OCF Core Specification Extension
CoAP Native Cloud

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1 Scope

This specification defines functional extensions to the capabilities defined in the OCF Core Specification to meet the requirements of the OCF Cloud. This specification specifies new Resource Types to enable the functionality and any extensions to the existing capabilities defined in the OCF Core Specification.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

OCF Core Specification, *Open Connectivity Foundation Core Specification*, Version 1.3
Available at: https://openconnectivity.org/specs/OCF_Core_Specification_v1.3.0.pdf
Latest version available at: https://openconnectivity.org/specs/OCF_Core_Specification.pdf

OCF Security Specification, *Open Connectivity Foundation Security Capabilities*, Version 1.3
Available at: https://openconnectivity.org/specs/OCF_Security_Specification_v1.3.0.pdf
Latest version available at: https://openconnectivity.org/specs/OCF_Security_Specification.pdf

OCF Core Specification Extension-Wi-Fi Easy Setup, *Open Connectivity Foundation Wi-Fi Easy Setup Specification*, Version 1.3
Available at: https://openconnectivity.org/specs/OCF_Core_Specification_Extension_Wi-Fi_Easy_Setup_v1.3.0.pdf
Latest version available at:
https://openconnectivity.org/specs/OCF_Core_Specification_Extension_Wi-Fi_Easy_Setup.pdf

IEEE 802.11:2016, IEEE Standard for Information technology—Telecommunications and information exchange between systems Local and metropolitan area networks—Specific requirements - Part 11: Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) Specifications, December 2016

https://standards.ieee.org/findstds/standard/802.11-2016.html

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

IETF RFC 7159, *The JavaScript Object Notation (JSON) Data Interchange Format*, March 2014 https://www.rfc-editor.org/info/rfc7159

IETF RFC 7252, *The Constrained Application Protocol (CoAP)*, June 2014 https://www.rfc-editor.org/info/rfc7252

JSON Schema Validation, *JSON Schema: interactive and non-interactive validation*, January 2013 http://json-schema.org/latest/json-schema-validation.html

OpenAPI specification, *aka Swagger RESTful API Documentation Specification*, Version 2.0 https://github.com/OAI/OpenAPI-Specification/blob/master/versions/2.0.md

3 Terms, definitions, symbols and abbreviations

All terms and definitions as defined in the OCF Core Specification also apply to this specification.

3.1 Terms and definitions

As defined in the OCF Core Specification and OCF Security Specification with the following additions

3.1.1

Cloud Provider

entity or organization that hosts an OCF Cloud.

3.1.2

OCF Cloud

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

3.2 Symbols and abbreviations

3.2.1

UX

User Experience

3.3 Conventions

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

3.4 Data types

As defined in the OCF Core Specification.

4 Document conventions and organization

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

Required (or shall or mandatory)(M).

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

Recommended (or should)(S).

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

Allowed (may or allowed)(O).

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

DEPRECATED.

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

Conditionally allowed (CA)

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

Conditionally required (CR)

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

Strings that are to be taken literally are enclosed in “double quotes”.

Words that are emphasized are printed in italic.

5 Overview

5.1 Introduction

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

- CoAP over TCP protocol defined in OCF Core Specification
- Resource Directory defined in OCF Core Specification Section
- The requirements within this specification
- Security requirements and SVRs defined within the OCF Security Specification

Devices which are not within a single local network may interact with each other using CoAP over TCP (see OCF Core Specification) via an OCF Cloud. At any point in time, a Device is configured to use at most one OCF Cloud. The OCF Cloud groups Devices that belong to same OCF Cloud User under an OCF Cloud created User ID. All the Devices registered to the OCF Cloud and belonging to the same User ID can communicate with each other subject to the Device(s) authorising the OCF Cloud in the ACE2 policies.

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

5.2 Interaction Flow

This section describes how the elements with the overall OCF Cloud interact. Figure 1 provides an overall introduction:

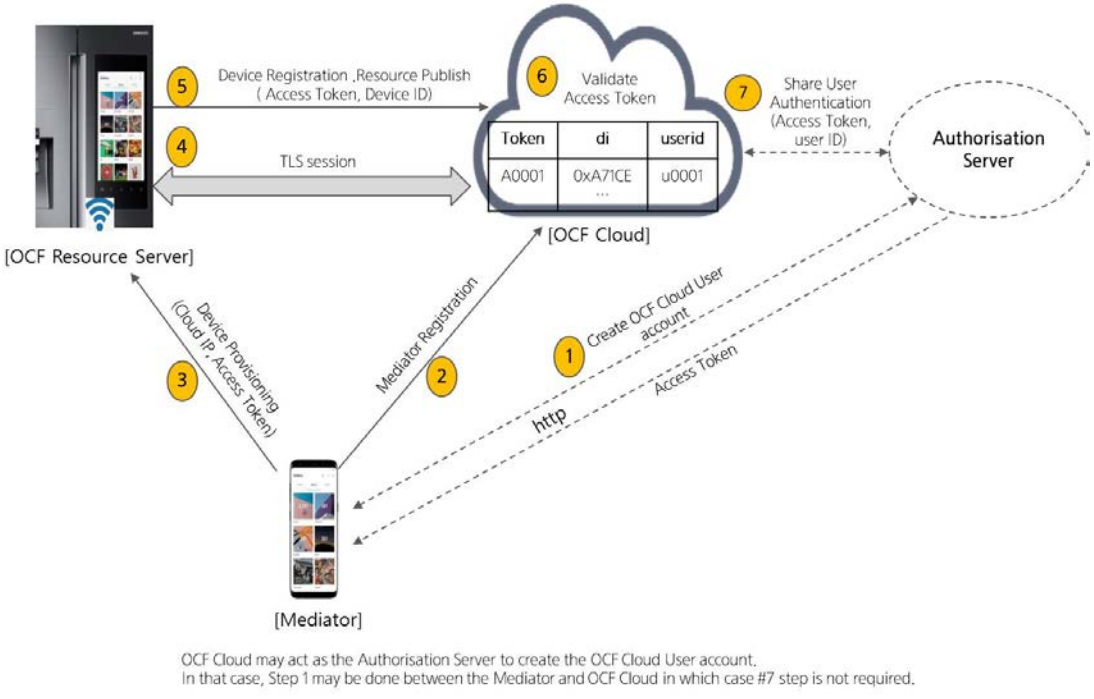


Figure 1 OCF Cloud deployment architecture

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.

Table 1 OCF Cloud Deployment Flow

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

- an account server function which is a logical entity that handles Device registration, Access Token validation and handles sign-in and token-refresh requests from the Device.
- a Resource Directory as defined by the OCF Core Specification. The Resource Directory exposes Resource information published by Devices. A Client, when discovering Devices, receives a response from the Resource Directory on behalf of the Device. With information included in the response from the Resource Directory, the Client may connect to the Device via the OCF Cloud.

5.3 Cloud Operational Flow

The following sub-sections provide an informative overview of the flow which results on a Device being registered with an OCF Cloud and Client interaction with that Device. The sections provide references to the applicable Sections within this Specification and other Specifications that provide normative details.

The flow consists of the following high-level steps:

- Pre-requisites and OCF Cloud User account creation (Section 5.3.1)
- Mediator registration with the OCF Cloud (Section 5.3.2)
- Device provisioning by the Mediator (Section 5.3.3)
- Device registration with the OCF Cloud (Section 5.3.4)
- Device connection with the OCF Cloud (Section 5.3.5)
- Devices Publishing Links to the OCF Cloud RD (Section 5.3.6)
- Client to Server communication through the OCF Cloud (Section 5.3.7)
- Device refreshing connection with the OCF Cloud (Section 5.3.8)
- Device closing connection with the OCF Cloud (Section 5.3.9)
- Device de-registering from the OCF Cloud (Section 5.3.10)

5.3.1 Pre-requisites and OCF Cloud User Account Creation

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

The Device is onboarded to the OCF Network as defined in the OCF Security Specification.

The OCF Cloud User downloads a Mediator onto their personal device (e.g. phone) which will be used to provision the Device. The Mediator is configured with or through some out of band

process to obtain the URL of the OCF Cloud (e.g. the Mediator may be an application from the Cloud Provider).

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

5.3.2 Mediator registration with the OCF Cloud

See Sections 8.1.2.2, 0

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

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

5.3.3 Device provisioning by the Mediator

See Section 8.1.2.3; see also OCF Security Specification Section 7.5.1

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

5.3.4 Device Registration with the OCF Cloud.

See Sections 8.1.3, 8.1.4; see also OCF Security Specification Sections 10.4, 13.10

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

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

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

The Device is now registered with the OCF Cloud.

5.3.5 Connection with the OCF Cloud

See Section 8.1.4, see also OCF Security Specification Section 13.11

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

5.3.6 Publishing Links to the OCF Cloud RD

See Section 8.2; see also OCF Security Specification Section 10.4

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

5.3.7 Client to Server communication through the OCF Cloud

See Sections 0, 8.4; see also OCF Security Specification Section 10.4

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

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

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

5.3.8 Refreshing connection with the OCF Cloud

See OCF Security Specification Section 13.12

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

5.3.9 Closing connection with the OCF Cloud

See OCF Security Specification Section 13.11

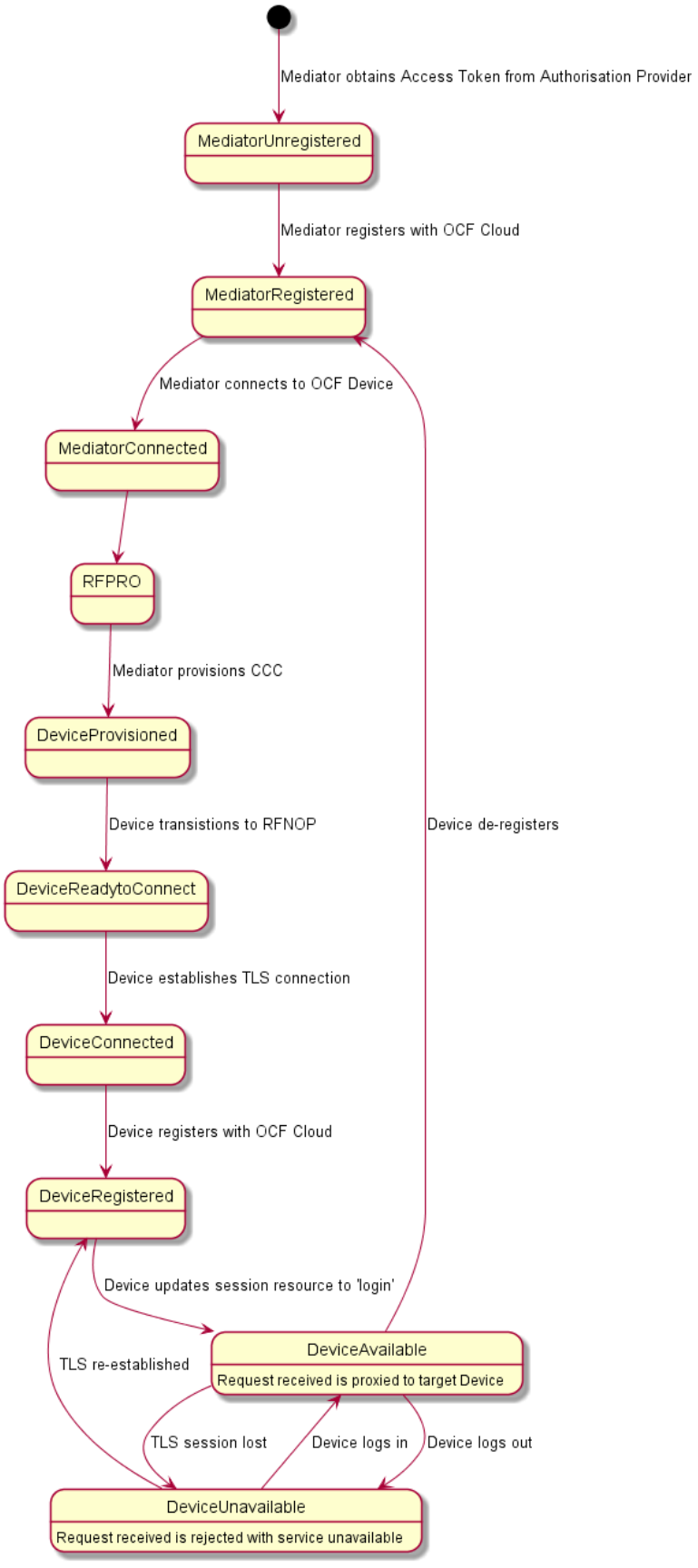
To log out of the OCF Cloud the Device sends an UPDATE request to the Session Resource indicating a “login” status of “false”. This does not delete or remove any of the Device Registration information. The Device may log back into the OCF Cloud at any point prior to expiration of the Access Token.

5.3.10 Deregistering from the OCF Cloud

See Section 8.5; see also OCF Security Specification Section 13.10

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

To connect to the OCF Cloud again, the Device has to re-follow the flow starting with Mediator provisioning (see Section 5.3.3).



335 Cloud Operational State Machine

Figure 2 Overall Operational State Machine captures the state machine that is described by the informative operation flow provided in Section 5.3

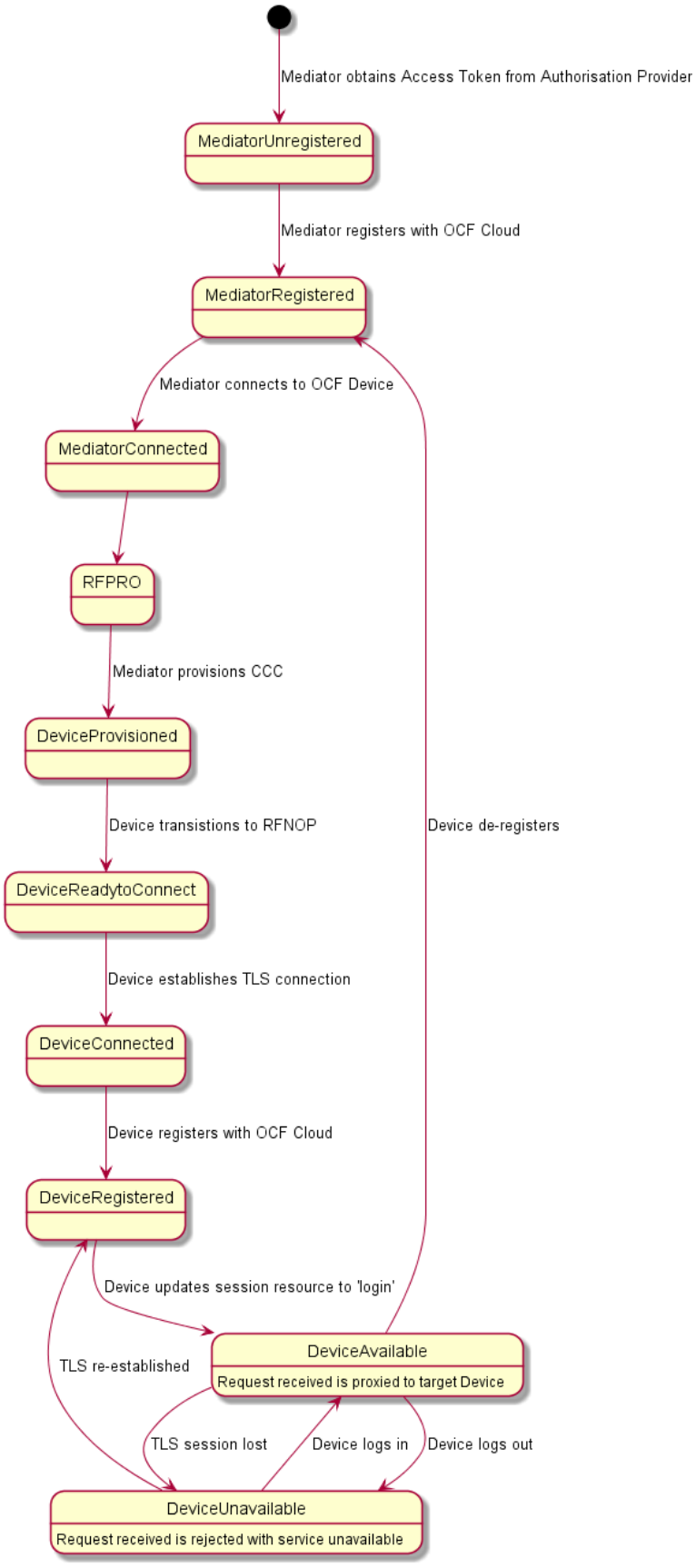


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Figure 2 Overall Operational State Machine

6 Resource model

6.1 CoAPCloudConf Resource

6.1.1 Introduction

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

The CoAPCloudConf Resource shall expose only secure Endpoints (e.g. CoAPS); see the OCF Core Specification, Section 10.

6.1.2 Resource Definition

The CoAPCloudConf Resource is as defined in Table 2.

Table 2 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 3.	

Table 3 defines the details for the "oic.r.coapcloudconf" Resource Type.

Table 3 oic.r.coapcloudconf Resource Type definition

Property title	Property name	Value type	Value rule	Unit	Access mode	Mandatory	Description
Auth Provider Name	apn	String			RW	No	The name of the Authorisation Provider through which access token was obtained.
OCF Cloud interface URL	cis	String	uri		RW	Yes	URL of OCF Cloud.
Access Token	at	String	The Access Token is a string of at least one character		W[1]	Yes (in an UPDATE only)	Access token which is returned by an Authorisation Provider or OCF Cloud.
OCF Cloud UUID	sid	uuid			RW	Yes	The identity of the OCF Cloud
Last Error Code during	clec	integer	enum		R	No	0: No Error, 1: Error response from the OCF Cloud,

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

Cloud Provisioning							2: Failed to connect to the OCF Cloud, 3: Failed to refresh Access Token, 4~254: Reserved, 255: Unknown error

If the “clec” Property is implemented by a Device it shall have an initial value of “0” (“No error”).

6.1.3 Error Handling

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

• The Device shall set the “clec” Property to 1 if it receives an error response from the OCF Cloud (e.g. error response from the Cloud).

• The Device shall set the “clec” Property to 2 if there is a failure to connect to the OCF Cloud (e.g. no reply, timeout, or timeout).

• The Device shall set the “clec” Property to 3 if it fails to refresh the Access Token (e.g. if it receives an error response during the token refresh procedure).

7 Network and connectivity

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

8 Functional interactions

8.1 Onboarding, Provisioning, and Configuration

8.1.1 Overview

Figure 3 Registration with OCF Cloud below provides an overview of the interaction between the different entities to get the Device registered with the OCF Cloud. Details with respect to the flow are presented in the following Sections. A summary of the flow is provided in Table 4:

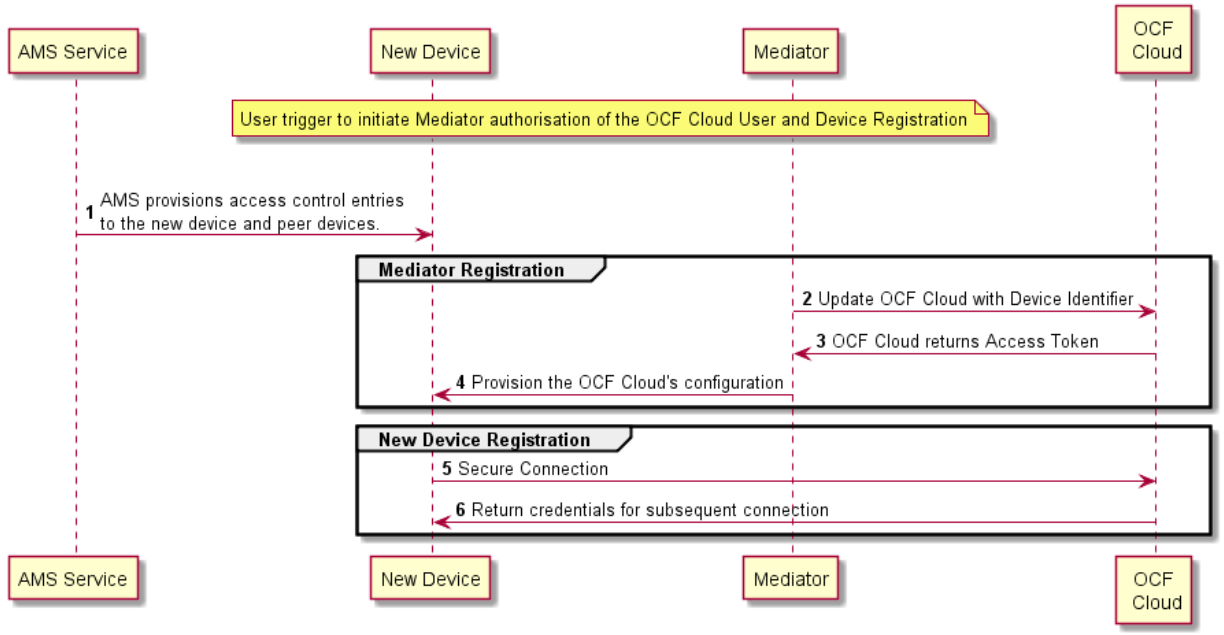

Figure 3 Registration with OCF Cloud

Steps	Description
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.

Table 4 Device - OCF Cloud Registration Flow

8.1.2 Use of Mediator

8.1.2.1 Introduction

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

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

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

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

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

8.1.2.2 OCF Cloud User Authorisation of the Mediator

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

A user authorisation mechanism is used to achieve the following:

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

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

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

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

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

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

8.1.2.3 Device Provisioning by the Mediator

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

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

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

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

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

See OCF Security Specification Section 7.5.1 for details on the population of ACE2 entries on the Device to allow CRUDN operations from the Mediator and OCF Cloud.

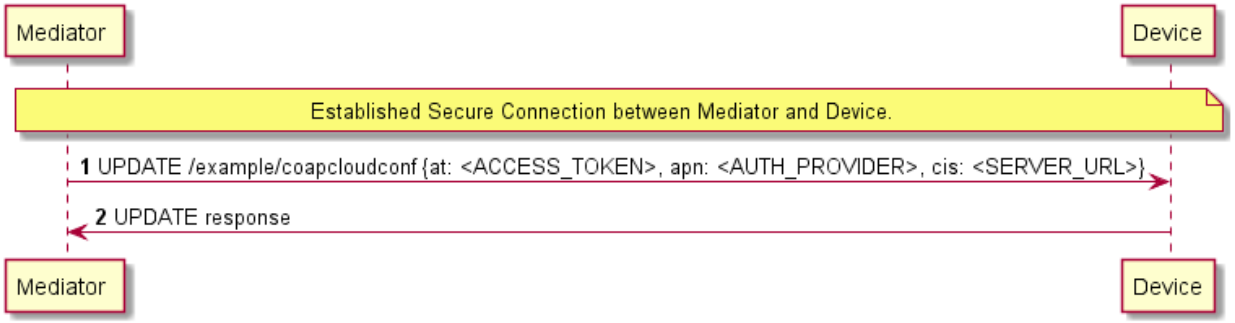

Figure 4 Device Provisioning by the Mediator

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

Table 5 Device Provisioning by the Mediator

Please see OCF Security Specification Section 7.5.1 for further details on the mapping of Properties between the Device and OCF Cloud.

8.1.3 Device Connection to the OCF Cloud

On conclusion of Device provisioning as defined in Section 8.1.2.3 and after transitioning to a state of RFNOP (if not already in RFNOP) the Device shall establish a TLS connection with the OCF Cloud as defined in the OCF Security Specification Section 10.4. Further see the OCF Security Specification Section 10.4.3 for additional security considerations.

If authentication of the TLS session being established as defined in the OCF Security Specification fails, the “clec” Property of the “oic.r.coapcloudconf” Resource on the Device (if supported) shall be updated about the failed state. If authentication succeeds, the Device and OCF Cloud establish an encrypted link in accordance with the negotiated cipher suite. Further, if the TLS connection is lost due to a failure the “clec” Property of the “oic.r.coapcloudconf” Resource on the Device (if supported) should be updated about the failed state (value of “2”).

If the TLS connection is lost either via a failure or closed by the OCF Cloud then it may be re-established by following the procedures in the OCF Security Specification Section 10.4. A Device may automatically attempt to re-establish the TLS connection, alternatively a Device may require some user trigger to initiate the re-establishment of the TLS connection.

8.1.4 Device Registration with the OCF Cloud

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

After the TLS connection is established with the OCF Cloud, the Device shall register with the OCF Cloud by sending an UPDATE request to “/oic/sec/account” as defined in Section 13.10 of the OCF Security Specification. The OCF Cloud consequently associates the TLS connection with the corresponding “uid” and “di” Properties populated in the “/oic/sec/account/” Resource. Any other Device registering with the OCF Cloud is assigned the same User ID by the OCF Cloud when registering with any Mediator associated with that User ID. Device Registration permits a Client to access Resources on the OCF Cloud which are associated with the same User ID as the Client.

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

If the UPDATE operation is accepted by the OCF Cloud, the OCF Cloud responds as defined in Section 13.10 of the OCF Security Specification.

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

On completion of Device Registration the Device shall send an UPDATE to “/oic/sec/session” as defined in Section 13.11 of the OCF Security Specification to ensure that the established TLS session is maintained for subsequent interaction with the OCF Cloud Resource Directory as defined in Section 8.2.

8.2 Resource Publication

An OCF Cloud exposes a Resource Directory as defined in the OCF Core Specification Section 11.3.6. After a Device is registered with an OCF Cloud, the Device should publish its Resources to the OCF Cloud's Resource Directory following the procedures defined in the OCF Core Specification Section 11.3.6. The Device and OCF Cloud maintain a persistent TLS connection over which requests received by the OCF Cloud for the Device are routed.

The OCF Cloud maintains an internal association between the published Endpoint information from the Device and the Endpoint information that it (the OCF Cloud) exposes in the Links within the OCF Cloud's Resource Directory. The Endpoint exposed by the OCF Cloud for all Resources published to it is that of the OCF Cloud itself and not the publishing Device. These Endpoints use a scheme of "coaps+tcp".

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

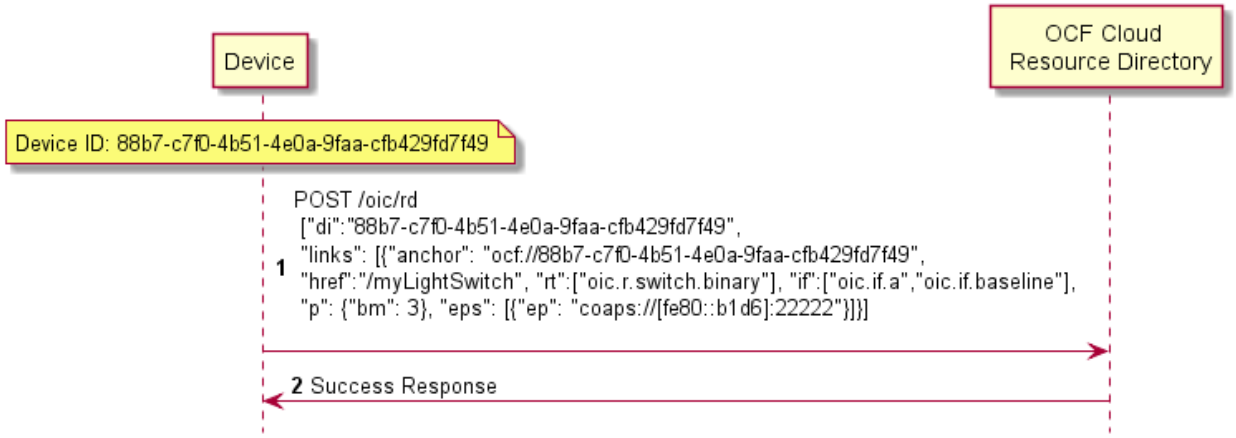

Figure 5 Resource publication to the OCF Cloud for an example showing the provided Device ID from the Device; Figure 6 Resource discovery through OCF Cloud shows the pre-pending of the Device ID to the 'href' Link Parameter in the Resource Directory itself.

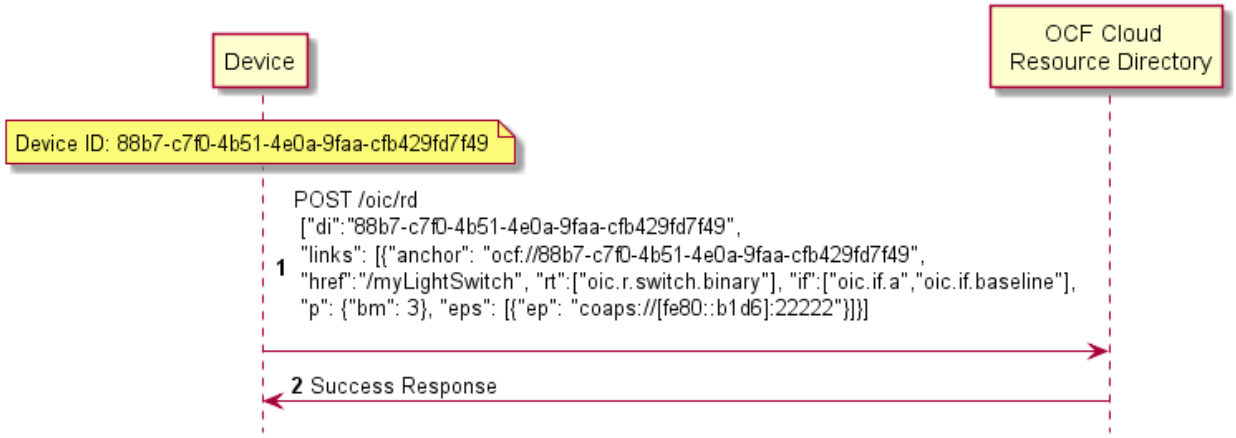

Figure 5 Resource publication to the OCF Cloud

8.3 Client Registration with the OCF Cloud

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

8.4 Resource Discovery

A remote Device may query "/oic/res" to discover Resources published to the OCF Cloud. The OCF Cloud's Resource Directory responds with Links for the Resources published to the OCF

Cloud by Devices that are registered to the OCF Cloud for the User ID with which the remote Device is associated. The “eps” Link Parameter in the “/oic/res” response are for the OCF Cloud and not the publishing Device.

See Figure 6 Resource discovery through OCF Cloud for an illustrative flow for Resource Discovery, note the population of the ‘href’ for instance of “oic.r.switch.binary” including the Device ID of the target Device in accordance with section 8.2:

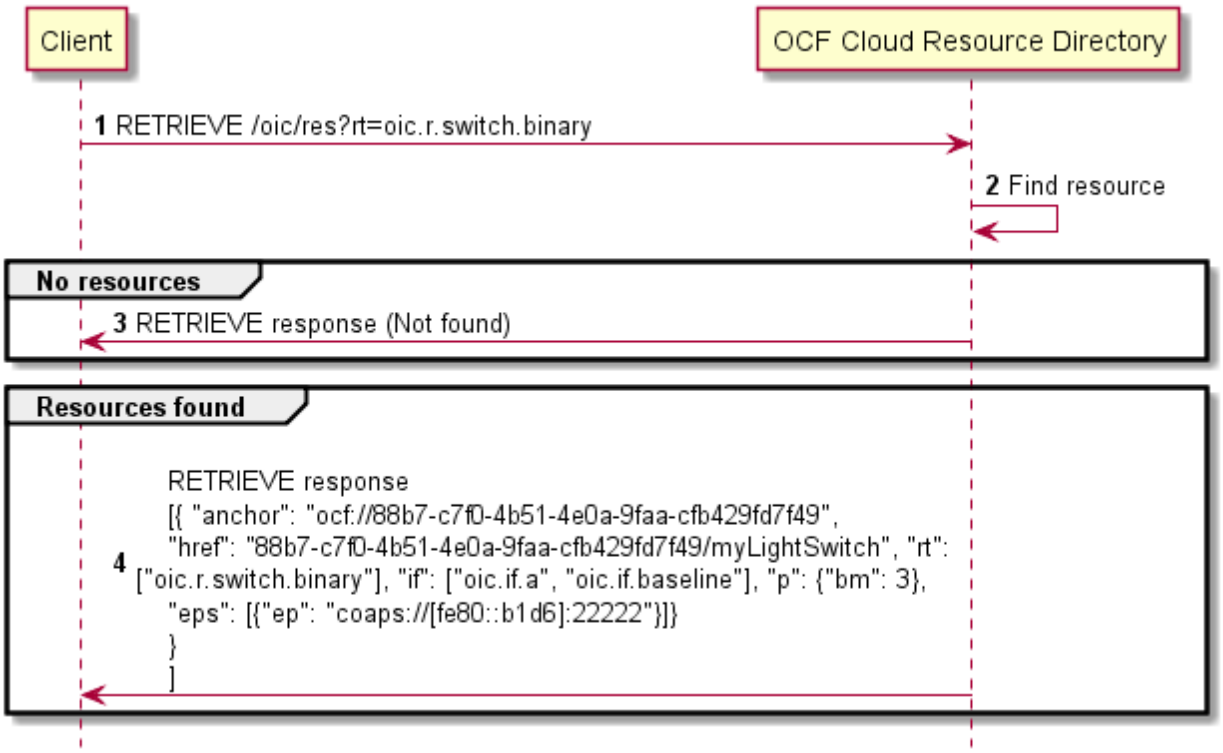

Figure 6 Resource discovery through OCF Cloud

The OCF Cloud acts as a simple proxy, forwarding the messages to the publishing Devices. The remote Device sends a RETRIEVE to the OCF Cloud to obtain the content of the Server’s published Resources, the OCF Cloud will route the message to the target Device after first removing the Device ID that had been preprended to the ‘href’ Link Parameter by the Cloud RD. Similarly, other CRUDN operations originated by a Client are routed to the Server via the OCF Cloud. The publishing Device treats the forwarded request message as a request from the OCF Cloud. The publishing Device authorises the request as specified in the OCF Security Specification, using the UUID of the OCF Cloud configured in the "sid" Property of "oic.r.coapcloudconf". The publishing Device sends a response message to the OCF Cloud, and the OCF Cloud forwards the response to the Client which sent the corresponding request.

Figure 7 Request routing through OCF Cloud illustrates request routing via the OCF Cloud

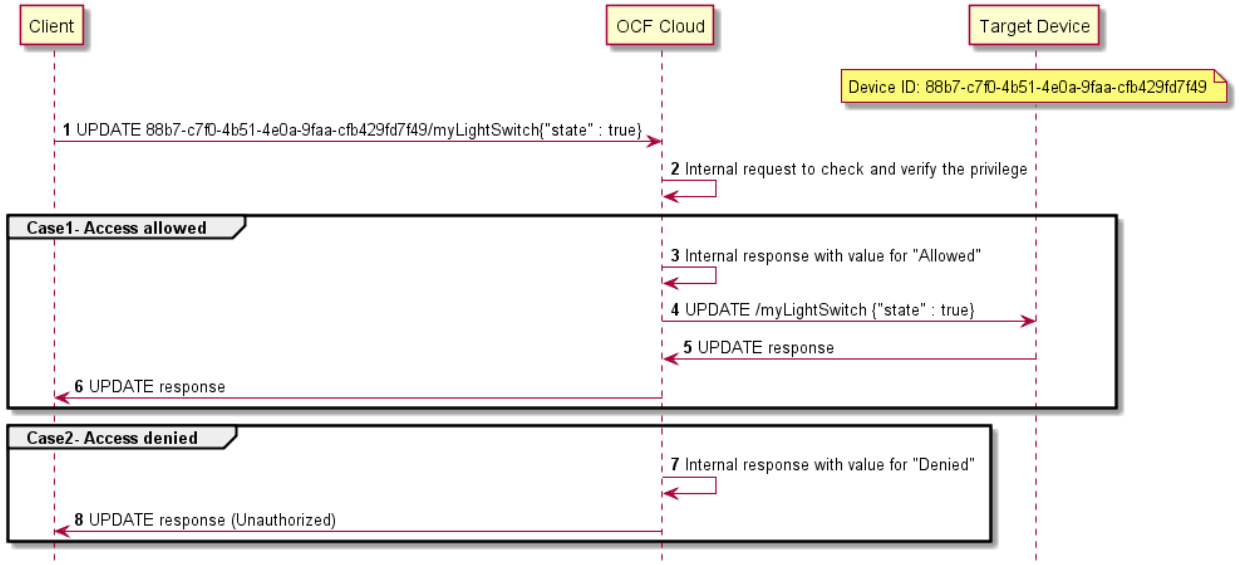

Figure 7 Request routing through OCF Cloud

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

8.5 Device Deregistration from the OCF Cloud

To deregister from the OCF Cloud the Device first sends a DELETE operation to the “/oic/sec/account” Resource as defined in the OCF Security Specification Section 13.10.

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

9 Security

OCF Cloud security requirements are captured in the OCF Security Specification.

Annex A (normative)

Resource Type definitions

A.1 List of Resource Type definitions

Table 6 contains the list of defined resources in this specification.

Table 6. Alphabetized list of resources

Friendly Name (informative)	Resource Type (rt)	Section
CoAP Cloud Configuration	“oic.r.coapcloudconf”	A.2

A.2 CoAP Cloud Configuration Resource

A.2.1 Introduction

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

A.2.2 Example URI

/CoAPCloudConfResURI

A.2.3 Resource Type

The resource type (rt) is defined as: oic.r.coapcloudconf.

A.2.4 RAML Definition

```
#%RAML 0.8
title: CoAP Cloud Configuration Resource
version: v0.0.3-20180116
traits:
 - interface-rw :
     queryParameters:
       if:
         enum: ["oic.if.rw"]
 - interface-baseline :
     queryParameters:
       if:
         enum: ["oic.if.baseline"]
 - interface-all :
     queryParameters:
       if:
         enum: ["oic.if.baseline", "oic.if.rw"]

/CoAPCloudConfResURI?if=oic.if.baseline:
  description: |
    The CoAPCloudConf Resource exposes configuration information for connecting to an OCF Cloud.

  is : ['interface-baseline']
  get:
    description: |
```



```
    responses :
      200:
        body:
          application/json:
            schema: |
              {
                "$schema": "http://json-schema.org/draft-04/schema#",
                "description" : "Copyright (c) 2017 Open Connectivity Foundation, Inc. All rights
reserved.",
                "id": "http://openconnectivityfoundation.github.io/core-
extensions/schemas/oic.r.coapcloudconf-schema.json#",
                "definitions": {
                  "oic.r.coapcloudconf": {
                    "type": "object",
                    "properties": {
                      "apn": {
                        "type": "string",
                        "description": "The Authorisation Provider through which an Access Token
was obtained."
                      },
                      "cis": {
                        "type": "string",
                        "description": "URL of OCF Cloud",
                        "format": "uri"
                      },
                      "sid": {
                        "$ref":
"http://openconnectivityfoundation.github.io/core/schemas/oic.types-schema.json#/definitions/uuid",
                        "description": "The identity of the OCF Cloud"
                      },
                      "clec": {
                        "enum": [0, 1, 2, 3, 255],
                        "description": "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)",
                        "readOnly": true
                      }
                    },
                    "required":["cis", "sid"]
                  }
                },
                "type": "object",
                "allOf": [
                  { "$ref": "http://openconnectivityfoundation.github.io/core/schemas/oic.core-
schema.json#/definitions/oic.core"},
                  { "$ref": "#/definitions/oic.r.coapcloudconf" }
                ]
              }

            example: |
              {
                "rt": ["oic.r.coapcloudconf"],
                "if" : ["oic.if.baseline", "oic.if.rw"],
                "apn": "github",
                "cis": "coaps+tcp://example.com:443",
                "sid" : "987e6543-a21f-10d1-a112-421345746237",
                "clec": 0
              }

  post:
    description: |
      Update properties of CoAPCloudConf resource.

    body:
```

```
      application/json:
        schema: |
          {
            "$schema": "http://json-schema.org/draft-04/schema#",
            "description" : "Copyright (c) 2017 Open Connectivity Foundation, Inc. All rights
reserved.",
            "id": "http://openconnectivityfoundation.github.io/core-
extensions/schemas/oic.r.coapcloudconf-update-schema.json#",
            "definitions": {
              "oic.r.coapcloudconf": {
                "type": "object",
                "properties": {
                  "apn": {
                    "type": "string",
                    "description": "The Authorisation Provider through which an Access Token was
obtained."
                  },
                  "cis": {
                    "type": "string",
                    "description": "URL of OCF Cloud",
                    "format": "uri"
                  },
                  "at": {
                    "type": "string",
                    "description": "Access Token which is returned by an Authorisation Provider or
OCF Cloud.",
                    "pattern": "(?!$|\\s+).*"
                  },
                  "sid": {
                    "$ref": "http://openconnectivityfoundation.github.io/core/schemas/oic.types-
schema.json#/definitions/uuid",
                    "description": "The identity of the OCF Cloud"
                  }
                },
                "required":["cis", "at", "sid"]
              }
            },
            "type": "object",
            "allOf": [
              { "$ref": "http://openconnectivityfoundation.github.io/core/schemas/oic.core-
schema.json#/definitions/oic.core"},
              { "$ref": "#/definitions/oic.r.coapcloudconf" }
            ]
          }

        example: |
          {
            "at": "0f3d9f7fe5491d54077d",
            "apn": "github",
            "cis": "coaps+tcp://example.com:443",
            "sid" : "987e6543-a21f-10d1-a112-421345746237"
          }

    responses :
      200:
        body:
          application/json:
            schema: |
              {
                "$schema": "http://json-schema.org/draft-04/schema#",
                "description" : "Copyright (c) 2017 Open Connectivity Foundation, Inc. All rights
reserved.",
                "id": "http://openconnectivityfoundation.github.io/core-
extensions/schemas/oic.r.coapcloudconf-schema.json#",
                "definitions": {
                  "oic.r.coapcloudconf": {
```

```
                    "type": "object",
                    "properties": {
                      "apn": {
                        "type": "string",
                        "description": "The Authorisation Provider through which an Access Token
was obtained."
                      },
                      "cis": {
                        "type": "string",
                        "description": "URL of OCF Cloud",
                        "format": "uri"
                      },
                      "sid": {
                        "$ref":
"http://openconnectivityfoundation.github.io/core/schemas/oic.types-schema.json#/definitions/uuid",
                        "description": "The identity of the OCF Cloud"
                      },
                      "clec": {
                        "enum": [0, 1, 2, 3, 255],
                        "description": "Last Error Code during Cloud Provisioning (0: No Error, 1:
Error response from the OCF Cloud, 2: Failed to connect to the OCF Cloud, 3: Failed to refresh
Access Token, 4~254: Reserved, 255: Unknown error)",
                        "readOnly": true
                      }
                    },
                    "required":["cis", "sid"]
                  }
                },
                "type": "object",
                "allOf": [
                  { "$ref": "http://openconnectivityfoundation.github.io/core/schemas/oic.core-
schema.json#/definitions/oic.core"},
                  { "$ref": "#/definitions/oic.r.coapcloudconf" }
                ]
              }

            example: |
              {
                "apn": "github",
                "cis": "coaps+tcp://example.com:443",
                "sid" : "987e6543-a21f-10d1-a112-421345746237",
                "clec": 0
              }
```

A.2.5 Property Definition

Table 7 CoAP Cloud Configuration Resource Property Definitions

Property name	Value type	Mandatory	Access mode	Description
cis	string	yes		URL of OCF Cloud
clec	multiple types: see schema		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)
apn	string			The Authorisation Provider through which an Access Token was obtained.
sid	multiple types: see schema	yes		The identity of the OCF Cloud
at	string	yes (UPDATE only)	Write Only	Access Token which is returned by an Authorisation Provider or OCF Cloud.

A.2.6 CRUDN behaviour

Table 8 CoAP Cloud Configuration Resource CRUDN operations

Resource	Create	Read	Update	Delete	Notify
/CoAPCloudConfResURI		get	post		

Annex B (informative)

Swagger2.0 definitions

B.1 CoAP Cloud Configuration Resource

B.1.1 Introduction

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

B.1.2 Example URI

/CoAPCloudConfResURI

B.1.3 Resource Type

The resource type (rt) is defined as: ['oic.r.coapcloudconf'].

B.1.4 Swagger2.0 Definition

```
{
  "swagger": "2.0",
  "info": {
    "title": "CoAP Cloud Configuration Resource Read Write Interface",
    "version": "v0.0.3-20180116",
    "license": {
      "name": "copyright 2016-2017 Open Connectivity Foundation, Inc. All rights reserved.",
      "x-description": "Redistribution and use in source and binary forms, with or without
modification, are permitted provided that the following conditions are met:\n        1.
Redistributions of source code must retain the above copyright notice, this list of conditions and
the following disclaimer.\n        2.  Redistributions in binary form must reproduce the above
copyright notice, this list of conditions and the following disclaimer in the documentation and/or
other materials provided with the distribution.\n\n        THIS SOFTWARE IS PROVIDED BY THE Open
Connectivity Foundation, INC. \"AS IS\" AND ANY EXPRESS OR IMPLIED WARRANTIES, INCLUDING, BUT NOT
LIMITED TO, THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE OR
WARRANTIES OF NON-INFRINGEMENT, ARE DISCLAIMED.\n        IN NO EVENT SHALL THE Open Connectivity
Foundation, INC. OR CONTRIBUTORS BE LIABLE FOR ANY DIRECT, INDIRECT, INCIDENTAL, SPECIAL,
EXEMPLARY, OR CONSEQUENTIAL DAMAGES (INCLUDING, BUT NOT LIMITED TO, PROCUREMENT OF SUBSTITUTE GOODS
OR SERVICES; LOSS OF USE, DATA, OR PROFITS; OR BUSINESS INTERRUPTION)\n        HOWEVER CAUSED AND
ON ANY THEORY OF LIABILITY, WHETHER IN CONTRACT, STRICT LIABILITY, OR TORT (INCLUDING NEGLIGENCE OR
OTHERWISE) ARISING IN ANY WAY OUT OF THE USE OF THIS SOFTWARE, EVEN IF ADVISED OF THE POSSIBILITY
OF SUCH DAMAGE.\n"
    }
  },
  "schemes": ["http"],
  "consumes": ["application/json"],
  "produces": ["application/json"],
  "paths": {
    "/CoAPCloudConfResURI?if=oic.if.rw" : {
      "get": {
        "description": "The CoAPCloudConf Resource exposes configuration information for connecting
to an OCF Cloud.\nRetrieve properties of CoAPCloudConf resource.\n",
        "parameters": [
          {"$ref": "#/parameters/interface-rw"}
        ],
        "responses": {
            "200": {
              "description" : "",
              "x-example":
                {
                  "apn": "github",
                  "cis": "coaps+tcp://example.com:443",
                  "sid" : "987e6543-a21f-10d1-a112-421345746237",
                  "clec": 0
                }
                ,
              "schema": { "$ref": "#/definitions/CoAPCloudConf" }
            }
```



```
          }
        },
        "post": {
          "description": "Update properties of CoAPCloudConf resource.\n",
          "parameters": [
            {"$ref": "#/parameters/interface-rw"},
            {
              "name": "body",
              "in": "body",
              "required": true,
              "schema": { "$ref": "#/definitions/CoAPCloudConfUpdate" },
              "x-example":
                {
                  "at": "0f3d9f7fe5491d54077d",
                  "apn": "github",
                  "cis": "coaps+tcp://example.com:443",
                  "sid" : "987e6543-a21f-10d1-a112-421345746237"
                }
            }
          ],
          "responses": {
              "200": {
                "description" : "",
                "x-example":
                  {
                    "apn": "github",
                    "cis": "coaps+tcp://example.com:443",
                    "sid" : "987e6543-a21f-10d1-a112-421345746237",
                    "clec": 0
                  }
                  ,
                "schema": { "$ref": "#/definitions/CoAPCloudConf" }
              }
          }
        }
      },
      "/CoAPCloudConfResURI?if=oic.if.baseline" : {
        "get": {
          "description": "The CoAPCloudConf Resource exposes configuration information for connecting
to an OCF Cloud.\n",
          "parameters": [
            {"$ref": "#/parameters/interface-baseline"}
          ],
          "responses": {
              "200": {
                "description" : "",
                "x-example":
                  {
                    "rt": ["oic.r.coapcloudconf"],
                    "if" : ["oic.if.baseline", "oic.if.rw"],
                    "apn": "github",
                    "cis": "coaps+tcp://example.com:443",
                    "sid" : "987e6543-a21f-10d1-a112-421345746237",
                    "clec": 0
                  }
                  ,
                "schema": { "$ref": "#/definitions/CoAPCloudConf" }
              }
          }
        },
        "post": {
          "description": "Update properties of CoAPCloudConf resource.\n",
          "parameters": [
            {"$ref": "#/parameters/interface-baseline"},
            {
              "name": "body",
              "in": "body",
              "required": true,
              "schema": { "$ref": "#/definitions/CoAPCloudConfUpdate" },
              "x-example":
                {
```



```
                  "at": "0f3d9f7fe5491d54077d",
                  "apn": "github",
                  "cis": "coaps+tcp://example.com:443",
                  "sid" : "987e6543-a21f-10d1-a112-421345746237"
                }
            }
          ],
          "responses": {
              "200": {
                "description" : "",
                "x-example":
                  {
                    "apn": "github",
                    "cis": "coaps+tcp://example.com:443",
                    "sid" : "987e6543-a21f-10d1-a112-421345746237",
                    "clec": 0
                  }
                  ,
                "schema": { "$ref": "#/definitions/CoAPCloudConf" }
              }
          }
        }
      },
      "parameters": {
        "interface-rw" : {
          "in" : "query",
          "name" : "if",
          "type" : "string",
          "enum" : ["oic.if.rw"]
        },
        "interface-baseline" : {
          "in" : "query",
          "name" : "if",
          "type" : "string",
          "enum" : ["oic.if.baseline"]
        },
        "interface-all" : {
          "in" : "query",
          "name" : "if",
          "type" : "string",
          "enum" : ["oic.if.baseline", "oic.if.rw"]
        }
      },
      "definitions": {
        "CoAPCloudConf" : {
          "properties": {
            "rt" :
                    {
              "description": "Resource Type of the Resource",
              "items": {
                "maxLength": 64,
                "type": "string"
              },
              "minItems": 1,
              "readOnly": true,
              "type": "array"
            },

            "n" :
                    {
              "description": "Friendly name of the resource",
              "maxLength": 64,
              "readOnly": true,
              "type": "string"
            },

            "cis" :
                    {
              "description": "URL of OCF Cloud",
              "format": "uri",
```



```
            "type": "string"
          },

          "apn" :
                  {
            "description": "The Authorisation Provider through which an Access Token was obtained.",
            "type": "string"
          },

          "sid" :
                  {
            "description": "Format pattern according to IETF RFC 4122.",
            "pattern": "^[a-fA-F0-9]{8}-[a-fA-F0-9]{4}-[a-fA-F0-9]{4}-[a-fA-F0-9]{4}-[a-fA-F0-
9]{12}$",
            "type": "string"
          },

          "clec" :
                  {
            "description": "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)",
            "enum": [
              0,
              1,
              2,
              3,
              255
            ],
            "readOnly": true
          },

          "id" :
                  {
            "description": "Instance ID of this specific resource",
            "maxLength": 64,
            "readOnly": true,
            "type": "string"
          },

          "if" :
                  {
            "description": "The interface set supported by this resource",
            "items": {
              "enum": [
                "oic.if.baseline",
                "oic.if.ll",
                "oic.if.b",
                "oic.if.lb",
                "oic.if.rw",
                "oic.if.r",
                "oic.if.a",
                "oic.if.s"
              ],
              "type": "string"
            },
            "minItems": 1,
            "readOnly": true,
            "type": "array"
          }

          }
          ,"type" : "object"
      }
      ,
      "CoAPCloudConfUpdate" : {
        "properties": {
          "rt" :
                  {
            "description": "Resource Type of the Resource",
            "items": {
```

```
              "maxLength": 64,
              "type": "string"
            },
            "minItems": 1,
            "readOnly": true,
            "type": "array"
          },

          "n" :
                  {
            "description": "Friendly name of the resource",
            "maxLength": 64,
            "readOnly": true,
            "type": "string"
          },

          "cis" :
                  {
            "description": "URL of OCF Cloud",
            "format": "uri",
            "type": "string"
          },

          "apn" :
                  {
            "description": "The Authorisation Provider through which an Access Token was obtained.",
            "type": "string"
          },

          "at" :
                  {
            "description": "Access Token which is returned by an Authorisation Provider or OCF
Cloud.",
            "type": "string".",
            "pattern": "(?!$|\\s+).*"
          },

          "sid" :
                  {
            "description": "Format pattern according to IETF RFC 4122.",
            "pattern": "^[a-fA-F0-9]{8}-[a-fA-F0-9]{4}-[a-fA-F0-9]{4}-[a-fA-F0-9]{4}-[a-fA-F0-
9]{12}$",
            "type": "string"
          },

          "id" :
                  {
            "description": "Instance ID of this specific resource",
            "maxLength": 64,
            "readOnly": true,
            "type": "string"
          },

          "if" :
                  {
            "description": "The interface set supported by this resource",
            "items": {
              "enum": [
                "oic.if.baseline",
                "oic.if.ll",
                "oic.if.b",
                "oic.if.lb",
                "oic.if.rw",
                "oic.if.r",
                "oic.if.a",
                "oic.if.s"
              ],
              "type": "string"
            },
            "minItems": 1,
            "readOnly": true,
```



```
            "type": "array"
          }

          }
          ,"type" : "object"
      }
    }
}
```

B.1.5 Property Definition

Table 9 The property definitions of the resource

Property name	Value type	Mandatory	Access mode	Description
rt	array: see schema		Read Only	Resource Type of the Resource
cis	string	yes	Read Write	URL of OCF Cloud
sid	string	yes	Read Write	Format pattern according to IETF RFC 4122.
apn	string		Read Write	The Authorisation Provider through which an Access Token was obtained.
clec	multiple types: see schema		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)
id	string		Read Only	Instance ID of this specific resource
n	string		Read Only	Friendly name of the resource
if	array: see schema		Read Only	The interface set supported by this resource

rt	array: see schema		Read Only	Resource Type of the Resource
cis	string	yes	Read Write	URL of OCF Cloud
sid	string	yes	Read Write	Format pattern according to IETF RFC 4122.
apn	string		Read Write	The Authorisation Provider through which an Access Token was obtained.
at	string	yes (UPDATE only)	Write Only	Access Token which is returned by an Authorisation Provider or OCF Cloud.
id	string		Read Only	Instance ID of this specific resource
n	string		Read Only	Friendly name of the resource
if	array: see schema		Read Only	The interface set supported by this resource

B.1.6 CRUDN behaviour

Table 10 The CRUDN operations of the resource

Resource	Create	Read	Update	Delete	Notify
/CoAPCloudConfResURI		get	post		observe

