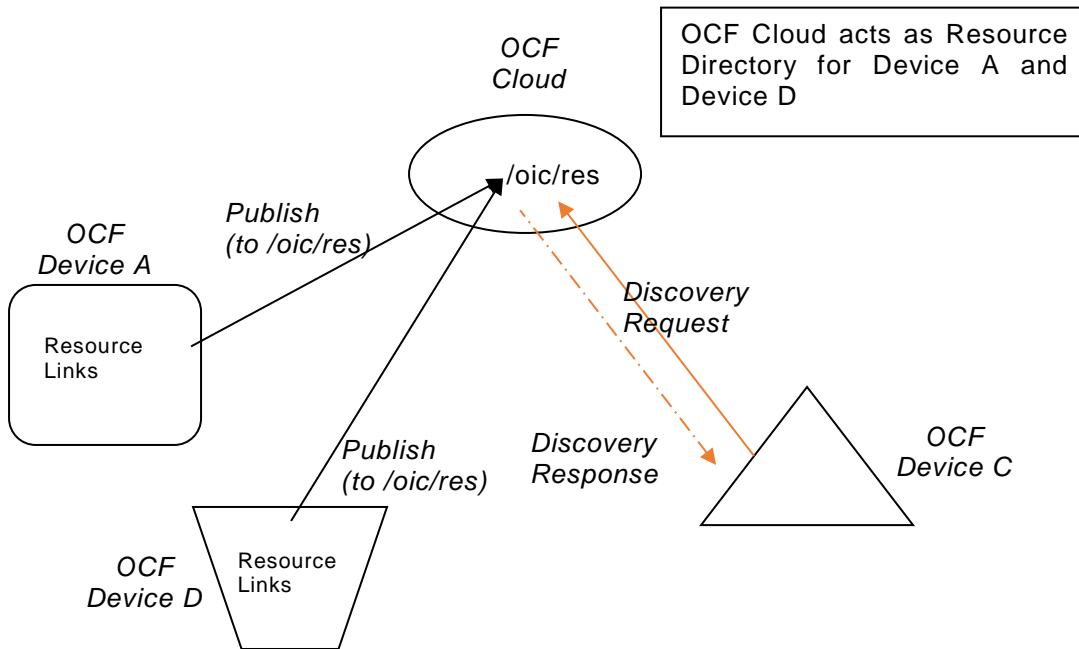
354 **6 Resource model**

355 **6.1 OCF Cloud Resource Directory**

356 **6.1.1 Indirect discovery for lookup of Resources**

357 Indirect discovery is when a 3rd party, other than the discovering Device and the discovered Device,
358 assists with the discovery process. The 3rd party, called a Resource Directory (RD), only provides
359 information on Resources on behalf of another Device but does not host Resources on part of that
360 Device.

361 In Figure 4, the OCF Cloud acts as Resource Directory for Device A and Device D which are both
362 part of the same account. Device A and Device D publish their Resource information to the OCF
363 Cloud. Device C which is also part of the same account as Devices A and D, may query the OCF
364 Cloud to acquire the Resource information of Devices A and D.



366
367 **Figure 4 – Indirect discovery of Resources by via an RD**

368 Indirect discovery is useful for when Devices may not be on the same network and require
369 optimization for discovery or routing. Once Resources are discovered using indirect discovery, i.e.,
370 RD query, then the access to the Resource is done by a request sent to the endpoint exposed by
371 the RD for the Resource.

372 **6.1.2 Resource Directory Definition**

373 An OCF Cloud which acts as a Resource Directory (RD) will be involved in the following operations.

- 374 – *RD discovery* – the procedure by which publishing Devices discover an RD, in the case of the
375 OCF Cloud this is a direct result of Device registration with an OCF Cloud.
- 376 – *Resource publish* – the procedures with which Devices publish their Resource information, i.e.
377 Links.

378 – *Resource exposure* – the feature with which RDs expose the Links hosted by the 3rd party
 379 Devices via their own "/oic/res".

380 An RD makes use of Resource Type "oic.wk.rd" defined in Table 2 and Table 3. An OCF Cloud that
 381 supports the capability to host indirect discovery shall expose an instance of the "oic.wk.rd"
 382 Resource Type in its "/oic/res" to announce that it serves as an RD. The use of the "oic.wk.rd"
 383 Resource Type is restricted to OCF Clouds only, a proximal network Device shall not expose the
 384 "oic.wk.rd" Resource Type.

385 The discoverable instance of "oic.wk.rd" shall allow only secure connections (e.g. OCF Endpoint
 386 with a scheme of "coaps" or "coaps+tcp"). A publishing Device sends an UPDATE request to
 387 "/oic/rd" with its Links in the payload to publish the Links in "/oic/res" of the RD. A publishing Device
 388 is responsible for ensuring the RD has the correct published Links exposed via its "/oic/res".

389 **Table 2 – "oic.wk.rd" Resource Type definition**

| Pre-defined URI | Resource Type Title | Resource Type ID ("rt" value) | OCF Interfaces | Description | Related Functional Interaction |
|-----------------|---------------------|-------------------------------|-------------------|---|--------------------------------|
| "/oic/rd" | Resource Directory | "oic.wk.rd" | "oic.if.baseline" | The Discoverable Resource Type through which an RD 1) facilitates its discovery and provides the criteria to select an RD and 2) allows Devices to publish their Links in "/oic/res" of the RD. | Discovery |

390

391 **Table 3 – "oic.wk.rd" Properties**

| Property title | Property name | Value type | Value rule | Unit | Access mode | Mandatory | Description |
|----------------|---------------|------------|------------|------|-------------|-----------|--|
| Selector | "sel" | "integer" | N/A | N/A | R | Yes | Provides the criteria for RD selection. An integer representing a value calculated by the RD. The value is in the range of 0 to 100. The lower the value, the more preferable the RD is. |

392

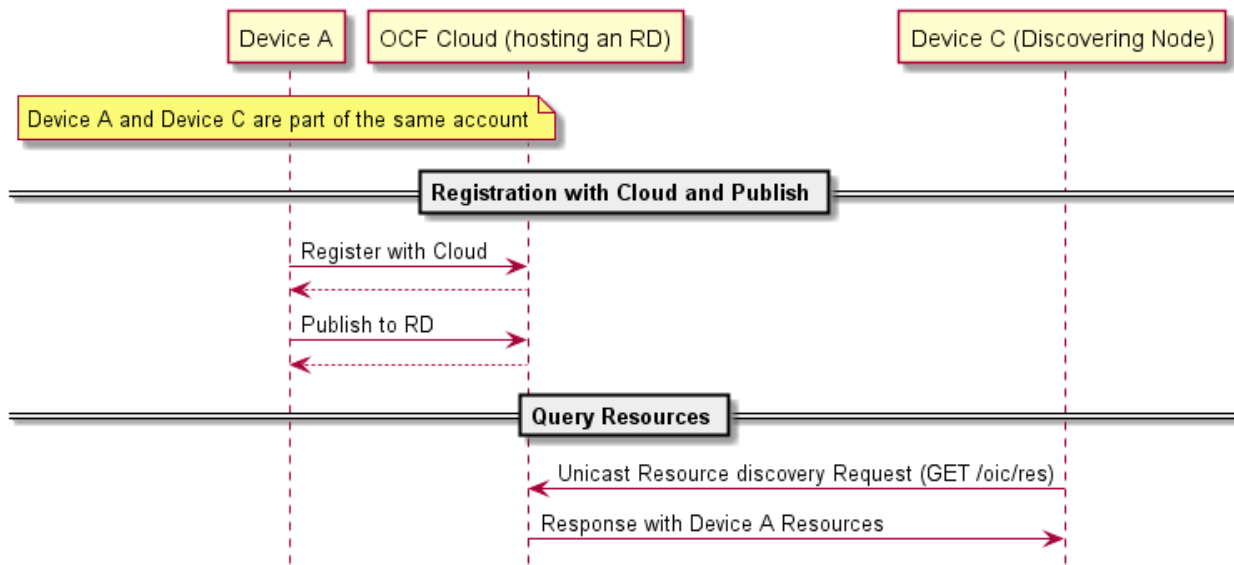
393 An RD may be queried at its "/oic/res" Resource to find Resources hosted on other Devices. A
 394 publishing Device may publish all or a partial list of Resources they host to an RD. The RD then
 395 responds to queries for Resource discovery on behalf of the publishing Device. Note that only
 396 Devices that belong to the same account as the querying Device are visible in the exposed instance
 397 of "/oic/res". For general Resource discovery, the RD behaves like any other Server in responding
 398 to requests to "/oic/res".

399 **6.1.3 RD operational flows**

400 **6.1.3.1 Discovering an RD**

401 In Figure 5, a Device that wishes to publish its Resources first registers with the OCF Cloud that
 402 hosts the RD and then publishes the desired Resource information.

403



404
405 **Figure 5 – RD discovery and RD supported query of Resources support**

406 A Client that performs Resource discovery via an OCF Cloud RD does so via a unicast request to
407 the RD; the Resource Directory defined in this document does not support the use of multicast
408 queries to discover instances of an RD.

409 6.1.3.2 Publish Resources

410 6.1.3.2.1 Overview

411 After the selection process of an RD, a Device may push its Resource information to the selected
412 RD, i.e., publish the Links in its "/oic/res" to the "/oic/res" of the RD.

413 The publishing Device may decide to publish all Resources or just a few of the Resources on the
414 RD. At a minimum a publishing Device shall publish the mandatory Core Resources "/oic/d" and
415 "/oic/p" as well as Resources that are defined as mandatory for the Device Type being published.
416 The publishing Device should only publish Resources that are otherwise published to its own
417 "/oic/res"; a publishing Device should not publish non-Discoverable Resources or Resources
418 hosted by some other Device. A publishing Device shall respond to discovery requests on its
419 "/oic/res" Resource unless all its Discoverable Resources have been published in an RD.

420 6.1.3.2.2 Publish: Push Resource information

421 Resource information may be published using an UPDATE request sent to "/oic/rd".

422 A Device which hosts a Resource may publish the Resource information, i.e. the Link targeting the
423 Resource, to an RD by sending an UPDATE request with the Link in the payload. The published
424 Link shall be exposed through the "/oic/res" of the RD.

425 When a Device first publishes a Link or Links, it shall send an UPDATE request to the "/oic/rd"
426 Resource of the RD including the following key-value pairs in the payload:

- 427 – "di" –its value shall be the Device ID of the publishing Device, i.e. the "di" value of "/oic/d".
- 428 – "links" –its value shall be the array of Links to be published. Links may omit the "ins" Parameter
429 in which case the RD will assign a value for each Link. The supplied "ins" Parameter by the
430 Client is allowed to be overruled by the RD, e.g. an RD can ignore the supplied "ins" value.
- 431 – "ttl" –its value indicates how long (in seconds) the publishing Device requests the RD to keep
432 this published Link.

433 Notice that the payload shall carry the appropriate Content-Format of "application/vnd.ocf+cbor".

```
434 {
435   "di": "e61c3e6b-9c54-4b81-8ce5-f9039c1d04d9",
436   "links": [
437     {
438       "anchor": "ocf://e61c3e6b-9c54-4b81-8ce5-f9039c1d04d9"
439       "href": "/myLightSwitch",
440       "rt": ["oic.r.switch.binary"],
441       "if": ["oic.if.a", "oic.if.baseline"],
442       "p": {"bm": 3},
443       "eps": [
444         {"ep": "coaps://[fe80:b1d6]:1111", "pri": 2},
445         {"ep": "coaps://[fe80:b1d6]:1122"},
446         {"ep": "coaps+tcp://[2001:db8:a::123]:2222", "pri": 3}
447       ]
448     },
449     {
450       "anchor": "ocf://e61c3e6b-9c54-4b81-8ce5-f9039c1d04d9",
451       "href": "/myLightBrightness",
452       "rt": ["oic.r.brightness"],
453       "if": ["oic.if.a", "oic.if.baseline"],
454       "p": {"bm": 3},
455       "eps": [
456         {"ep": "coaps://[[2001:db8:a::123]:2222"}
457       ]
458     }
459   ],
460   "ttl": 600
461 }
```

462 When an RD receives this initial UPDATE request, it determines whether to grant the request or
463 not. Upon granting the request, the RD shall send back an UPDATE response to the publishing
464 Device. The response shall include a payload with the same information as the original UPDATE
465 request with the following possible differences:

- 466 – For each Link, an "ins" Parameter shall be included in the response. The RD shall assign a
467 unique "ins" value identifying the Link among all the Links it advertises. If the publishing Device
468 included an "ins" value in the UPDATE request, the RD may use it as long as it doesn't match
469 any existing "ins" value in the published Links.
- 470 – The "ttl" Property Value shall be assigned by the RD and it shall be included in the response.
471 The RD should use the value included in the UPDATE request but may assign a value that is
472 lower if it is not able to honour the requested "ttl" value. After this time elapses, the RD shall
473 remove the Links. To keep a Link alive, the publishing Device may update the "ttl" using the
474 UPDATE schema.

475 The RD shall add the new Links to its "/oic/res" and expose them to a valid discovery query, i.e.
476 RETRIEVE request:

```
477 {
478   "di": "e61c3e6b-9c54-4b81-8ce5-f9039c1d04d9",
479   "links": [
480     {
481       "anchor": "ocf://e61c3e6b-9c54-4b81-8ce5-f9039c1d04d9",
482       "href": "/myLightSwitch",
483       "rt": ["oic.r.switch.binary"],
484       "if": ["oic.if.a", "oic.if.baseline"],
485       "p": {"bm": 3},
486       "eps": [
487         {"ep": "coaps://[fe80:b1d6]:1111", "pri": 2},
488         {"ep": "coaps://[fe80:b1d6]:1122"},
489         {"ep": "coaps+tcp://[2001:db8:a::123]:2222", "pri": 3}

```

```

490     ],
491     "ins": 11235
492   },
493   {
494     "anchor": "ocf://e61c3e6b-9c54-4b81-8ce5-f9039c1d04d9",
495     "href": "/myLightBrightness",
496     "rt": ["oic.r.brightness"],
497     "if": ["oic.if.a", "oic.if.baseline"],
498     "p": {"bm": 3},
499     "eps": [
500       {"ep": "coaps://[[2001:db8:a::123]:2222"}
501     ],
502     "ins": 112358
503   }
504 ].
505 "ttl": 600
506 }

```

507 6.1.3.3 Resource exposure

508 6.1.3.3.1 "/oic/res" and retrieving of the Resources

509 The "/oic/res" based discovery process for an OCF Cloud does not support the use of multicast. A
510 registered Client may discover Resources by sending a unicast RETRIEVE to "/oic/res". Only those
511 Resources for Devices that are registered with the same account as the Client are returned in a
512 response to the RETRIEVE.

513 Interaction with Resources discovered using the RD is done using the same mechanism and
514 methods as with Resources discovered by retrieving the "/oic/res" Resource of the Device hosting
515 the Resources (e.g., connect to the exposed endpoint and perform CRUDN operations on the
516 Resource).

517 The "/oic/res" response to a requesting Client includes the Links with the "anchor" Parameter
518 containing an OCF URI. The "/oic/res" response has a single array of Links. Each Link shall contain
519 the "anchor" Parameter of the value OCF URI where the authority component of <deviceId>
520 indicates the Device hosting the target Resource.

521 For example, an RD may return the following to a Client.

```

522 [
523   {
524     "anchor": "ocf://88b7c7f0-4b51-4e0a-9faa-cfb439fd7f49",
525     "href": "/oic/res",
526     "rel": "self",
527     "rt": ["oic.wk.res"],
528     "if": ["oic.if.ll", "oic.if.baseline"],
529     "p": {"bm": 3},
530     "eps": [
531       {"ep": "coap://[2001:db8:a::b1d4]:7777"},
532       {"ep": "coaps://[2001:db8:a::b1d4]:33333"}
533     ]
534   },
535   {
536     "anchor": "ocf://88b7c7f0-4b51-4e0a-9faa-cfb439fd7f49",
537     "href": "/oic/d",
538     "rt": ["oic.wk.d", "oic.d.fan"],
539     "if": ["oic.if.r", "oic.if.baseline"],
540     "p": {"bm": 3},
541     "eps": [
542       {"ep": "coap://[2001:db8:a::b1d4]:7777"},
543       {"ep": "coaps://[2001:db8:a::b1d4]:33333"}
544     ]
545   },

```

```

546 {
547   "anchor": "ocf://88b7c7f0-4b51-4e0a-9faa-cfb439fd7f49",
548   "href": "/oic/p",
549   "rt": ["oic.wk.p"],
550   "if": ["oic.if.r", "oic.if.baseline"],
551   "p": {"bm": 3},
552   "eps": [
553     {"ep": "coaps://[2001:db8:a::b1d4]:33333"}
554   ],
555 },
556 {
557   "anchor": "ocf://88b7c7f0-4b51-4e0a-9faa-cfb439fd7f49",
558   "href": "/myFanIntrospection",
559   "rt": ["oic.wk.introspection"],
560   "if": ["oic.if.r", "oic.if.baseline"],
561   "p": {"bm": 3},
562   "eps": [
563     {"ep": "coaps://[2001:db8:a::b1d4]:33333"}
564   ],
565 },
566 {
567   "anchor": "ocf://88b7c7f0-4b51-4e0a-9faa-cfb439fd7f49",
568   "href": "/oic/rd",
569   "rt": ["oic.wk.rd"],
570   "if": ["oic.if.baseline"],
571   "p": {"bm": 3},
572   "eps": [
573     {"ep": "coaps://[2001:db8:a::b1d4]:33333"}
574   ],
575 },
576 {
577   "anchor": "ocf://88b7c7f0-4b51-4e0a-9faa-cfb439fd7f49",
578   "href": "/myFanSwitch",
579   "rt": ["oic.r.switch.binary"],
580   "if": ["oic.if.a", "oic.if.baseline"],
581   "p": {"bm": 3},
582   "eps": [
583     {"ep": "coaps://[2001:db8:a::b1d4]:33333"}
584   ],
585 },
586 {
587   "anchor": "ocf://dc70373c-1e8d-4fb3-962e-017eaa863989",
588   "href": "/oic/d",
589   "rt": ["oic.wk.d", "oic.d.light"],
590   "if": ["oic.if.r", "oic.if.baseline"],
591   "p": {"bm": 3},
592   "eps": [
593     {"ep": "coap://[2001:db8:b::c2e5]:66666"},
594     {"ep": "coaps://[2001:db8:b::c2e5]:22222"}
595   ],
596 },
597 {
598   "anchor": "ocf://dc70373c-1e8d-4fb3-962e-017eaa863989",
599   "href": "/oic/p",
600   "rt": ["oic.wk.p"],
601   "if": ["oic.if.r", "oic.if.baseline"],
602   "p": {"bm": 3},
603   "eps": [
604     {"ep": "coaps://[2001:db8:b::c2e5]:22222"}
605   ],
606 },
607 {
608   "anchor": "ocf://dc70373c-1e8d-4fb3-962e-017eaa863989",

```

```

609     "href": "/myLightSwitch",
610     "rt": ["oic.r.switch.binary"],
611     "if": ["oic.if.a", "oic.if.baseline"],
612     "p": {"bm": 3},
613     "eps": [
614       {"ep": "coaps://[2001:db8:b::c2e5]:22222"}
615     ]
616   },
617   {
618     "anchor": "ocf://dc70373c-1e8d-4fb3-962e-017eaa863989",
619     "href": "/myLightBrightness",
620     "rt": ["oic.r.brightness"],
621     "if": ["oic.if.a", "oic.if.baseline"],
622     "p": {"bm": 3},
623     "eps": [
624       {"ep": "coaps://[2001:db8:b::c2e5]:22222"}
625     ]
626   }
627 ]

```

628

629 6.2 CoAPCloudConf Resource

630 6.2.1 Introduction

631 The CoAPCloudConf resource exposes configuration information for connecting to an OCF Cloud.
632 This is an optional discoverable Resource, which may additionally be included within the Easy
633 Setup Collection ("oic.r.easyssetup") and so used during the Easy Setup process as defined in
634 OCF Wi-Fi Easy Setup.

635 The CoAPCloudConf Resource shall expose only secure Endpoints (e.g. CoAPS); see the
636 ISO/IEC 30118-1:2018, clause 10.

637 6.2.2 Resource Definition

638 The CoAPCloudConf Resource is as defined in Table 4.

639

Table 4 – CoAPCloudConf Resource

| Example URI | Resource Type Title | Resource Type ID ("rt" value) | Interfaces | Description | Related Functional Interaction |
|--------------------------------|---------------------|-------------------------------|-----------------------------------|---|--------------------------------|
| "/example/CoapCloudConfResURI" | CoAPCloudConf | "oic.r.coapcloudconf" | "oic.if.rw", "oic.if.baseline" | Configuration information for connecting to an OCF Cloud. The Resource properties exposed are listed in Table 5. | N/A |

640

641

642 Table 5 defines the details for the "oic.r.coapcloudconf" Resource Type.

643 **Table 5 – oic.r.coapcloudconf Resource Type definition**

| Property title | Property name | Value type | Value rule | Unit | Access mode | Mandatory | Description |
|---|---------------|------------|--|------|----------------|-------------------------|---|
| Auth Provider Name | apn | String | N/A | N/A | RW | No | The name of the Authorisation Provider through which access token was obtained. |
| OCF Cloud interface URL | cis | String | uri | N/A | RW | Yes | URL of OCF Cloud. |
| Access Token | at | String | The Access Token is a string of at least one character | N/A | W ¹ | Yes (in an UPDATE only) | Access token which is returned by an Authorisation Provider or OCF Cloud. |
| OCF Cloud UUID | sid | uuid | N/A | N/A | RW | Yes | The identity of the OCF Cloud |
| Last Error Code during Cloud Provisioning | clec | integer | enum | N/A | R | No | 0: No Error, 1: Error response from the OCF Cloud, 2: Failed to connect to the OCF Cloud, 3: Failed to refresh Access Token, 4~254: Reserved, 255: Unknown error |

¹ The Access Token is not included in a RETRIEVE response payload. It can only be the target of an UPDATE.

644
645 If the "clec" Property is implemented by a Device, it shall have an initial value of 0 ("No error").

646 **6.2.3 Error Handling**

647 The "clec" Property of the CoAPCloudConf Resource (i.e. "oic.r.coapcloudconf") is used to indicate
648 any error that occurred in the cloud configuration process while trying to connect to the OCF Cloud
649 (using the information populated by the Mediator in the CoAPCloudConf Resource). This is an
650 optional Property and if implemented, is set by the Device:

- 651 – The Device shall set the "clec" Property to 1 if it receives an error response from the OCF Cloud
652 (e.g. error response from the Cloud).
- 653 – The Device shall set the "clec" Property to 2 if there is a failure to connect to the OCF Cloud
654 (e.g. no reply, timeout, or timeout).
- 655 – The Device shall set the "clec" Property to 3 if it fails to refresh the Access Token (e.g. if it
656 receives an error response during the token refresh procedure).

657 **7 Network and connectivity**

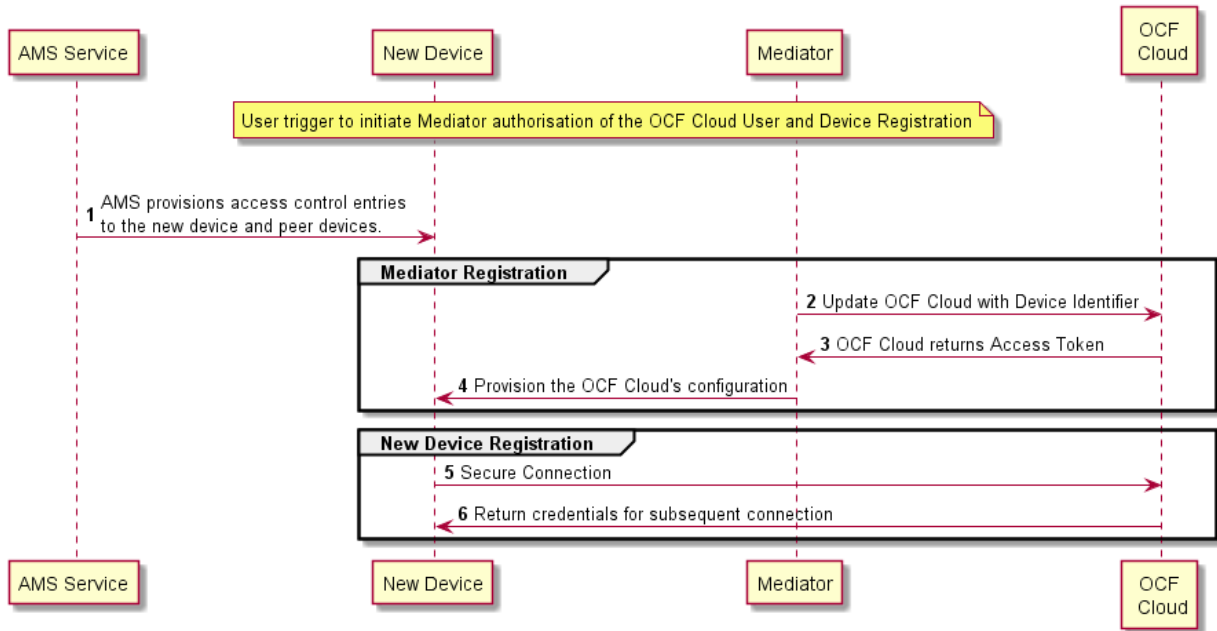
658 A TLS session exists between a Device and the OCF Cloud as specified in IETF RFC 8323; this is
659 established following device configuration as detailed in 8.1.2.3.

660 **8 Functional interactions**

661 **8.1 Onboarding, Provisioning, and Configuration**

662 **8.1.1 Overview**

663 Figure 6 provides an overview of the interaction between the different entities to get the Device
 664 registered with the OCF Cloud. A summary of the flow is provided in Table 4.



665
 666 **Figure 6 – Registration with OCF Cloud**

667
 668 **Table 6 – Device to OCF Cloud Registration Flow**

| Steps | Description |
|-------|--|
| 1 | AMS provisions access control entries to the new device and peer devices. |
| 2-3 | Mediator obtains the OCF Cloud User's information and authorisation. |
| 4 | Mediator provisions the credentials for the Device to connect to the OCF Cloud |
| 5-6 | Device connects to the OCF Cloud using manufacturer certificate. The OCF Cloud returns credentials to the Device, used for subsequent connection to the OCF Cloud. |

669

670 **8.1.2 Use of Mediator**

671 **8.1.2.1 Introduction**

672 The Mediator is a specialised service that is used for provisioning the "oic.r.coapcloudconf"
 673 Resource, and enabling connection of a headless Device to an OCF Cloud. The Mediator is
 674 specified in OCF Wi-Fi Easy Setup.

675 The Mediator is implemented as part of the OBT (Onboarding Tool); and so could be part of any
 676 Device that itself hosts an OBT. A Device is authorized to communicate with an OCF Cloud if a
 677 trusted Mediator has provisioned the Device. The Device and Mediator connect over DTLS using
 678 credentials from "/oic/sec/cred".

679 As part of Device provisioning, the Mediator sets the following information in the
680 "oic.r.coapcloudconf" Resource exposed by the Device:

- 681 – OCF Cloud Interface URL ("cis") Property
- 682 – OCF Cloud UUID ("sid") Property (to verify Cloud identity)
- 683 – Access Token ("at") Property that is validated by the OCF Cloud
- 684 – Optionally the Authorisation Provider name ("apn") Property through which the Access Token
685 was obtained

686 If an error occurs during the process of registering and authenticating a Device with the OCF Cloud
687 the Mediator may RETRIEVE the "clec" Property if implemented by the "oic.r.coapcloudconf"
688 Resource on the Device to obtain a hint as to the cause of the error.

689 **8.1.2.2 OCF Cloud User Authorisation of the Mediator**

690 The Mediator uses a user authorisation mechanism to enable the OCF Cloud to validate the OCF
691 Cloud User's authorisation and obtain the OCF Cloud User's identity. The Authorisation Provider
692 should be trusted by both the OCF Cloud User and the OCF Cloud. The Mediator may use OAUTH
693 2.0 (see IETF RFC 6749) or another user authentication mechanism to obtain an Access Token as
694 a form of authorisation from an OCF Cloud User via an Authorisation Provider. This authorisation
695 achieves a variety of purposes. Firstly, the authorisation shows OCF Cloud User consent for
696 Mediator to connect to the OCF Cloud. Secondly, the authorisation is used to obtain information to
697 map the Devices to the same OCF Cloud User.

698 A user authorisation mechanism is used to achieve the following:

- 699 – Obtain an Access Token that is validated by the Cloud
- 700 – OCF Cloud User authorisation via an Authorisation Provider; this provides consent to connect
701 to the OCF Cloud.

702 If a different Mediator is used by the same OCF Cloud User, a new Access Token may be obtained
703 from an Authorisation Provider. Mediator Registration with the OCF Cloud

704 The Mediator connects to the OCF Cloud using a provisioned certificate on the Mediator to establish
705 a TLS connection.

706 On its first connection, the Mediator starts the registration process with the OCF Cloud. The
707 Mediator provides the OCF Cloud with the Mediator's Access Token received from the Authorisation
708 Provider in 8.1.2.2 in order to register with the OCF Cloud.

709 The OCF Cloud then verifies the Access Token with the Authorisation Provider. If the Authorisation
710 Provider validates the Access Token successfully, then it will return information about the OCF
711 Cloud User to whom the Access Token belongs. The OCF Cloud generates a unique Access Token
712 for the Mediator (which may be the original Access Token from the Mediator or a new Access Token)
713 and a User ID (i.e. "uid" Property of "oic.r.account") if this is the first instance of registering a
714 Mediator with this OCF Cloud User. The User ID acts as a unique identity for the OCF Cloud User.
715 All instances of a Mediator for the same OCF Cloud User will be associated with the same User ID.
716 This information is returned to the Mediator over TLS. The returned Access Token and User ID are
717 used by the OCF Cloud to identify the Mediator. This returned Access Token is used by the
718 Mediator in subsequent interactions with the OCF Cloud.

719 All Devices registering with the OCF Cloud receive the same User ID from the OCF Cloud when
720 registering with the same Mediator.

721 **8.1.2.3 Device Provisioning by the Mediator**

722 The Mediator obtains the OCF Cloud User's permission before the Mediator and OCF Cloud interact to
723 preregister the Device with the OCF Cloud. This clause provides an informative description of
724 the expected subsequent exchange between a Mediator and an OCF Cloud.

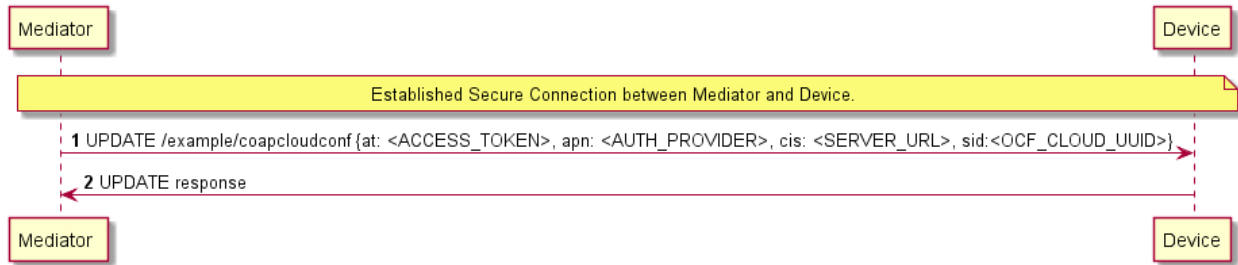
725 Once the OCF Cloud has associated the Mediator with a User ID, the Mediator can request the
726 OCF Cloud to associate OCF Devices with the same User ID. To register the Device with the OCF
727 Cloud, the Mediator first requests an Access Token for the Device from the OCF Cloud. The
728 Mediator may provide the following information to the OCF Cloud to obtain an Access Token for
729 the Device:

- 730 – Device ID (i.e. "di" Property Value of "/oic/d" of the Device)

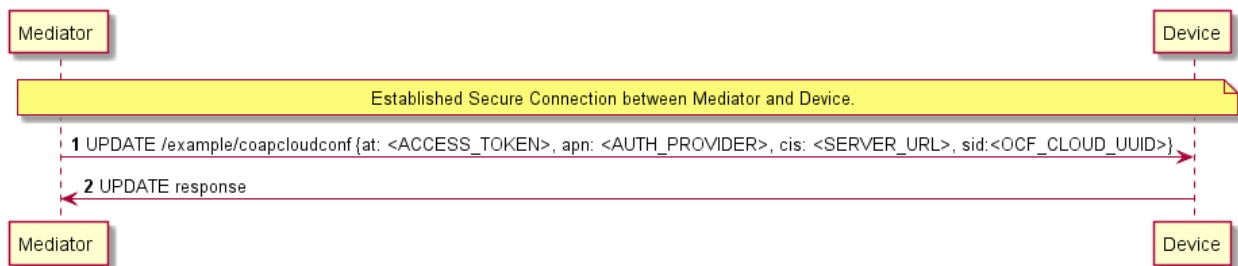
731 The OCF Cloud then returns a unique Access Token for the Device. The OCF Cloud maintains a
732 map where Access Token and Mediator-provided Device ID are stored. At the time of Device
733 Registration OCF Cloud validates the Access Token and associates the TLS session with
734 corresponding Device ID. The OCF Cloud may also return an Authorisation Provider Name
735 associated with the Access Token if the Access Token for the Device was created by an entity
736 other than the OCF Cloud.

737 The Mediator provides this Access Token to the Device ("at" Property) via an UPDATE to the
738 Device's "oic.r.coapcloudconf" Resource. The provisioned Access Token is to be treated by Device
739 as an Access Token with "Bearer" token type as defined in IETF RFC 6750. The Mediator also
740 provisions the OCF Cloud URI ("cis" Property), where the OCF Cloud URI can be either pre-
741 configured or provided to the Mediator via OCF Cloud User input. The Mediator further provisions
742 the OCF Cloud UUD ("sid" Property) to the identity of the OCF Cloud. If the OCF Cloud also
743 returned an Authorisation Provider Name in association with the Access Token for the Device, then
744 this is also provisioned by the Mediator on the Device ("apn" Property of "oic.r.coapcloudconf").

745 See ISO/IEC 30118-2:2018 clause 7.5.2 for details on the population of ACE2 entries on the Device
746 to allow CRUDN operations from the Mediator and OCF Cloud.



747
748 Figure 7 describes the flow for provisioning of the Device by a Mediator. Table 7 provides additional
749 context around the flow.



750
751 **Figure 7 – Device Provisioning by the Mediator**

752

753

Table 7 – Device Provisioning by the Mediator

| Steps | Description |
|-------|---|
| 1 - 2 | Mediator updates the "oic.r.coapcloudconf" Resource on the Device with configuration information to enable the Device to connect to the OCF Cloud |

754

755 Please see ISO/IEC 30118-2:2018 clause 7.5.2 for further details on the mapping of Properties
756 between the Device and OCF Cloud.

757 **8.1.3 Device Connection to the OCF Cloud**

758 On conclusion of Device provisioning as defined in 8.1.2.3 and after transitioning to a state of
759 RFNOP (if not already in RFNOP) the Device shall establish a TLS connection with the OCF Cloud
760 as defined in the ISO/IEC 30118-2:2018 clause 10.5. Further see the ISO/IEC 30118-2:2018 clause
761 10.5.3 for additional security considerations.

762 If authentication of the TLS session being established as defined in the ISO/IEC 30118-2:2018 fails,
763 the "clec" Property of the "oic.r.coapcloudconf" Resource on the Device (if supported) shall be
764 updated about the failed state. If authentication succeeds, the Device and OCF Cloud establish an
765 encrypted link in accordance with the negotiated cipher suite. Further, if the TLS connection is lost
766 due to a failure the "clec" Property of the "oic.r.coapcloudconf" Resource on the Device (if
767 supported) should be updated about the failed state (value of "2").

768 If the TLS connection is lost either via a failure or closed by the OCF Cloud then it may be re-
769 established by following the procedures in the ISO/IEC 30118-2:2018 clause 10.5. A Device may
770 automatically attempt to re-establish the TLS connection, alternatively a Device may require some
771 user trigger to initiate the re-establishment of the TLS connection.

772 **8.1.4 Device Registration with the OCF Cloud**

773 The OCF Cloud maintains a map of User IDs ("uid" Property of "oic.r.account"), Device IDs ("di"
774 Property of "oic.r.account") and Access Tokens ("accesstoken" Property of "oic.r.account";
775 populated with the same value as the "at" Property obtained from "oic.r.coapcloudconf") to
776 authenticate Devices connecting to the OCF Cloud.

777 After the TLS connection is established with the OCF Cloud, the Device shall register with the OCF
778 Cloud by sending an UPDATE request to "/oic/sec/account" as defined in clause 13.10 of the
779 ISO/IEC 30118-2:2018. The OCF Cloud consequently associates the TLS connection with the
780 corresponding "uid" and "di" Properties populated in the "/oic/sec/account/" Resource. Any other
781 Device registering with the OCF Cloud is assigned the same User ID by the OCF Cloud when
782 registering with any Mediator associated with that User ID. Device Registration permits a Client to
783 access Resources on the OCF Cloud which are associated with the same User ID as the Client.

784 If the Property values in the UPDATE to "/oic/sec/account" do not match the equivalents provided
785 to the Mediator by the OCF Cloud the OCF Cloud should close the TLS connection with the Device.
786 Note that the OCF Cloud may also apply additional out-of-band measures, for example the OCF
787 Cloud may send an email to the OCF Cloud User for additional verification to register the Device.

788 If the UPDATE operation is accepted by the OCF Cloud, the OCF Cloud responds as defined in
789 clause 13.10 of the ISO/IEC 30118-2:2018.

790 The "accesstoken" Property that is returned in the UPDATE response may be valid for limited
791 duration; in this instance the Device may use the "/oic/sec/tokenrefresh" Resource to renew the
792 "accesstoken" before the Access Token expires at the time specified in the "expiresin" Property.

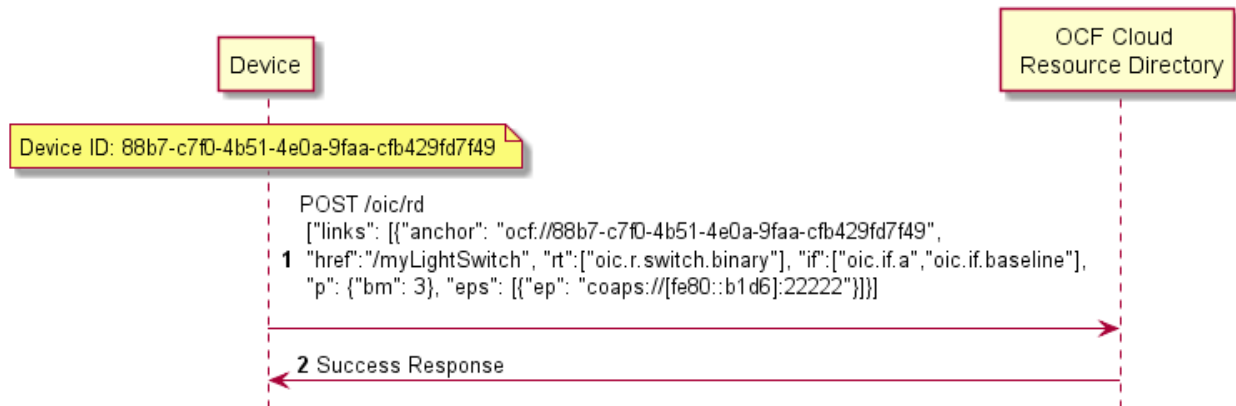
793 On completion of Device Registration the Device shall send an UPDATE to "/oic/sec/session" as
794 defined in clause 13.11 of the ISO/IEC 30118-2:2018 to ensure that the established TLS session
795 is maintained for subsequent interaction with the OCF Cloud Resource Directory as defined in
796 clause 8.2.

797 8.2 Resource Publication

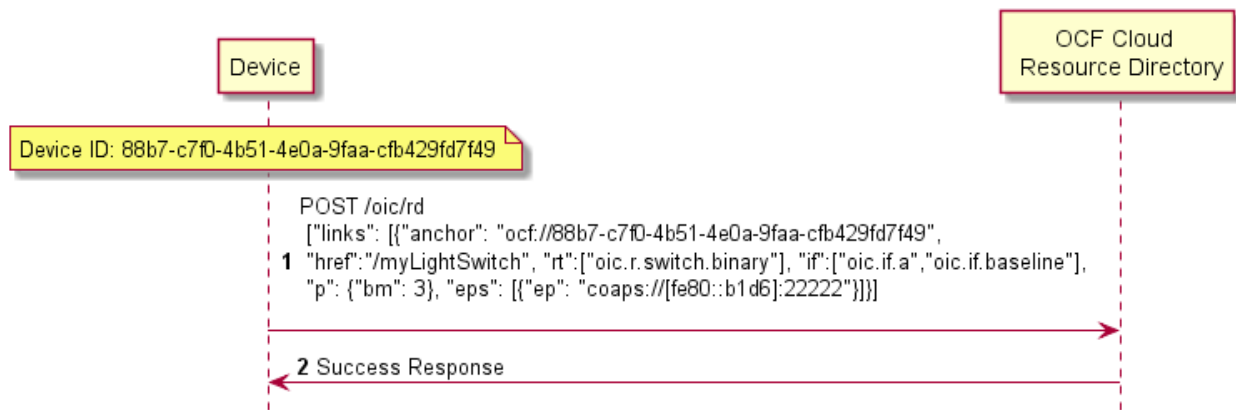
798 An OCF Cloud exposes a Resource Directory as defined in the ISO/IEC 30118-1:2018 clause
799 11.3.6. After a Device is registered with an OCF Cloud, the Device should publish its Resources to
800 the OCF Cloud's Resource Directory following the procedures defined in the ISO/IEC 30118-1:2018
801 clause 11.3.6. The Device and OCF Cloud maintain a persistent TLS connection over which
802 requests received by the OCF Cloud for the Device are routed.

803 The OCF Cloud maintains an internal association between the published Endpoint information from
804 the Device and the Endpoint information that it (the OCF Cloud) exposes in the Links within the
805 OCF Cloud's Resource Directory. The Endpoint exposed by the OCF Cloud for all Resources
806 published to it is that of the OCF Cloud itself and not the publishing Device. These Endpoints use
807 a scheme of "coaps+tcp". The Links within the OCF Cloud's Resource Directory are only identified
808 per the OCF Cloud User Account (User ID). For example, the registered Links are only returned to
809 Client under same User ID with a Server, and not returned to any other Client under a different
810 User ID with the Server.

811 There is potential ambiguity where different instances of Devices from the same vendor (e.g.
812 multiple lights) publish their Resources; this is because the local "href" Link Parameter that is
813 provided to the RD is likely to be the same in each case. In order to avoid this ambiguity, the
814 Resource Directory shall prepend the "href" that is published with the Device ID for the publishing
815 Device. Thus ensuring that all requests received by the OCF Cloud have a unique URI per
816 published Resource.



817
818 Figure 8 provides an example showing the provided Device ID from the Device; Figure 9 shows the
819 pre-pending of the Device ID to the "href" Link Parameter in the Resource Directory itself.



820

821

Figure 8 – Resource publication to the OCF Cloud

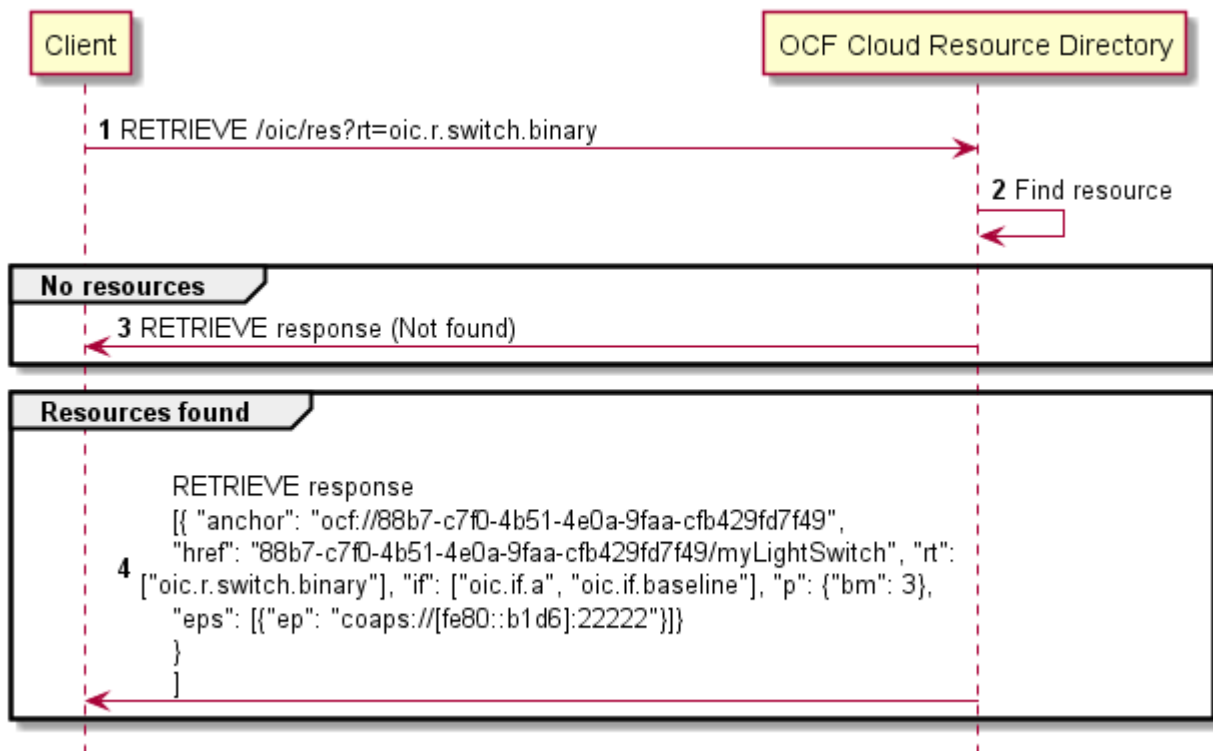
822 **8.3 Client Registration with the OCF Cloud**

823 A Device acting in the Client role follows the same procedures as a Device in the Server role
 824 registering with the OCF Cloud. This Client is associated with a User ID in the same manner in
 825 which a Server is associated with the same User ID

826 **8.4 Resource Discovery**

827 A remote Device may query "/oic/res" to discover Resources published to the OCF Cloud. The OCF
 828 Cloud's Resource Directory responds with Links for the Resources published to the OCF Cloud by
 829 Devices that are registered to the OCF Cloud for the User ID with which the remote Device is
 830 associated. The "eps" Link Parameter in the "/oic/res" response is for the OCF Cloud and not the
 831 publishing Device.

832 Figure 9 provides an illustrative flow for Resource Discovery, note the population of the 'href' for
 833 instance of "oic.r.switch.binary" including the Device ID of the target Device in accordance with 8.2:



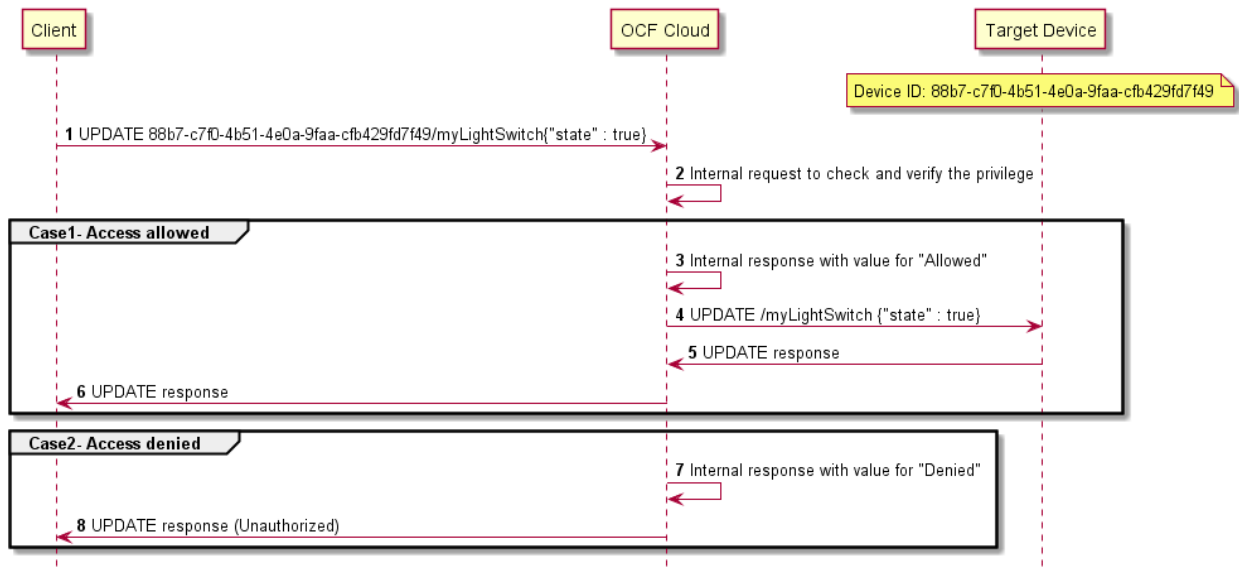
834

835

Figure 9 – Resource discovery through OCF Cloud

836 The OCF Cloud acts as a simple proxy, forwarding the messages to the publishing Devices. The
 837 remote Device sends a RETRIEVE to the OCF Cloud to obtain the content of the Server’s published
 838 Resources, the OCF Cloud will route the message to the target Device after first removing the
 839 Device ID that had been prepended to the ‘href’ Link Parameter by the Cloud RD. Similarly, other
 840 CRUDN operations originated by a Client are routed to the Server via the OCF Cloud. The
 841 publishing Device treats the forwarded request message as a request from the OCF Cloud. The
 842 publishing Device authorises the request as specified in ISO/IEC 30118-2:2018, using the UUID of
 843 the OCF Cloud configured in the "sid" Property of "oic.r.coapcloudconf". The publishing Device
 844 sends a response message to the OCF Cloud, and the OCF Cloud forwards the response to the
 845 Client which sent the corresponding request.

846 Figure 10 illustrates request routing via the OCF Cloud



847

848

Figure 10 – Request routing through OCF Cloud

849 If it is not possible for whatever reason for the OCF Cloud to route a Client request to the Server
 850 that OCF Cloud may reject the request with a final response (e.g. "Service Unavailable").

851 **8.5 Device Deregistration from the OCF Cloud**

852 To deregister from the OCF Cloud the Device first sends a DELETE operation to the
 853 "/oic/sec/account" Resource as defined in the ISO/IEC 30118-2:2018 clause 13.11.

854 Upon completion of deregistration of the Device the OCF Cloud deletes the links for the
 855 deregistered Device from the Resource Directory that is exposed by the OCF Cloud.

856 **9 Security**

857 OCF Cloud shall follow the security requirements captured in the ISO/IEC 30118-2:2018.

858

Annex A (normative)

Swagger2.0 definitions

A.1 List of Resource Type definitions

Table A.1 contains the list of defined resources in this document.

Table A.1 – Alphabetized list of resources

| Friendly Name (informative) | Resource Type (rt) | Clause |
|-----------------------------|-----------------------|--------|
| Resource Directory | "oic.wk.rd" | A.2 |
| CoAP Cloud Configuration | "oic.r.coapcloudconf" | A.3 |

A.2 Resource directory resource

A.2.1 Introduction

Resource to be exposed by any Device that can act as a Resource Directory.
1) Provides selector criteria (e.g., integer) with GET request
2) Publish a Link in /oic/res with POST request

A.2.2 Well-known URI

/oic/rd

A.2.3 Resource type

The Resource Type is defined as: "oic.wk.rd".

A.2.4 OpenAPI 2.0 definition

```
{
  "swagger": "2.0",
  "info": {
    "title": "Resource directory resource",
    "version": "2019-02-22",
    "license": {
      "name": "OCF Data Model License",
      "url":
"https://github.com/openconnectivityfoundation/core/blob/e28a9e0a92e17042ba3e83661e4c0fbce8bdc4ba/LI
CENSE.md",
      "x-copyright": "Copyright 2016-2019 Open Connectivity Foundation, Inc. All rights reserved."
    },
    "termsOfService": "https://openconnectivityfoundation.github.io/core/DISCLAIMER.md"
  },
  "schemes": ["http"],
  "consumes": ["application/json"],
  "produces": ["application/json"],
  "paths": {
    "/oic/rd": {
      "get": {
        "description": "Resource to be exposed by any Device that can act as a Resource
Directory.\n1) Provides selector criteria (e.g., integer) with GET request\n2) Publish a Link in
/oic/res with POST request\n",
        "parameters": [
          {"$ref": "#/parameters/rdgetinterface"}
        ],
        "responses": {
          "200": {
            "description": "Respond with the selector criteria - either the set of attributes or
the bias factor\n",
            "x-example": {
```

```

907         "rt": ["oic.wk.rd"],
908         "if": ["oic.if.baseline"],
909         "sel": 50
910     },
911     "schema": { "$ref": "#/definitions/rdSelection" }
912 }
913 },
914 ],
915 "post": {
916     "description": "Publish the Resource information for the first time in /oic/res. Updates to
917 existing entries are not allowed.\nAppropriates parts of the information, i.e., Links of the
918 published Resources will be discovered through /oic/res.\n1) When a Device first publishes a Link,
919 the request payload to RD may include the Links without an \"ins\" Parameter.\n2) Upon granting the
920 request, the RD assigns a unique instance value identifying the Link among all the Links it
921 advertises\n and sends back the instance value in the \"ins\" Parameter in the Link to the
922 publishing Device.\n",
923     "parameters": [
924         { "$ref": "#/parameters/rdpostinterface" },
925         {
926             "name": "body",
927             "in": "body",
928             "required": true,
929             "schema": { "$ref": "#/definitions/rdPublish" },
930             "x-example": {
931                 "di": "e61c3e6b-9c54-4b81-8ce5-f9039c1d04d9",
932                 "links": [
933                     {
934                         "anchor": "ocf://e61c3e6b-9c54-4b81-8ce5-f9039c1d04d9",
935                         "href": "/myLightSwitch",
936                         "rt": [ "oic.r.switch.binary" ],
937                         "if": [ "oic.if.a", "oic.if.baseline" ],
938                         "p": { "bm": 3 },
939                         "eps": [
940                             { "ep": "coaps://[2001:db8:a::b1d6]:1111", "pri": 2 },
941                             { "ep": "coaps://[2001:db8:a::b1d6]:1122" },
942                             { "ep": "coaps+tcp://[2001:db8:a::123]:2222", "pri": 3 }
943                         ]
944                     },
945                     {
946                         "anchor": "ocf://e61c3e6b-9c54-4b81-8ce5-f9039c1d04d9",
947                         "href": "/myLightBrightness",
948                         "rt": [ "oic.r.brightness" ],
949                         "if": [ "oic.if.a", "oic.if.baseline" ],
950                         "p": { "bm": 3 },
951                         "eps": [
952                             { "ep": "coaps://[2001:db8:a::123]:2222" }
953                         ]
954                     }
955                 ],
956                 "ttl": 600
957             }
958         }
959     ],
960     "responses": {
961         "200": {
962             "description": "Respond with the same schema as publish with the additional \"ins\"
963 Parameter in the Link.\n",
964             "x-example": {
965                 "di": "e61c3e6b-9c54-4b81-8ce5-f9039c1d04d9",
966                 "links": [
967                     {
968                         "anchor": "ocf://e61c3e6b-9c54-4b81-8ce5-f9039c1d04d9",
969                         "href": "/myLightSwitch",
970                         "rt": [ "oic.r.switch.binary" ],
971                         "if": [ "oic.if.a", "oic.if.baseline" ],
972                         "p": { "bm": 3 },
973                         "eps": [
974                             { "ep": "coaps://[2001:db8:a::b1d6]:1111", "pri": 2 },
975                             { "ep": "coaps://[2001:db8:a::b1d6]:1122" },
976                             { "ep": "coaps+tcp://[2001:db8:a::123]:2222", "pri": 3 }
977                         ]
978                     }
979                 ],

```

```

978         "ins": 11235
979     },
980     {
981         "anchor": "ocf://e61c3e6b-9c54-4b81-8ce5-f9039c1d04d9",
982         "href": "/myLightBrightness",
983         "rt": ["oic.r.brightness"],
984         "if": ["oic.if.a", "oic.if.baseline"],
985         "p": {"bm": 3},
986         "eps": [
987             {"ep": "coaps://[2001:db8:a::123]:2222"}
988         ],
989         "ins": 112358
990     }
991 ],
992 "ttl": 600
993 },
994 "schema": { "$ref": "#/definitions/rdPublish" }
995 }
996 }
997 }
998 }
999 },
1000 "parameters": {
1001     "rdgetinterface" : {
1002         "in" : "query",
1003         "name" : "if",
1004         "type" : "string",
1005         "enum" : ["oic.if.baseline"]
1006     },
1007     "rdpostinterface" : {
1008         "in" : "query",
1009         "name" : "if",
1010         "type" : "string",
1011         "enum" : ["oic.if.baseline"]
1012     }
1013 },
1014 "definitions": {
1015     "rdSelection" : {
1016         "properties": {
1017             "rt" : {
1018                 "description": "Resource Type of the Resource",
1019                 "items": {
1020                     "enum": ["oic.wk.rd"],
1021                     "type": "string",
1022                     "maxLength": 64
1023                 },
1024                 "minItems": 1,
1025                 "uniqueItems": true,
1026                 "readOnly": true,
1027                 "type": "array"
1028             },
1029             "n" : {
1030                 "$ref":
1031 "https://openconnectivityfoundation.github.io/core/schemas/oic.common.properties.core-
1032 schema.json#/definitions/n"
1033             },
1034             "sel" : {
1035                 "description": "A bias factor calculated by the Resource Directory",
1036                 "maximum": 100,
1037                 "minimum": 0,
1038                 "readOnly": true,
1039                 "type": "integer"
1040             },
1041             "id" : {
1042                 "$ref":
1043 "https://openconnectivityfoundation.github.io/core/schemas/oic.common.properties.core-
1044 schema.json#/definitions/id"
1045             },
1046             "if" : {
1047                 "description": "The OCF Interfaces supported by this Resource",
1048                 "items": {

```

```

1049         "enum": [
1050             "oic.if.baseline"
1051         ],
1052         "type": "string",
1053         "maxLength": 64
1054     },
1055     "minItems": 1,
1056     "readOnly": true,
1057     "uniqueItems": true,
1058     "type": "array"
1059 }
1060 },
1061 "type" : "object",
1062 "required": ["sel"]
1063 },
1064 "rdPublish" : {
1065     "properties": {
1066         "di" : {
1067             "$ref":
1068 "https://openconnectivityfoundation.github.io/core/schemas/oic.links.properties.core-
1069 schema.json#/definitions/di"
1070         },
1071         "ttl" : {
1072             "description": "Time to indicate a RD, i.e. how long to keep this published item.",
1073             "type": "integer"
1074         },
1075         "links" : {
1076             "description": "A set of simple or individual OCF Links.",
1077             "items": {
1078                 "properties": {
1079                     "anchor": {
1080                         "$ref":
1081 "https://openconnectivityfoundation.github.io/core/schemas/oic.links.properties.core-
1082 schema.json#/definitions/anchor"
1083                     },
1084                     "di": {
1085                         "$ref":
1086 "https://openconnectivityfoundation.github.io/core/schemas/oic.links.properties.core-
1087 schema.json#/definitions/di"
1088                     },
1089                     "eps": {
1090                         "$ref":
1091 "https://openconnectivityfoundation.github.io/core/schemas/oic.links.properties.core-
1092 schema.json#/definitions/eps"
1093                     },
1094                     "href": {
1095                         "$ref":
1096 "https://openconnectivityfoundation.github.io/core/schemas/oic.links.properties.core-
1097 schema.json#/definitions/href"
1098                     },
1099                     "if": {
1100                         "description": "The interface set supported by the published resource",
1101                         "items": {
1102                             "enum": [
1103                                 "oic.if.baseline",
1104                                 "oic.if.ll",
1105                                 "oic.if.b",
1106                                 "oic.if.rw",
1107                                 "oic.if.x",
1108                                 "oic.if.a",
1109                                 "oic.if.s"
1110                             ],
1111                             "type": "string",
1112                             "maxLength": 64
1113                         },
1114                         "minItems": 1,
1115                         "uniqueItems": true,
1116                         "type": "array"
1117                     },
1118                     "ins": {
1119                         "$ref":

```

```

1120 "https://openconnectivityfoundation.github.io/core/schemas/oic.links.properties.core-
1121 schema.json#/definitions/ins"
1122     },
1123     "p": {
1124         "$ref":
1125 "https://openconnectivityfoundation.github.io/core/schemas/oic.links.properties.core-
1126 schema.json#/definitions/p"
1127     },
1128     "rel": {
1129         "description": "The relation of the target URI referenced by the Link to the context
1130 URI",
1131         "oneOf": [
1132             {
1133                 "default": [
1134                     "hosts"
1135                 ],
1136                 "items": {
1137                     "maxLength": 64,
1138                     "type": "string"
1139                 },
1140                 "minItems": 1,
1141                 "type": "array"
1142             },
1143             {
1144                 "default": "hosts",
1145                 "maxLength": 64,
1146                 "type": "string"
1147             }
1148         ]
1149     },
1150     "rt": {
1151         "description": "Resource Type of the published Resource",
1152         "items": {
1153             "maxLength": 64,
1154             "type": "string"
1155         },
1156         "minItems": 1,
1157         "maxItems": 1,
1158         "uniqueItems": true,
1159         "type": "array"
1160     },
1161     "title": {
1162         "$ref":
1163 "https://openconnectivityfoundation.github.io/core/schemas/oic.links.properties.core-
1164 schema.json#/definitions/title"
1165     },
1166     "type": {
1167         "$ref":
1168 "https://openconnectivityfoundation.github.io/core/schemas/oic.links.properties.core-
1169 schema.json#/definitions/type"
1170     }
1171 },
1172 "required": [
1173     "href",
1174     "rt",
1175     "if"
1176 ],
1177 "type": "object"
1178 },
1179 "type": "array"
1180 }
1181 },
1182 "type": "object",
1183 "required": ["di", "links", "ttl"]
1184 }
1185 }
1186 }
1187

```

1188 **A.2.5 Property definition**

1189 Table A-2 defines the Properties that are part of the "oic.wk.rd" Resource Type.

1190 **Table A-2 – The Property definitions of the Resource with type "rt" = "oic.wk.rd".**

| Property name | Value type | Mandatory | Access mode | Description |
|---------------|----------------------------|-----------|-------------|---|
| rt | array: see schema | No | Read Only | Resource Type of the Resource. |
| n | multiple types: see schema | No | Read Write | |
| sel | integer | Yes | Read Only | A bias factor calculated by the Resource Directory. |
| id | multiple types: see schema | No | Read Write | |
| if | array: see schema | No | Read Only | The OCF Interfaces supported by this Resource. |
| di | multiple types: see schema | Yes | Read Write | |
| ttl | integer | Yes | Read Write | Time to indicate a RD, i.e. how long to keep this published item. |
| links | array: see schema | Yes | Read Write | A set of simple or individual OCF Links. |

1191 **A.2.6 CRUDN behaviour**

1192 Table A-3 defines the CRUDN operations that are supported on the "oic.wk.rd" Resource Type.

1193 **Table A-3 – The CRUDN operations of the Resource with type "rt" = "oic.wk.rd".**

| Create | Read | Update | Delete | Notify |
|--------|------|--------|--------|---------|
| | get | post | | observe |

1194 **A.3 CoAP Cloud Configuration Resource**

1195 **A.3.1 Introduction**

1196 The CoAPCloudConf Resource exposes configuration information for connecting to an OCF Cloud.
1197

1198 **A.3.2 Example URI**

1199 /CoAPCloudConfResURI

1200 **A.3.3 Resource type**

1201 The Resource Type is defined as: "oic.r.coapcloudconf".

1202 **A.3.4 OpenAPI 2.0 definition**

```
1203 {
1204   "swagger": "2.0",
1205   "info": {
1206     "title": "CoAP Cloud Configuration Resource",
1207     "version": "20190327",
1208     "license": {
```

```

1209     "name": "OCF Data Model License",
1210     "url":
1211 "https://github.com/openconnectivityfoundation/core/blob/e28a9e0a92e17042ba3e83661e4c0fbce8bdc4ba/LI
1212 CENSE.md",
1213     "x-copyright": "Copyright 2018-2019 Open Connectivity Foundation, Inc. All rights reserved."
1214   },
1215   "termsOfService": "https://openconnectivityfoundation.github.io/core/DISCLAIMER.md"
1216 },
1217 "schemes": ["http"],
1218 "consumes": ["application/json"],
1219 "produces": ["application/json"],
1220 "paths": {
1221   "/CoAPCloudConfResURI?if=oic.if.rw" : {
1222     "get": {
1223       "description": "The CoAPCloudConf Resource exposes configuration information for connecting
1224 to an OCF Cloud.\n",
1225       "parameters": [
1226         { "$ref": "#/parameters/interface-all" }
1227       ],
1228       "responses": {
1229         "200": {
1230           "description": "",
1231           "x-example":
1232             {
1233               "rt": ["oic.r.coapcloudconf"],
1234               "apn": "github",
1235               "cis": "coaps+tcp://example.com:443",
1236               "sid": "987e6543-a21f-10d1-a112-421345746237",
1237               "clec": 0
1238             },
1239           "schema": { "$ref": "#/definitions/CoAPCloudConf" }
1240         }
1241       }
1242     },
1243     "post": {
1244       "description": "Update properties of the CoAPCloudConf Resource.\n",
1245       "parameters": [
1246         { "$ref": "#/parameters/interface-all" },
1247         {
1248           "name": "body",
1249           "in": "body",
1250           "required": true,
1251           "schema": { "$ref": "#/definitions/CoAPCloudConfUpdate" },
1252           "x-example":
1253             {
1254               "at": "0f3d9f7fe5491d54077d",
1255               "apn": "github",
1256               "cis": "coaps+tcp://example.com:443",
1257               "sid": "987e6543-a21f-10d1-a112-421345746237"
1258             }
1259         }
1260       ],
1261       "responses": {
1262         "200": {
1263           "description": "",
1264           "x-example":
1265             {
1266               "apn": "github",
1267               "cis": "coaps+tcp://example.com:443",
1268               "sid": "987e6543-a21f-10d1-a112-421345746237",
1269               "clec": 0
1270             },
1271           "schema": { "$ref": "#/definitions/CoAPCloudConf" }
1272         }
1273       }
1274     }
1275   },
1276   "/CoAPCloudConfResURI?if=oic.if.baseline" : {
1277     "get": {
1278       "description": "The CoAPCloudConf Resource exposes configuration information for connecting
1279 to an OCF Cloud.\n",

```



```

1280     "parameters": [
1281       { "$ref": "#/parameters/interface-all" }
1282     ],
1283     "responses": {
1284       "200": {
1285         "description": "",
1286         "x-example":
1287           {
1288             "rt": ["oic.r.coapcloudconf"],
1289             "if": ["oic.if.rw", "oic.if.baseline"],
1290             "apn": "github",
1291             "cis": "coaps+tcp://example.com:443",
1292             "sid": "987e6543-a21f-10d1-a112-421345746237",
1293             "clec": 0
1294           },
1295         "schema": { "$ref": "#/definitions/CoAPCloudConf" }
1296       }
1297     },
1298   },
1299   "post": {
1300     "description": "Update Properties of the CoAPCloudConf Resource.\n",
1301     "parameters": [
1302       { "$ref": "#/parameters/interface-all" },
1303       {
1304         "name": "body",
1305         "in": "body",
1306         "required": true,
1307         "schema": { "$ref": "#/definitions/CoAPCloudConfUpdate" },
1308         "x-example":
1309           {
1310             "at": "0f3d9f7fe5491d54077d",
1311             "apn": "github",
1312             "cis": "coaps+tcp://example.com:443",
1313             "sid": "987e6543-a21f-10d1-a112-421345746237"
1314           }
1315       }
1316     ],
1317     "responses": {
1318       "200": {
1319         "description": "",
1320         "x-example":
1321           {
1322             "apn": "github",
1323             "cis": "coaps+tcp://example.com:443",
1324             "sid": "987e6543-a21f-10d1-a112-421345746237",
1325             "clec": 0
1326           },
1327         "schema": { "$ref": "#/definitions/CoAPCloudConf" }
1328       }
1329     }
1330   }
1331 },
1332 },
1333 "parameters": {
1334   "interface-all": {
1335     "in": "query",
1336     "name": "if",
1337     "type": "string",
1338     "enum": ["oic.if.rw", "oic.if.baseline"]
1339   }
1340 },
1341 "definitions": {
1342   "CoAPCloudConf": {
1343     "properties": {
1344       "rt": {
1345         "description": "Resource Type of the Resource",
1346         "items": {
1347           "enum": ["oic.r.coapcloudconf"],
1348           "type": "string",
1349           "maxLength": 64
1350         }
1351       }
1352     }
1353   }
1354 }

```

```

1351         "minItems": 1,
1352         "uniqueItems": true,
1353         "readOnly": true,
1354         "type": "array"
1355     },
1356     "n" : {
1357         "$ref":
1358 "https://openconnectivityfoundation.github.io/core/schemas/oic.common.properties.core-
1359 schema.json#/definitions/n"
1360     },
1361     "cis" : {
1362         "description": "URL of OCF Cloud",
1363         "format": "uri",
1364         "type": "string"
1365     },
1366     "apn" : {
1367         "description": "The Authorisation Provider through which an Access Token was obtained.",
1368         "type": "string"
1369     },
1370     "sid" : {
1371         "$ref": "http://openconnectivityfoundation.github.io/core/schemas/oic.types-
1372 schema.json#/definitions/uuid"
1373     },
1374     "clec" : {
1375         "description": "Last Error Code during Cloud Provisioning (0: No Error, 1: Error response
1376 from the OCF Cloud, 2: Failed to connect to the OCF Cloud, 3: Failed to refresh Access Token, 4~254:
1377 Reserved, 255: Unknown error)",
1378         "enum": [
1379             0,
1380             1,
1381             2,
1382             3,
1383             255
1384         ],
1385         "readOnly": true
1386     },
1387     "id" : {
1388         "$ref":
1389 "https://openconnectivityfoundation.github.io/core/schemas/oic.common.properties.core-
1390 schema.json#/definitions/id"
1391     },
1392     "if" : {
1393         "description": "The OCF Interfaces supported by this Resource",
1394         "items": {
1395             "enum": [
1396                 "oic.if.rw",
1397                 "oic.if.baseline"
1398             ],
1399             "type": "string",
1400             "maxLength": 64
1401         },
1402         "minItems": 2,
1403         "uniqueItems": true,
1404         "readOnly": true,
1405         "type": "array"
1406     }
1407 },
1408 "type" : "object",
1409 "required":["cis", "sid"]
1410 },
1411 "CoAPCloudConfUpdate" : {
1412     "properties": {
1413         "cis" : {
1414             "description": "URL of OCF Cloud",
1415             "format": "uri",
1416             "type": "string"
1417         },
1418         "apn" : {
1419             "description": "The Authorisation Provider through which an Access Token was obtained.",
1420             "type": "string"
1421         },

```

```

1422     "at" : {
1423         "description": "Access Token which is returned by an Authorisation Provider or OCF
1424 Cloud.",
1425         "type": "string"
1426     },
1427     "sid" : {
1428         "$ref": "http://openconnectivityfoundation.github.io/core/schemas/oic.types-
1429 schema.json#/definitions/uuid"
1430     }
1431 },
1432 "type" : "object",
1433 "required":["cis", "at", "sid"]
1434 }
1435 }
1436 }
1437

```

1438 A.3.5 Property definition

1439 Table A.4 defines the Properties that are part of the "oic.r.coapcloudconf" Resource Type.

1440 **Table A.4 – The Property definitions of the Resource with type "rt" = "oic.r.coapcloudconf".**

| Property name | Value type | Mandatory | Access mode | Description |
|---------------|----------------------------|-----------|-------------|---|
| sid | multiple types: see schema | Yes | Read Write | |
| rt | array: see schema | No | Read Only | Resource Type of the Resource. |
| id | multiple types: see schema | No | Read Write | |
| n | multiple types: see schema | No | Read Write | |
| cis | string | Yes | Read Write | URL of OCF Cloud. |
| apn | string | No | Read Write | The Authorisation Provider through which an Access Token was obtained. |
| if | array: see schema | No | Read Only | The OCF Interfaces supported by this Resource. |
| clcc | multiple types: see schema | No | Read Only | Last Error Code during Cloud Provisioning (0: No Error, 1: Error response from the OCF Cloud, 2: Failed to connect to the OCF Cloud, 3: Failed to refresh Access Token, 4~254: Reserved, 255: Unknown error). |
| sid | multiple types: see schema | Yes | Read Write | |
| at | string | Yes | Read Write | Access Token which is returned by an Authorisation Provider or OCF Cloud. |
| apn | string | No | Read Write | The Authorisation Provider through |

| | | | | |
|-----|--------|-----|------------|-------------------------------------|
| | | | | which an Access Token was obtained. |
| cis | string | Yes | Read Write | URL of OCF Cloud. |

1441 **A.3.6 CRUDN behaviour**

1442 Table A.5 defines the CRUDN operations that are supported on the "oic.r.coapcloudconf" Resource
 1443 Type.

1444 **Table A.5 – The CRUDN operations of the Resource with type "rt" = "oic.r.coapcloudconf".**

| Create | Read | Update | Delete | Notify |
|--------|------|--------|--------|---------|
| | get | post | | observe |

1445