

OCF Security Specification

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Introduction

This document, and all the other parts associated with this document, were developed in response to worldwide demand for smart home focused Internet of Things (IoT) devices, such as appliances, door locks, security cameras, sensors, and actuators; these to be modelled and securely controlled, locally and remotely, over an IP network.

While some inter-device communication existed, no universal language had been developed for the IoT. Device makers instead had to choose between disparate frameworks, limiting their market share, or developing across multiple ecosystems, increasing their costs. The burden then falls on end users to determine whether the products they want are compatible with the ecosystem they bought into, or find ways to integrate their devices into their network, and try to solve interoperability issues on their own.

In addition to the smart home, IoT deployments in commercial environments are hampered by a lack of security. This issue can be avoided by having a secure IoT communication framework, which this standard solves.

The goal of these documents is then to connect the next 25 billion devices for the IoT, providing secure and reliable device discovery and connectivity across multiple OSs and platforms. There are multiple proposals and forums driving different approaches, but no single solution addresses the majority of key requirements. This document and the associated parts enable industry consolidation around a common, secure, interoperable approach.

Scope

This document defines security objectives, philosophy, Resources and mechanism that impacts OCF base layers of ISO/IEC 30118-1. ISO/IEC 30118-1 contains informative security content. The OCF Security Specification contains security normative content and may contain informative content related to the OCF base or other OCF documents.

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.

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

ISO/IEC 30118-3 Information technology -- Open Connectivity Foundation (OCF) Specification -- Part 3: Bridging specification
<https://www.iso.org/standard/74240.html>
Latest version available at:
https://openconnectivity.org/specs/OCF_Bridging_Specification.pdf

OCF Wi-Fi Easy Setup, Information technology – Open Connectivity Foundation (OCF) Specification – Part 7: Wi-Fi Easy Setup specification
Latest version available at:
https://openconnectivity.org/specs/OCF_Wi-Fi_Easy_Setup_Specification.pdf

OCF Cloud Specification, Information technology – Open Connectivity Foundation (OCF) Specification – Part 8: Cloud Specification
Latest version available at:
https://openconnectivity.org/specs/OCF_Cloud_Specification.pdf

OCF Cloud Security Specification - Open Connectivity Foundation (OCF) Specification – Cloud Security Specification
Latest version available at:
https://openconnectivity.org/specs/OCF_Cloud_Security_Specification.pdf

OCF Onboarding Tool Specification - Open Connectivity Foundation (OCF) Specification – Onboarding Tool Specification
Latest version available at:
https://openconnectivity.org/specs/OCF_Onboarding_Tool_Specification.pdf

OCF Cloud API for Cloud Services Specification - Open Connectivity Foundation (OCF) Cloud API for Cloud Services Specification
Latest version available at:
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483 <https://tools.ietf.org/html/rfc4122>

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485 2005, <https://tools.ietf.org/html/rfc4279>

486 IETF RFC 4492, *Elliptic Curve Cryptography (ECC) Cipher Suites for Transport Layer Security*
487 *(TLS)*, May 2006, <https://tools.ietf.org/html/rfc4492>

488 IETF RFC 5246, *The Transport Layer Security (TLS) Protocol Version 1.2*, August 2008,
489 <https://tools.ietf.org/html/rfc5246>

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497 <https://tools.ietf.org/html/rfc5755>

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499 <https://tools.ietf.org/html/rfc6347>

500 IETF RFC 6655, *AES-CCM Cipher Suites for Transport Layer Security (TLS)*, July 2012,
501 <https://tools.ietf.org/html/rfc6655>

502 IETF RFC 7228, *Terminology for Constrained-Node Networks*, May 2014,
503 <https://tools.ietf.org/html/rfc7228>

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505 *Transport Layer Security (DTLS)*, June 2014, <https://tools.ietf.org/html/rfc7250>

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507 <https://tools.ietf.org/html/rfc7251>

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509 <https://tools.ietf.org/html/rfc7252>

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512 IETF RFC 8520, *Manufacturer Usage Description Specification*, Mar 2019,
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515 <https://tools.ietf.org/html/rfc8613>

516 oneM2M Release 3 Specifications, <http://www.onem2m.org/technical/published-drafts>

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518 <https://github.com/OAI/OpenAPI-Specification/blob/master/versions/2.0.md>

Terms, definitions, and abbreviated terms

3.1 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO/IEC 30118-1, ISO/IEC 30118-3 and the following apply.

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

– ISO Online browsing platform: available at <https://www.iso.org/obp>

– IEC Electropedia: available at <http://www.electropedia.org/>

3.1.1

Access Management Service (AMS)

service that dynamically constructs ACL Resources in response to a Device Resource request

Note 1 to entry: An AMS can evaluate access policies remotely and supply the result to a Server which allows or denies a pending access request. An AMS is authorised to provision ACL Resources.

3.1.2

Credential Management Service (CMS)

Device that is authorized to provision credential Resources

3.1.3

Device Class

IETF RFC 7228 defined device class

3.1.4

Device Ownership Transfer Service (DOTS)

logical entity that establishes device ownership

3.1.5

End-Entity

any certificate holder which is not a Root or Intermediate Certificate Authority

Note 1 to entry: Typically, a device certificate.

3.1.6

Intermediary

Device that implements both Client and Server roles and may perform protocol translation, virtual device to physical device mapping or Resource translation

3.1.7

OCF Cipher Suite

set of algorithms and parameters that define the cryptographic functionality of a Device. The OCF Cipher Suite includes the definition of the public key group operations, signatures, and specific hashing and encoding used to support the public key.

3.1.8

OCF Rooted Certificate Chain

collection of X.509 v3 certificates in which each certificate chains to a trust anchor certificate which has been issued by a certificate authority under the direction, authority, and approval of the Open Connectivity Foundation Board of Directors as a trusted root for the OCF ecosystem.

3.1.9

Onboarding Tool (OBT)

tool that implements *DOTS*(3.1.4), *AMS*(3.1.1), and *CMS*(3.1.2) functionality

3.1.10

Out of Band Communication Channel

any mechanism for delivery of a secret from one party to another, not specified by OCF

3.1.11

Owner Credential (OC)

credential, provisioned to a Device, for the purposes of mutual authentication of the Device and *OBT*(3.1.9) during subsequent interactions, identified by having a Subject UUID matching the Resource Owner Id of the Device Ownership Transfer Resource hosted by a Device that has the credential

3.1.12

Role (Network context)

stereotyped behavior of a Device; one of [Client, Server or Intermediary]

3.1.13

Role Identifier

Property of an OCF credentials Resource or element in a role certificate that identifies a privileged role that a Server Device associates with a Client Device for the purposes of making authorization decisions when the Client Device requests access to Device Resources.

3.1.14

Secure Resource Manager (SRM)

module in the OCF Core that implements security functionality that includes management of security Resources such as ACLs, credentials and Device owner transfer state.

3.1.15

Security Virtual Resource (SVR)

Resource supporting security features.

Note 1 to entry: For a list of all the SVRs please see clause 0.

3.1.16

Trust Anchor

well-defined, shared authority, within a trust hierarchy, by which two cryptographic entities (e.g. a Device and an *OBT*(3.1.9)) can assume trust

3.1.17

Device Configuration Resource (DCR)

Resource that is any of the following:

- a) a Discovery Core Resource, or
- b) a Security Virtual Resource, or
- c) a Wi-Fi Easy Setup Resource ("oic.r.easysetup", "oic.r.wificonf", "oic.r.devconf"), or
- d) a CoAP Cloud Configuration Resource ("oic.r.coapcloudconf"), or
- e) a Software Update Resource ("oic.r.softwareupdate"), or
- f) a Maintenance Resource ("oic.wk.mnt").

3.1.18

Non-Configuration Resource (NCR)

Resource that is not a Device Configuration Resource (3.1.17)

3.1.19

OCF Security Domain

set of onboarded OCF Devices that are provisioned with credentialing information for confidential communication with one another

3.1.20

Owned (or "in Owned State")

having the "owned" Property of the "/oic/sec/doxm" Resource equal to "TRUE"

611 **3.1.21**
612 **Unowned (or "in Unowned State")**
613 having the "owned" Property of the "/oic/sec/doxm" Resource equal to "FALSE"

614 **3.1.22**
615 **OCF Onboarding**
616 initial establishment of ownership over a Device, and initial provisioning of the Device for normal
617 operation

618 **3.1.23**
619 **Auditable Event**
620 system activity that may be indicative of a violation of security policy

621 **3.1.24**
622 **Auditable Event Entry**
623 record of the details of an Auditable Event

624 **3.1.25**
625 **End User**
626 person using the [particular] product

627 **3.1.26**
628 **End-to-End Secure**
629 securely encapsulate information so that *OCF Proxies* (3.1.28) on the end-to-end delivery path do
630 not need to be trusted with the confidentiality, integrity and freshness of that information

631 **3.1.27**
632 **End-to-End Security of Unicast Messages**
633 interoperable mechanism which End-to-End Secures the exchange of unicast OCF CRUDN
634 messages

635 **3.1.28**
636 **OCF Proxy**
637 functionality which can interpret the OCF compliant URIs of request messages intended for
638 resources on another OCF Server and can route those request messages accordingly

639 **3.1.29**
640 **Origin Client**
641 Client which originally generated a request, as opposed to the Client functionality of a Proxy which
642 is forwarding a request from another Device

643 **3.1.30**
644 **OSCORE Master Secret**
645 "Master Secret" as defined in clause 3.1 of IETF RFC 8613

646 **3.1.31**
647 **OSCORE Recipient ID**
648 "Recipient ID" as defined in clause 3.1 of IETF RFC 8613

649 **3.1.32**
650 **OSCORE Security Context**
651 "Security Context" as defined in clause 3.1 of IETF RFC 8613

652 **3.1.33**
653 **OSCORE Sender ID**
654 "Sender ID" as defined in clause 3.1 of IETF RFC 8613

655 **3.1.34**
656 **OSCORE Sender Sequence Number**
657 "Sender Sequence Number" as defined in clause 3.1 of IETF RFC 8613

658 **3.1.35**
659 **Target Server**
660 Server to which a request is addressed, as opposed to the Server functionality of a *OCF Proxy*
661 (3.1.28) which receives a request to be forwarded to another Device

662 **3.1.36**
663 **Simple Secure Multicast**
664 delivery of UPDATE request messages from a Client to a group of Servers using network-layer
665 multicast, where the messages are protected with a simple security mechanism

666 **3.1.37**
667 **Simple Secure Multicast Client Context**
668 *OSCORE Security Context* (3.1.32) parameters provisioned to the Client of a *Simple Secure*
669 *Multicast Group* (3.1.38) to enable End-to-End Security of *Simple Secure Multicast Requests*
670 (3.1.39) sent to Servers of that *Simple Secure Multicast Group* (3.1.38)

671 **3.1.38**
672 **Simple Secure Multicast Group**
673 group of Servers and one (1) associated Client provisioned with credentials to enable *Simple*
674 *Secure Multicast* (3.1.36) from the Client to the set of Servers

675 **3.1.39**
676 **Simple Secure Multicast Request**
677 OSCORE-protected UPDATE request message delivered from a Client to a group of Servers using
678 *Simple Secure Multicast* (3.1.36)

679 **3.1.40**
680 **Simple Secure Multicast Server Context**
681 OSCORE Security Context parameters provisioned to Servers of a Simple Secure Multicast Group
682 (3.1.38) to enable End-to-End Security of *Simple Secure Multicast Requests* (3.1.39) sent by the
683 Client of that *Simple Secure Multicast Group* (3.1.38)

684 **3.1.41**
685 **Device Onboarding Connection (DOC)**
686 special DTLS connection established for the purposes of onboarding the Device securely when a
687 Device is in RFOTM

688 NOTE: The Owner Transfer Method selected will determine the specifics of the DOC used.

689 **3.1.42**
690 **Ready For Normal Operation State**
691 state of a Device in which *NCRs* (3.1.18) can be accessed

692 **3.1.43**
693 **Ready For Owner Transfer Mechanism State**
694 state of a Device in which a Device can be Onboarded

695 **3.1.44**
696 **Ready For Provisioning State**
697 state of a Device in which *SVRs* (3.1.15) can be configured

698	3.1.45	
699	Reset State	
700	state of a Device in which the configurable Properties of Device's resources are reset to the	
701	manufacturer default and the Device becomes <i>Unowned</i> (3.1.21)	
702	3.1.46	
703	Soft Reset State	
704	state of a Device in which SVRs (3.1.15) can be configured, with slightly more Properties available	
705	than in RFPRO	
706	3.2	Symbols and abbreviated terms
707	AC	Access Control
708	ACE	Access Control Entry
709	ACL	Access Control List
710	AEAD	Authenticated Encryption with Authenticated Data
711	NOTE: Defined in IETF RFC 8152	
712	AEE	Auditable Event Entry
713	AES	Advanced Encryption Standard
714	AMS	Access Management Service
715	CMS	Credential Management Service
716	COSE	CBOR Object Signing and Encryption
717	NOTE: Defined in IETF RFC 8152	
718	CRUDN	CREATE, RETREIVE, UPDATE, DELETE, NOTIFY
719	CSR	Certificate Signing Request
720	DOC	Device Onboarding Connection
721	ECC	Elliptic Curve Cryptography
722	ECDSA	Elliptic Curve Digital Signature Algorithm
723	EKU	Extended Key Usage
724	DOTS	Device Ownership Transfer Service
725	ID	Identity/Identifier
726	JSON	JavaScript Object Notation.
727	NVRAM	Non-Volatile Random-Access Memory
728	OC	Owner Credential
729	OCSP	Online Certificate Status Protocol
730	OBT	Onboarding Tool
731	OID	Object Identifier

732 OSCORE Object Security for Constrained RESTful Environments

733 NOTE: Defined in IETF RFC 8613

734 OTM Owner Transfer Method

735 PE Policy Engine

736 PIN Personal Identification Number

737 PPSK PIN-authenticated pre-shared key

738 PRF Pseudo Random Function

739 PSI Persistent Storage Interface

740 PSK Pre Shared Key

741 RBAC Role Based Access Control

742 RM Resource Manager

743 RNG Random Number Generator

744 RESET Reset State

745 RFNOP Ready For Normal Operation State

746 RFOTM Ready For Owner Transfer Mechanism State

747 RFPRO Ready For Provisioning State

748 SBAC Subject Based Access Control

749 SEE Secure Execution Environment

750 SRESET Soft Reset State

751 SRM Secure Resource Manager

752 SSM Simple Secure Multicast

753 SVR Security Virtual Resource

754 URI Uniform Resource Identifier

755 VOD Virtual OCF Device

756 **Document Conventions and Organization**

757 **4.1 Conventions**

758 This document defines Resources, protocols and conventions used to implement security for OCF
759 core framework and applications.

760 For the purposes of this document, the terms and definitions given in ISO/IEC 30118-1 apply.

761 In this document, to be consistent with the IETF usages for RESTful operations, the RESTful
762 operation words CRUDN, CREATE, RETRIVE, UPDATE, DELETE, and NOTIFY will have all letters
763 capitalized. Any lowercase uses of these words have the normal technical English meaning.

764 Figure 1 depicts interaction between OCF Devices.

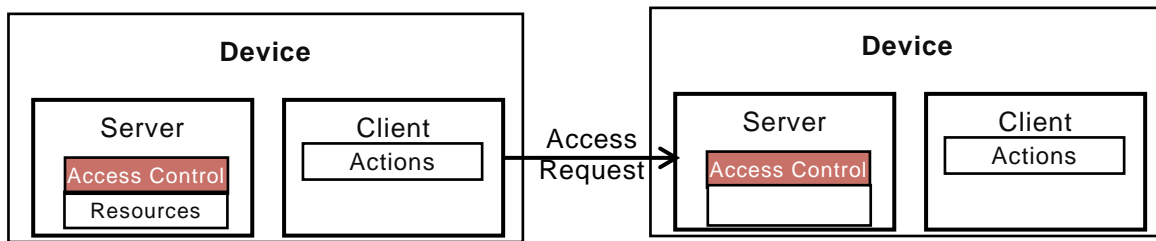


Figure 1 – OCF Interaction

Devices may implement a Client role that performs Actions on Servers. Actions access Resources managed by Servers. The OCF stack enforces access policies on Resources. End-to-end Device interaction can be protected using session protection protocol (e.g. DTLS) or with data encryption methods.

4.2 Notation

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

Required (or shall or mandatory).

These basic features shall be implemented to comply with OCF 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).

These features add functionality supported by OCF Core Architecture and should be implemented. Recommended features take advantage of the capabilities OCF 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).

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

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.

DEPRECATED

Although these features are still described in this document, they should not be implemented except for backward compatibility. The occurrence of a deprecated feature during operation of an implementation compliant with the current document has no effect on the implementation's

799 operation and does not produce any error conditions. Backward compatibility may require that a
800 feature is implemented and functions as specified but it shall never be used by implementations
801 compliant with this document.

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

803 Words that are emphasized are printed in *italic*.

804 **4.3 Data types**

805 See ISO/IEC 30118-1.

806 **4.4 Document structure**

807 Informative clauses may be found in the Overview clauses, while normative clauses fall outside of
808 those clauses.

809 The Security Specification may use the OpenAPI specification as the API definition language. The
810 mapping of the CRUDN actions is specified in ISO/IEC 30118-1.

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840 3) The Client submits a request to the Server.

841 4) The Server receives the request.

842 a) If the request is received over an unsecured channel, the Server treats the request as

843 anonymous and no "deviceUUID" or "roleid" are associated with the request.

844 b) If the request is received over a secured channel, then the Server associates the request

845 with the "deviceUUID" of the Client and all valid "roleid" values of the Client by default.

846 c) The Server then consults the Access Control List (ACL), and looks for an Access Control

847 Entry (ACE) matching the following criteria:

848 i) The requested Resource matches a Resource reference in the ACE

849 ii) The requested operation is permitted by the "permissions" of the ACE, and

850 iii) The "subjectUUID" contains either one of a special set of wildcard values or, if the

851 Device is not anonymous, the subject matches the Client "deviceUUID" associated with

852 the request or a valid "roleid" associated with the request. The special wildcard values

853 authorize all Devices communicating over either authenticated and encrypted sessions

854 or unsecured sessions to interact according to the ACE.

855 If there is a matching ACE, then access to the Resource is permitted; otherwise access

856 is denied. Access is enforced by the Server's Secure Resource Manager (SRM).

857 5) The Server sends a response back to the Client.

858 OCF also supports exchange of messages between an Origin Client and Target Server facilitated

859 at one or more entities acting as OCF Proxies.

860 NOTE 1: Any number of OCF Proxies may be on the path between the Origin Client and Target Server, although this

861 number is expected to be small in practice.

862 In some scenarios, an OCF Proxy acts as a Server to incoming OCF CRUDN request messages:

863 processing the OCF CRUDN request messages; and then sending appropriate OCF CRUDN

864 request messages onwards towards the Target Server. The OCF Proxy can also process the

865 corresponding incoming OCF CRUDN response message and send appropriate OCF CRUDN

866 request messages back towards the Origin Client.

867 This approach implies that the owner of the Security Domain (containing the Origin Client and

868 Target Server) is willing to trust all OCF Proxies on the message delivery path with the

869 confidentiality, integrity and freshness of the OCF CRUDN messages. Alternatively, the Origin

870 Client and Target Server can apply End-to-End Security of Unicast Messages which enables

871 securing the exchange of OCF CRUDN messages so that OCF Proxies do not need to be trusted

872 with the confidentiality and integrity of the OCF CRUDN messages.

873 The security model of operation when using OCF Proxies without End-to-End Security of Unicast

874 Messages is described in OCF Cloud Specification, OCF Cloud Security Specification, and C2C

875 API.

876 Figure 3 and Figure 4 depict the security model of operation when using OCF Proxies and End-to-

877 End Security of Messages is applied; see also the following steps. Figure 3 illustrates an example

878 with one OCF Proxy. Figure 4 illustrates a more complex example with two OCF Proxies using OCF

879 Cloud API for Cloud Services Specification; see notes 1 and 2.

880 NOTE 2: If the OCF Proxies in Figure 4 are OCF Clouds, OCF Proxy A is the Origin Cloud to which the Origin Client is

881 registered, and OCF Proxy B is the Target Cloud to which the Target Server is registered.

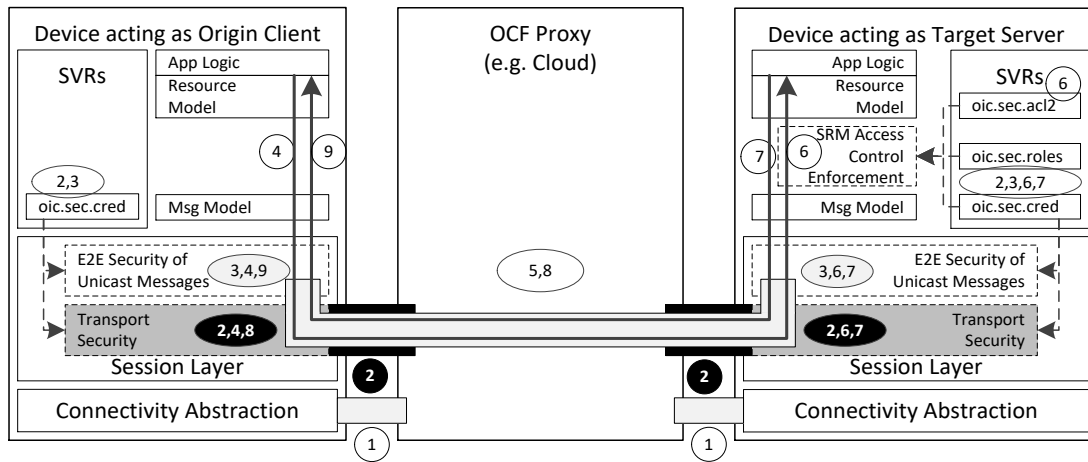


Figure 3 – OCF Layers for interactions via one OCF Proxy

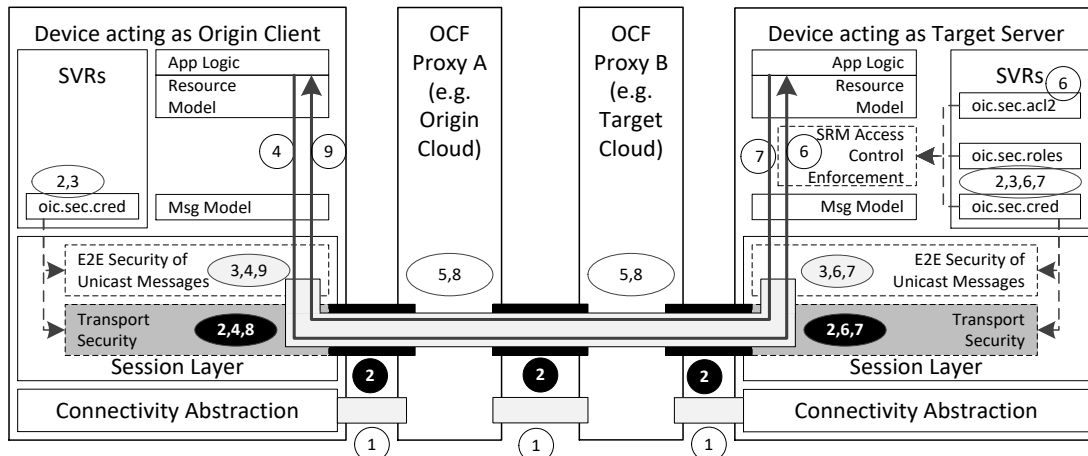


Figure 4 – OCF Layers for interactions via two OCF Proxies

- 1) Pairwise network connections are established.
- 2) Messages are exchanged over each network connection via pairwise mutually-authenticated secure transport connection.
- 3) The Origin Client and Target Server establish an End-to-End Secured channel which is mutually-authenticated using credentials held in the "/oic/sec/cred" Resources of the Origin Client and Target Server.
- 4) The Origin Client generates an OCF CRUDN request message to the Target Server. The Origin Client encapsulates the OCF CRUDN request message into an End-to-End Secured request message of the End-to-End Secured channel (established in step 3). Information identifying the Target Server is left un-encrypted in the End-to-End Secured request message, so OCF Proxies can use the identifying information to route the End-to-End Secured request message correctly. The Origin Client sends the End-to-End Secured request message to its OCF Proxy, over the optionally secured transport connection established with that OCF Proxy. See Note 3.

- 5) Each OCF Proxy on the path extracts the identifying information of the Target Server from the request message and, subject to the OCF Proxy's policies governing End-to-End Secured request messages, forwards the end-to- End-to-End Secured request message towards the Target Server over an optionally secured transport connection. See notes 3, 4 and 5.
- 6) The Target Server verifies and decrypts the End-to-End Secured request message as a message of the End-to-End Secured channel (established at step 3) to extract the encapsulated OCF CRUDN request message from the Origin Client. The OCF CRUDN request message is treated as being received over an authenticated encrypted ("auth-crypt") connection and associated with a "deviceUUID". The "deviceUUID" is associated with the credential in the "/oic/sec/cred" Resource used to establish the End-to-End Secured channel in step 3.
- 7) The Target Server determines whether access to the resource is permitted as described in step 4c of the Security model for direct Device-to-Device interaction shown in Figure 2.
- 8) The Target Server generates an OCF CRUDN response message and encapsulates the OCF CRUDN response message into an End-to-End Secured response message of the End-to-End Secured channel (established at step 3). The Target Secure sends the End-to-End Secured response message to its OCF Proxy, over the optionally secured transport connection on which the corresponding request was received. See Note 3.
- 9) Each OCF Proxy on the path forwards the End-to-End Secured response message towards the Origin Client over the optionally secured transport connection on which the corresponding request message was received. See Note 3.
- 10) The Origin Client verifies and decrypts the End-to-End Secured response message as a message of the End-to-End Secured channel (established at step 3) to extract the encapsulated OCF CRUDN response message from the Target Server.

NOTE 3: While in transit, the OCF CRUDN message might be secured by up to two independent layers of Security: a layer of End-to-End Security of Unicast Messages (using OSCORE), and an independent layer of transport Security (using DTLS or TLS).

NOTE 4: This document does not address details of how an OCF Proxy determines if its policies permit forwarding the request message towards the identified Target Server. If an OCF Proxy permits forwarding a request message towards a Target Server, then it is assumed that the OCF Proxy also permits forwarding the corresponding response message(s) over the transport connection on which the corresponding request message was received.

NOTE 5: This document does not address how OCF Proxy A determines that OCF Proxy B is the correct OCF Proxy to forward the request message to. The OCF Cloud API for Cloud Services Specification provides the details for the case where the OCF Proxy A and OCF Proxy B are OCF Clouds.

As shown in Figure 5, Simple Secure Multicast (SSM) enables a Client to securely communicate an UPDATE request to a group of Servers with a single non-confirmable UPDATE request delivered via networking-layer multicast.

The Client sends the Secured UPDATE request message to the multicast URL of the Servers, using the URL of the multicast enabled resource.

- 5) The Servers decrypt the message. The UPDATE request message is treated as being received over an authenticated encrypted ("auth-crypt") connection and associated with a "deviceUUID" (which can be the Device UUID of the Client).
- 6) The Server determines whether access to the Resource is permitted as described in step 4c of the Security model for direct Device-to-Device interaction shown in Figure 2.

Resource protection includes protection of data both while at rest and during transit. Aside from access control mechanisms, the OCF Security Specification does not include specification of secure storage of Resources. Secure storage may be accomplished through the use of hardware security or encryption of data at rest. The exact implementation of secure storage is subject to a set of hardening requirements that are specified in clause 0 and may be subject to certification guidelines.

Data in transit protection is specified fully as a normative part of this document. This document supports data in transit data protection at the transport layer through use of mechanisms such as DTLS and end-to-end data-in-transit protection through OSCORE.

NOTE 6: DTLS will provide packet by packet protection, rather than protection for the OCF CRUDN message as whole. For instance, if the integrity of the entire OCF CRUDN message as a whole is required, separate end-to-end Security (for example, using OSCORE) should be applied before passing the packet down to the transport layer.

Figure 7 depicts OCF Security Enforcement Points.

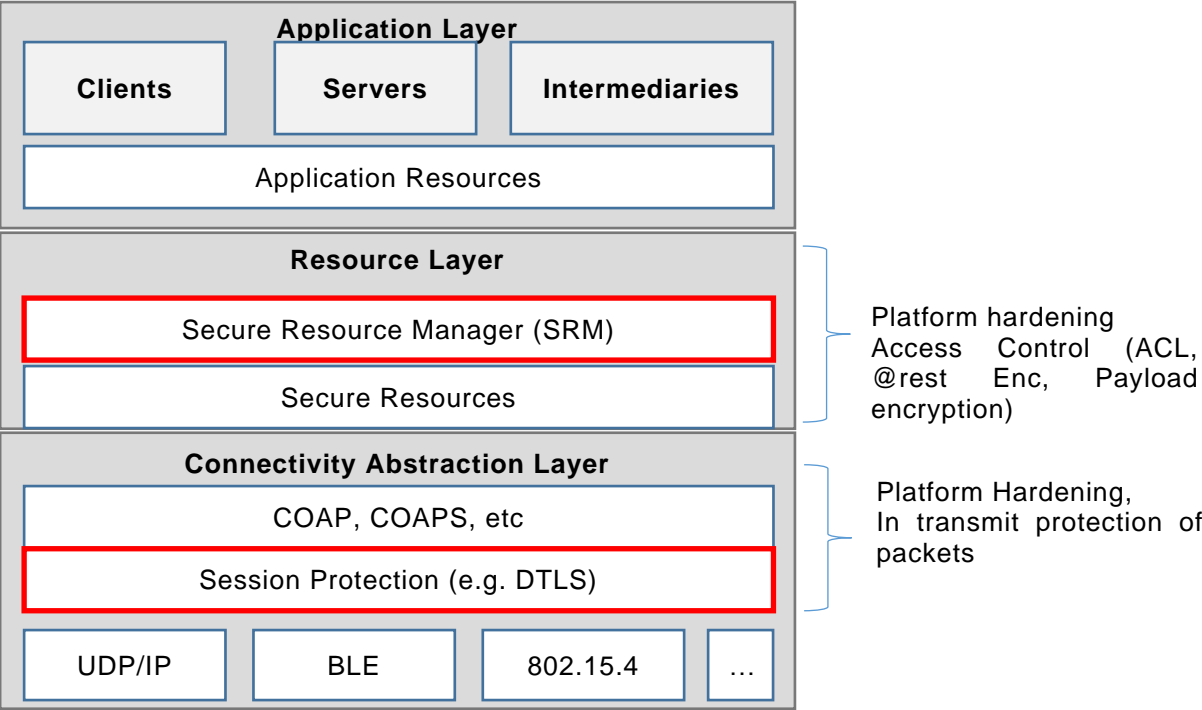


Figure 7 – OCF Security Enforcement Points

5.2 Access Control

5.2.1 Access Control General

The OCF framework assumes that Resources are hosted by a Server and are made available to Clients subject to access control and authorization mechanisms. The Resources at the Server are protected through implementation of access control, authentication and confidentiality protection.

976 This clause provides an overview of access control through the use of Access Control Lists.
977 However, access control in OCF is agnostic regarding transport and connectivity abstraction layers.

978 Implementation of access control relies on a-priori definition of a set of access policies for the
979 Resource. The policies are stored locally in an ACL Resource provisioned by an Access
980 Management Service (AMS) in the form of Access Control Entries (ACE). The lack of such an
981 associated ACE results in the Resource being inaccessible. Multiple types of access control
982 mechanisms may be applied:

- 983 – Subject-based access control (SBAC), where the ACE matches the identity of the Client against
984 the subject included in the policy defined for the Resource. Asserting the identity of the Client
985 requires an authentication process.
- 986 – Role-based Access Control (RBAC), where the ACE matches a role identifier included in the
987 policy for the Resource to a role identifier associated with the Client.
- 988 – Wildcard-based Access Control, where the ACE matches a connection type, used to access the
989 Resource (i.e. any mutually-authenticated connection).

990
991 The ACE only applies if the ACE matches both the subject (i.e. Client) and the requested Resource.
992 There are multiple ways a subject could be matched, (1) Device UUID, (2) Role Identifier or (3)
993 wildcard. The way in which the Client connects to the Server may be relevant for making access
994 control decisions. Wildcard matching on authenticated vs. unauthenticated and encrypted vs.
995 unencrypted connection allows an access policy to be broadly applied to subject classes.

996 Example Wildcard Matching Policy:

```
997 "aclist2": [  
998   {  
999     "subject": {"conntype" : "anon-clear" },  
1000     "resources": [  
1001       { "wc": "*" }  
1002     ],  
1003     "permission": 31  
1004   },  
1005   {  
1006     "subject": {"conntype" : "auth-crypt" },  
1007     "resources": [  
1008       { "wc": "*" }  
1009     ],  
1010     "permission": 31  
1011   },  
1012 ]
```

1013 Details of the format for ACL are defined in clause 0. The ACL is composed of one or more ACEs.

1014 Some Resources, such as Collections, generate requests to linked Resources when appropriate
1015 Interfaces are used. In such cases, additional access control considerations are necessary.
1016 Additional access control considerations for Collections when using the batch OCF Interface are
1017 found in clause 12.2.7.3. ACL Resource requires the same security protection as other sensitive
1018 Resources when it comes to both storage and handling by the SRM.

1019 **5.2.2 ACL Architecture**

1020 The Server examines the Resource(s) requested by the client before processing the request. The
1021 access control Resource is searched to find one or more ACE entries that match the Client and
1022 the requested Resources. If a match is found, then permission and period constraints are applied.
1023 If more than one match is found, then each ACE entry is evaluated for a match independently.

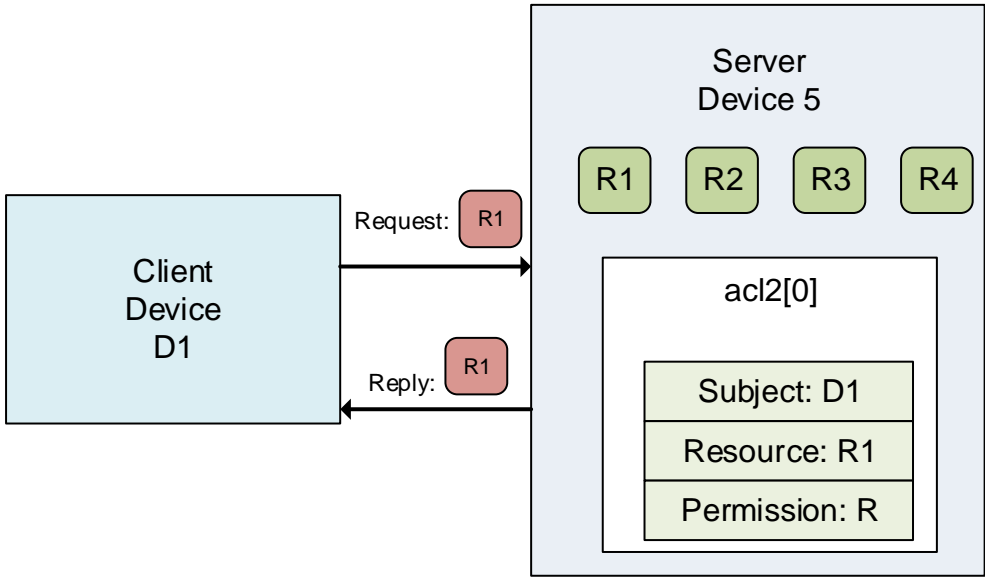
1024 The Server uses the connection context to determine whether the subject has authenticated or not
1025 and whether data confidentiality has been applied or not. If the user has authenticated, then subject
1026 matching may happen at increased granularity based on role or device identity.

1027 Each ACE contains the permission set that will be applied for a given Client. Permissions consist
1028 of a combination of CREATE, RETREIVE, UPDATE, DELETE and NOTIFY (CRUDN) actions.
1029 Clients authenticate as a Device and optionally operating with one or more roles. Devices may
1030 acquire elevated access permissions when asserting a role. For example, an "oic.role.owner" role
1031 might expose additional Resources and OCF Interfaces not normally accessible.

1032 Servers host ACL Resources locally. Local ACLs allow greater autonomy in access control
1033 processing.

1034 The following use cases describe the operation of access control:

1035 Use Case 1: As depicted in Figure 8, Server Device hosts 4 Resources (R1, R2, R3 and R4). Client
1036 Device D1 requests access to Resource R1 hosted at Server Device 5. ACL[0] corresponds to
1037 Resource R1 and includes D1 as an authorized subject. Thus, Device D1 receives access to
1038 Resource R1 because the local ACL "/oic/sec/acl2/0" matches the request.



1040 **Figure 8 – Use case-1 showing simple ACL enforcement**

1042 **5.3 Onboarding Overview**

1043 **5.3.1 Onboarding General**

1044 Before a Device becomes operational in an OCF environment and is able to interact with other
1045 Devices, it needs to be appropriately onboarded. The first step in onboarding a Device is to
1046 configure the ownership where the legitimate user that owns/purchases the Device uses an
1047 Onboarding tool (OBT) and using the OBT uses one of the Owner Transfer Methods (OTMs) to
1048 establish ownership. Once ownership is established, the OBT provisions the Device, at the end of
1049 which the Device becomes operational and is able to interact with other Devices in an OCF
1050 environment.

1051 Figure 9 depicts an overview of Onboarding.

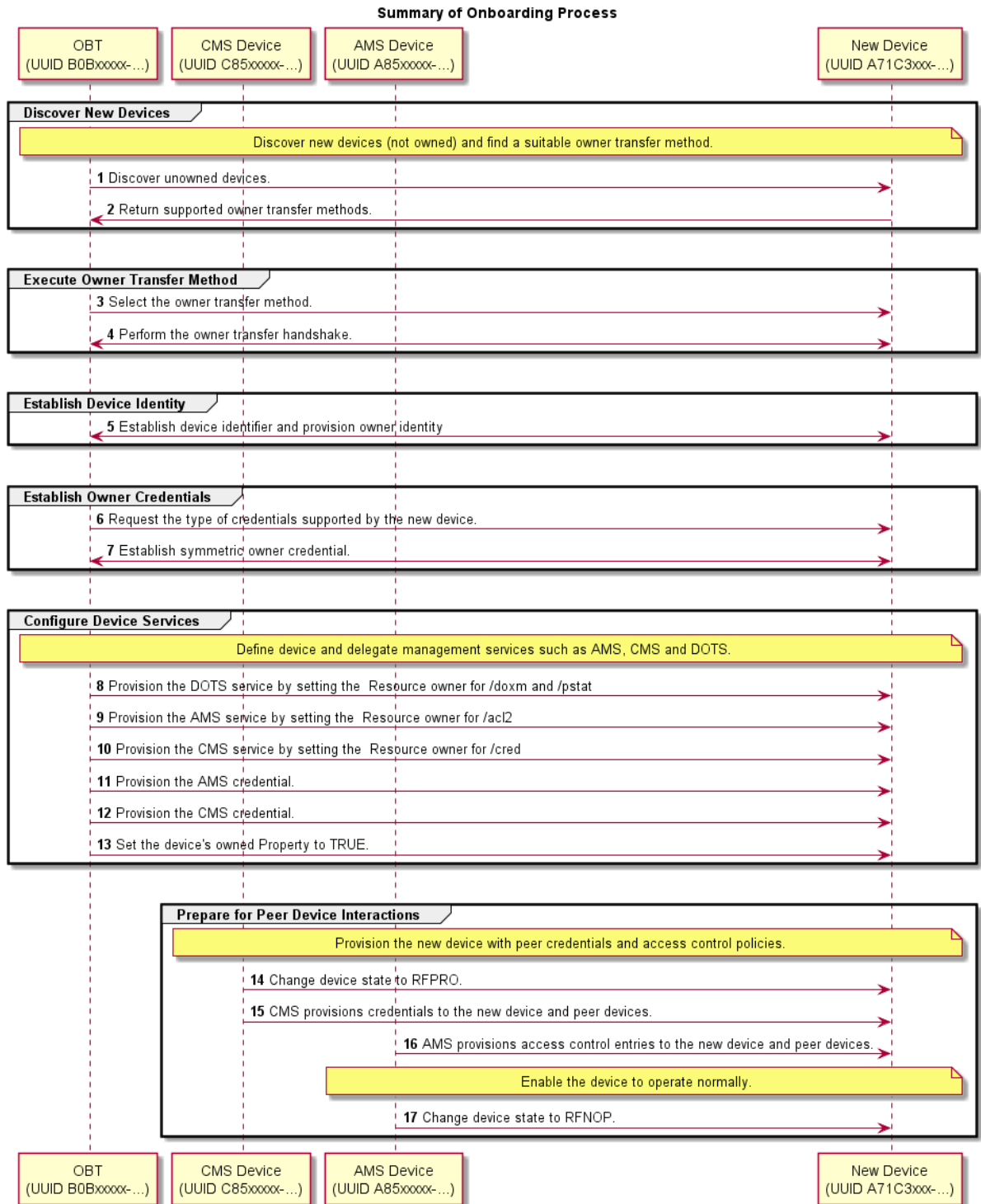


Figure 9 – Onboarding overview

This clause explains the onboarding and security provisioning process but leaves the provisioning of non-security aspects to other OCF documents. In the context of security, all Devices are required to be provisioned with minimal security configuration that allows the Device to securely interact/communicate with other Devices in an OCF environment. This minimal security configuration is defined as the Onboarded Device RFNOP and is specified in 0.

5.3.2 Onboarding Steps

The flowchart in Figure 10 shows the typical steps that are involved during onboarding. Although onboarding may include a variety of non-security related steps, the diagram focus is mainly on the security related configuration to allow a new Device to function within an OCF environment. Onboarding typically begins with the Device becoming an Owned Device followed by configuring the Device for the environment that it will operate in. This would include setting information such as who may access the Device and what actions may be performed as well as what permissions the Device has for interacting with other Devices.

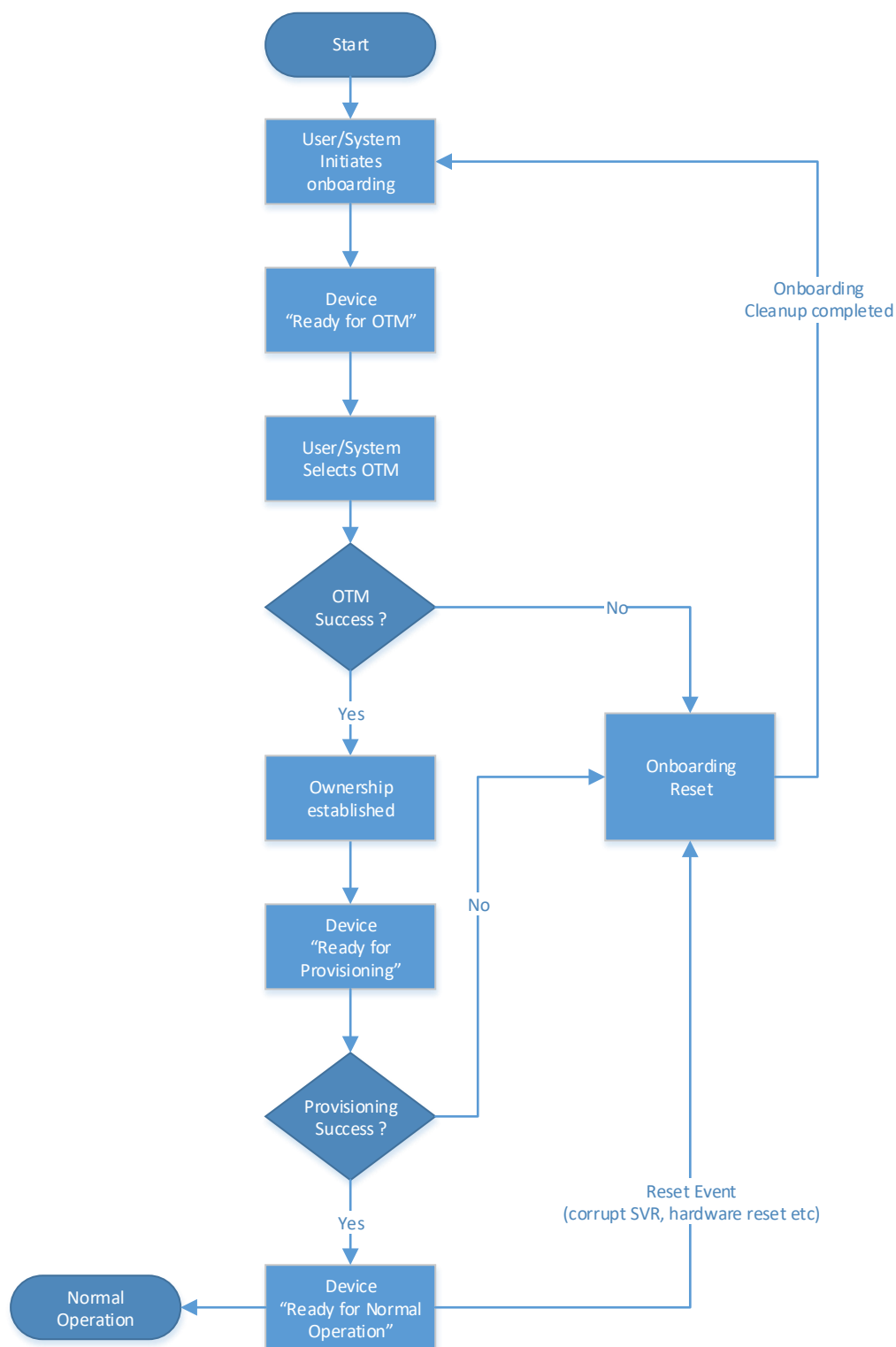


Figure 10 – OCF Onboarding Process

5.3.3 Establishing a Device Owner

The objective behind establishing Device ownership is to allow the OCF Security Domain Owner to assert itself as the owner and manager of the Device and introduce the Device into the OCF Security Domain. This is done through the use of a DOTS that includes the creation of an ownership

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1073 context between the new Device and the DOTS and asserts operational control and management
1074 of the Device. The DOTS is hosted on an OBT.

1075 The DOTS uses one of the OTMs specified in 7.3 to securely establish Device ownership.

1076 An OTM establishes a new owner (the operator of DOTS) that is authorized to manage the Device.
1077 Ownership Transfer accomplishes the following:

- 1078 – The DOTS provisions an Owner Credential (OC) to the "creds" Property in the "/oic/sec/cred"
1079 Resource of the Device. This OC allows the Device and DOTS to mutually authenticate during
1080 subsequent interactions. The OC associates the DOTS Device UUID with the "rowneruuid"
1081 Property of the "/oic/sec/doxm" Resource establishing it as the Resource owner.
- 1082 – The Device owner establishes trust in the Device through the OTM.
- 1083 – Provisioning of appropriate credentials for the Device to be a member of the OCF Security
1084 Domain.

1085 **5.3.4 Provisioning for Normal Operation**

1086 Once the Device has the necessary information to initiate provisioning, the next step is to provision
1087 additional security configuration that allows the Device to become operational. This may include
1088 setting various parameters and may also involve multiple steps. Also provisioning of ACL's for the
1089 various Resources hosted by the Server on the Device is done at this time. The provisioning step
1090 is not limited to this stage only. Device provisioning may happen at multiple stages in the Device's
1091 operational lifecycle. However specific security related provisioning of Resource and Property state
1092 would likely happen at this stage at the end of which, each Device reaches RFNOP. RFNOP is
1093 consistent and well defined regardless of the specific OTM used or regardless of the variability in
1094 what gets provisioned. However individual OTM mechanisms and provisioning steps may specify
1095 additional configuration of Resources and Property states. The minimal mandatory configuration
1096 required for a Device to be in RFNOP is specified in 0.

1097 **5.3.5 OCF Compliance Management System**

1098 The OCF Compliance Management System (OCMS) is a service maintained by the OCF that
1099 provides Certification status and information for OCF Devices.

1100 The OCMS shall provide a JSON-formatted Certified Product List (CPL), hosted at the URI:
1101 <https://www.openconnectivity.org/certification/ocms-cpl.json>

1102 The OBT shall possess the Root Certificate needed to enable https connection to the URI
1103 <https://www.openconnectivity.org/certification/ocms-cpl.json>.

1104 The OBT should periodically refresh its copy of the CPL via the URI
1105 <https://www.openconnectivity.org/certification/ocms-cpl.json>, as appropriate to OCF Security
1106 Domain owner policy requirements.

1107 **5.4 Provisioning**

1108 **5.4.1 Provisioning General**

1109 OCF security provisioning includes processes during and after the ownership transfer like
1110 configuration of credentials for interacting with provisioning services, configuration of any security
1111 related Resources and credentials for interacting with any services or Devices that the provisioned
1112 Device needs to contact later on.

1113 The Device needs to engage with the CMS and AMS to be provisioned with:

- 1114 – Security credentials through a CMS, which is currently assumed to be embedded in the same
1115 OBT as the DOTS.
- 1116 – Access control policies and ACLs through an AMS, which is currently assumed to be embedded
1117 in the same OBT as the DOTS.

1118 To be able to support the use of distinct device management services, some Device Secure Virtual
1119 Resources (SVRs) have an associated Resource owner identified in the Resource's rowneruuid
1120 Property.

1121 The "rowneruuid" Property of the "/oic/sec/doxm" and "/oic/sec/pstat" Resources identifies the
1122 DOTS.

1123 The "rowneruuid" Property of the "/oic/sec/cred" Resource identifies the CMS.

1124 The "rowneruuid" Property of the "/oic/sec/acl2" Resource identifies the AMS.

1125 The DOTS provisions credentials that enable secure connections between OCF Services and the
1126 new Device. The DOTS initiates client-directed provisioning by signaling the OCF Service.

1127 **5.4.2 Access Control Provisioning**

1128 ACL provisioning is performed over a secure connection between the AMS and its Devices. The
1129 AMS provisions the ACL by updating the Device's ACL Resource.

1130 **5.4.3 Credential Provisioning**

1131 The CMS securely provisions credentials for Device-to-Device interactions using the CMS
1132 credential provisioned by the DOTS during the onboarding procedure. The CMS is also expected
1133 to proactively monitor the credentials installed on the Device and update them when needed (e.g.
1134 close to the expiration date).

1135 **5.4.4 Role Provisioning**

1136 The Servers, receiving requests for Resources they host, need to verify the role identifier(s)
1137 asserted by the Client requesting the Resource and compare that role identifier(s) with the
1138 constraints described in the Server's ACLs. Thus, a Client may need to be provisioned with one or
1139 more role credentials. Once provisioned, the Client can assert the role it is using as described in
1140 10.4.2, if it has a certificate role credential.

1141 Each Device holds the assertable role(s) information as a Property within the Credential Resource.
1142 Each Device holds the asserted role(s) information as Properties within the Roles Resource.

1143 All asserted roles are used in ACL enforcement. When a server has multiple roles asserted for a
1144 Client, access to a Resource is granted if it would be granted under any of the roles.

1145 **5.5 Secure Resource Manager (SRM)**

1146 SRM plays a key role in the overall security operation. In short, SRM performs both management
1147 of SVR and access control for requests to access and manipulate Resources. SRM consists of 3
1148 main functional elements:

- 1149 – A Resource manager (RM): responsible for 1) Loading SVRs from persistent storage (using PSI)
1150 as needed. 2) Supplying the Policy Engine (PE) with Resources upon request. 3) Responding
1151 to requests for SVRs. While the SVRs are in SRM memory, the SVRs are in a format that is
1152 consistent with device-specific data store format. However, the RM will use JSON format to
1153 marshal SVR data structures before being passed to PSI for storage, or travel off-device.
- 1154 – A Policy Engine (PE) that takes requests for access to SVRs and based on access control
1155 policies responds to the requests with either "ACCESS_GRANTED" or "ACCESS_DENIED". To
1156 make the access decisions, the PE consults the appropriate ACL and looks for best Access
1157 Control Entry (ACE) that can serve the request given the subject (Device or role) that was
1158 authenticated by DTLS.
- 1159 – Persistent Storage Interface (PSI): PSI provides a set of APIs for the RM to manipulate files in
1160 its own memory and storage. The SRM design is modular such that it may be implemented in
1161 the Platform's secure execution environment; if available.

Figure 11 depicts OCF's SRM Architecture.

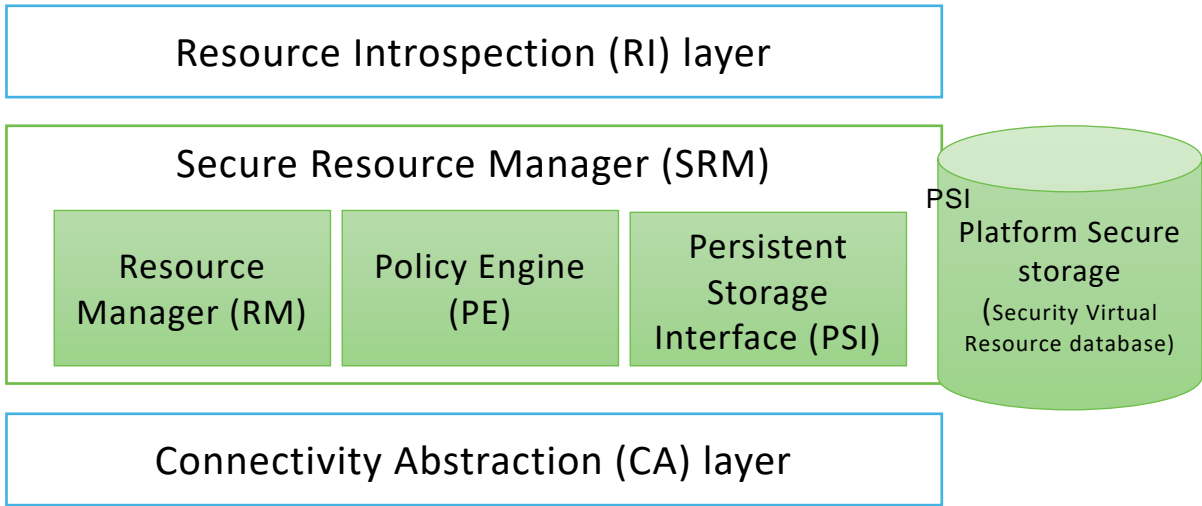


Figure 11 – OCF's SRM Architecture

5.6 Credential Overview

Devices may use credentials to prove the identity and role(s) of the parties in the Client to Server communication. Credentials may be symmetric or asymmetric. Each Device stores secret and public parts of its own credentials where applicable, as well as credentials for other Devices that have been provisioned by the DOTS or a CMS. These credentials may then be used in the establishment of secure communication sessions (e.g. using DTLS, TLS or OSCORE). Role certificates may be used after an authenticated session is established to assert one or more roles for a Device.

The credential types available within this document include:

- Pairwise symmetric keys
- Certificates
- Raw asymmetric keys

Devices may not support all of these credential types. The set of supported credential types for any Device is contained in its "sct" Property of the "/oic/sec/doxm" Resource.

5.7 Event Logging

5.7.1 Event Logging General

An OCF Platform can generate various kinds of Auditable Events. These Auditable Events can be used for log analysis or for real-time understanding of a system condition. Usually multiple Auditable Events are stored to backtrack problems that have occurred in the system. The storage capacity of IoT devices is typically very limited, so a specific type of data structure such as a ring buffer is often used.

An OCF Device logs Auditable Event Entries (AEE) for all Auditable Events that satisfy the "categoryfilter" and "priorityfilter" Properties of the "/oic/sec/ael" Resource. The AEEs are stored in local storage (see Figure 1). Due to the limited size of the local storage, OCF Security Domain Owner is expected to adjust the filtering options.



Figure 12 – Store Events in local storage

5.8 End-to-End Security of Unicast Messages

The Security model for End-to-End Security of Unicast Messages is described in Figure 3 and Figure 4 of clause 5.1 and the accompanying steps.

OCF uses the Object Security for Constrained RESTful Environments (OSCORE) protocol IETF RFC 8613 for End-to-End Security of Unicast Messages. The Origin Client transforms a CoAP-encoded OCF CRUDN request message into an OSCORE request message which can be forwarded towards the Target Server by OCF Proxies; the Target Server then processes the OSCORE request message to extract the OCF CRUDN request message. Likewise, the Target Server then transforms a CoAP-encoded OCF CRUDN response message into an OSCORE response message which can be forwarded towards the Origin Client by OCF Proxies; the Origin Client then processes the OSCORE response message to extract the OCF CRUDN response message. OSCORE preserves the confidentiality, integrity and freshness of the OCF CRUDN messages while in transit between the Origin Client and the Target Server.

OSCORE specification supports transporting OSCORE messages using the CoAP protocol already used in OCF specifications. The payload of the OSCORE message is a CBOR Object Signature and Encryption (COSE) object (see IETF RFC 8152) in which all elements of the CoAP-encoded OCF CRUDN message, other than those parts which are needed for delivering the message to the receiving Device, are encrypted and integrity protected. OSCORE also includes replay protection.

5.9 Overview of Simple Secure Multicast

The Security model for SSM is described in Figure 6 of clause 5.1 and the accompanying steps. OCF uses the OSCORE protocol IETF RFC 8613 for the Security of SSM Messages. The Client transforms a CoAP-encoded UPDATE request message into an OSCORE request message which can be forwarded towards the Servers of the SSM Group using network-layer multicast; the Server then processes the OSCORE request message to extract the UPDATE request message.

Note: OSCORE is also used, albeit slightly differently, for End-to-End Security of Unicast Messages.

The intended use of the SSM feature is only for updating Resources with one non-confirmable multicast request. Other CRUDN operations (e.g. RETRIEVE, confirmable UPDATE, etc) are not supported because the SSM protocol is not designed to send individual responses back on the request. Hence when sending such operation by means of SSM, the individual Servers will silently ignore the request message and not send a response.

The OSCORE specification supports transporting OSCORE messages using the CoAP protocol already used in OCF specifications. The payload of the OSCORE message is a CBOR Object Signing and Encryption (COSE) object (see IETF RFC 8152) in which all elements of the CoAP-encoded UPDATE request message, other than those parts which are needed for delivering the message to the receiving Device, are encrypted and integrity protected. OSCORE also includes replay protection.

The setup of the OSCORE security context for an SSM Group is a 1-N relationship:

- the SSM Client Context of the SSM Group is only provisioned once in the Client of the SSM Group, and
- copies of the SSM Server Context of the SSM Group are provisioned to one or more Servers in the SSM Group.

Figure 13 depicts the relationship of the SSM Client Context and SSM Server Context.

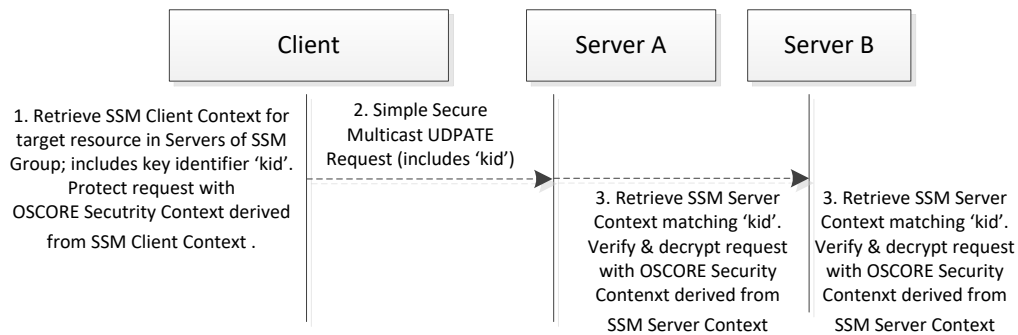


Figure 13 – Relationship diagram for Simple Secure Multicast messages

Figure 14 depicts the full setup and usage.

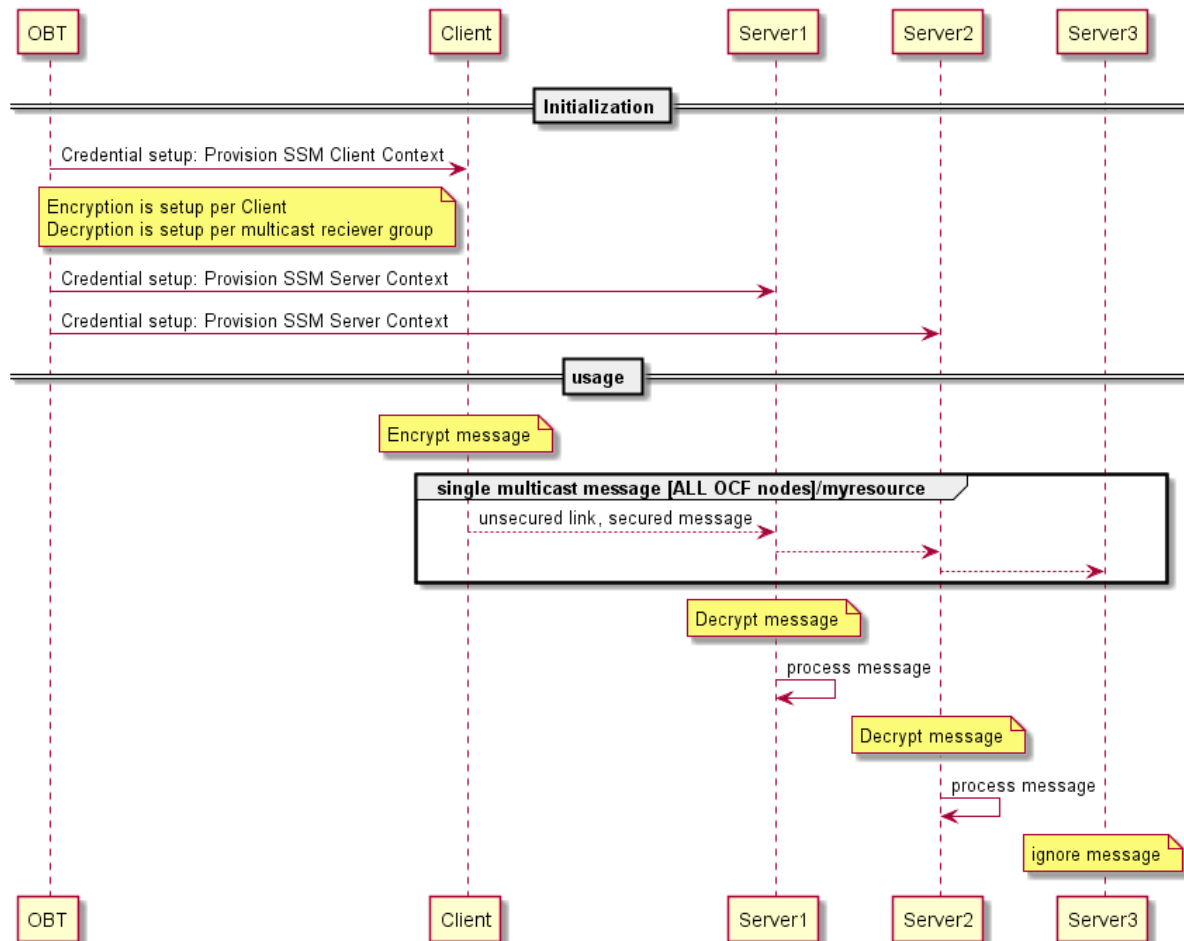


Figure 14 – Setup and usage of Secure Simple Multicast

The first message after onboarding is implicitly trusted by the Server as being a valid message. This is due to the replay window not yet being set up by the Server. The Server stores the received information so that the replay protection is enabled after receiving the first message.

Security for the Discovery Process

6.1 Preamble

The main function of a discovery mechanism is to provide Universal Resource Identifiers (URIs, called links) for the Resources hosted by the Server, complemented by attributes about those Resources and possible further link relations. (in accordance to clause 10 in ISO/IEC 30118-1)

6.2 Security Considerations for Discovery

When defining discovery process, care must be taken that only a minimum set of Resources are exposed to the discovering entity without violating security of sensitive information or privacy requirements of the application at hand. This includes both data included in the Resources, as well as the corresponding metadata.

To achieve extensibility and scalability, this document does not provide a mandate on discoverability of each individual Resource. Instead, the Server holding the Resource will rely on ACLs for each Resource to determine if the requester (the Client) is authorized to see/handle any of the Resources.

The `"/oic/sec/acl2"` Resource contains ACL entries governing access to the Server hosted Resources. (See 13.5)

Aside from the privacy and discoverability of Resources from ACL point of view, the discovery process itself needs to be secured. This document sets the following requirements for the discovery process:

- 1) Providing integrity protection for discovered Resources.
- 2) Providing confidentiality protection for discovered Resources that are considered sensitive.

The discovery of Resources is done by doing a RETRIEVE operation (either unicast or multicast) on the known `"/oic/res"` Resource.

The discovery request is sent over a non-secure channel (multicast or unicast without DTLS), a Server cannot determine the identity of the requester. In such cases, a Server that wants to authenticate the Client before responding can list the secure discovery URI (e.g. `coaps://IP:PORT/oic/res`) in the unsecured `"/oic/res"` Resource response. This means the secure discovery URI is by default discoverable by any Client. The Client will then be required to send a separate unicast request using DTLS to the secure discovery URI.

For example, a Client with Device UUID `"d1"` (UUID:`"0685B960-736F-46F7-BEC0-9E6CBD61ADC1"`) makes a RETRIEVE request on the `"/door"` Resource hosted on a Server with Device UUID `"d3"` where d3 has the ACL2s:

```
{
  "aclist2": [
    {
      "subject": {"uuid": "0685B960-736F-46F7-BEC0-9E6CBD61ADC1"},
      "resources": [{"href": "/door"}],
      "permission": 2, // RETRIEVE
      "aceid": 1
    },
    {
      "subject": {"authority": "owner", "role": "owner"},
      "resources": [{"href": "/door"}],
      "permission": 2, // RETRIEVE
      "aceid": 2
    }
  ]
}
```

```

1288     },
1289     {
1290         "subject": {"uuid": "0685B960-736F-46F7-BEC0-9E6CBD61ADC1"},
1291         "resources": [{"href": "/door/lock"}],
1292         "permission": 4, // UPDATE
1293         "aceid": 3
1294     }
1295 ],
1296 "rowneruuid": "0685B960-736F-46F7-BEC0-9E6CBD61ADC1"
1297 }

```

1298 The ACL indicates that Client "d1" has RETRIEVE permissions on the Resource. Hence when
 1299 device "d1" does a discovery on the "/door" Resource of the Server "d3", the response will include
 1300 all the URIs in the "/door" Resource. Client "d2" without a Role ID "owner" will get an error response
 1301 that includes no URI.

1302 Discovery results delivered to d1 regarding d3's "/door" Resource from the secure interface:

```

1303 [
1304   {
1305     "href": "/door",
1306     "rel": "self",
1307     "rt": ["oic.wk.col"],
1308     "if": ["oic.if.ll", "oic.if.b", "oic.if.baseline"],
1309     "eps": [{"ep": "coaps://[2001:db8:a::b1d4]:5555"}]
1310   },
1311   {
1312     "href": "/door/lock",
1313     "rt": ["oic.r.lock.status"],
1314     "if": ["oic.if.a", "oic.if.baseline"],
1315     "eps": [{"ep": "coaps://[2001:db8:a::b1d4]:5555"}]
1316   }
1317 ]

```

Security Provisioning

7.1 Device Identity

7.1.1 General Device Identity

A Device shall be identified by a Device UUID value that is established as part of the device onboarding and contained in the "deviceuuid" Property of the "/oic/sec/doxm" Resource. Device UUIDs shall be unique within the scope of the corresponding OCF Security Domain, and are expected to be randomly generated and provisioned by the OBT. The DOTS is expected to verify that the chosen new Device UUID does not conflict with Device UUIDs previously introduced into the OCF Security Domain.

Devices maintain an association of their Device UUIDs and their own cryptographic credential(s) via "/oic/sec/cred" Resource. The identity is cryptographically bound in case of a certificate credential, or is bound via internal mappings in the "/oic/sec/cred" Resource otherwise. The "/oic/sec/cred" Resource maintains a list of a Device's own and other Device's credentials. Multiple credentials may be associated with the same Device UUID. A Device is expected to only present credentials associated with its own Device UUID for peer authentication purposes. Devices regard the "/oic/sec/cred" Resource as authoritative when verifying authentication credentials of a peer Device.

In case of an authenticated connection, the Device UUID is treated as a Client's identity for purposes of the Access Control check for the target Resource. The Device UUID of a Client is matched against the Subject UUIDs in the pre-provisioned entries of Server's "/oic/sec/acl2" Resource. The Server determines Client's Device UUID based on the credential used for the establishment of the session.

An OCF Platform, which may host multiple Devices, is identified by a Platform ID. The Platform ID is globally unique and inserted in the device in an integrity protected manner (e.g. inside secure storage or signed and verified).

An OCF Platform may have a secure execution environment, used to secure unique identifiers and secrets. If a Platform hosts multiple Devices, some mechanism is needed to provide each Device with the appropriate and separate security context.

7.1.2 Device Identity for Devices with UAID [Deprecated]

This clause is intentionally left blank.

7.2 Device Ownership

This is an informative clause. Devices are logical entities that are security endpoints that have an identity that is authenticable using cryptographic credentials. A Device is Unowned when it is first initialized. Establishing device ownership is a process by which the device asserts its identity to the DOTS and the DOTS provisions an owner identity. This exchange results in the device changing its ownership state, thereby preventing a different DOTS from asserting administrative control over the device.

The ownership transfer process starts with the OBT discovering a new device that is in Unowned state through examination of the "Owned" Property of the "/oic/sec/doxm" Resource of the new device. At the end of ownership transfer, the following is accomplished:

- 1) The DOTS establishes a secure session with new device.
- 2) Optionally asserts any of the following:
 - a) Proximity (using PIN) of the OBT to the Platform.
 - b) Manufacturer's certificate asserting Platform vendor, model and other Platform specific attributes.

- 3) Determines the device identifier.
- 4) Determines the device owner.
- 5) Specifies the device owner (e.g. Device UUID of the OBT).
- 6) Provisions the device with owner's credentials.
- 7) Sets the "Owned" state of the new device to TRUE.

7.3 Device Ownership Transfer Methods

7.3.1 OTM implementation requirements

This document provides specifications for several methods for ownership transfer. Implementation of each individual ownership transfer method is considered optional. However, each device shall implement at least one of the ownership transfer methods not including vendor specific methods.

All OTMs included in this document are considered optional. Each vendor is required to choose and implement at least one of the OTMs specified in this document. The OCF, does however, anticipate vendor-specific approaches will exist. Should the vendor wish to have interoperability between a vendor-specific OTM and OBTs from other vendors, the vendor must work directly with OBT vendors to ensure interoperability. Notwithstanding, standardization of OTMs is the preferred approach. In such cases, a set of guidelines is provided in 7.3.7 to help vendors in designing vendor-specific OTMs.

The "/oic/sec/doxm" Resource is extensible to accommodate vendor-defined owner transfer methods (OTM). The DOTS determines which OTM is most appropriate to onboard the new Device. All OTMs shall represent the onboarding capabilities of the Device using the "oxms" Property of the "/oic/sec/doxm" Resource. The DOTS determines the Device's supported credential types using the Supported Credential Types "sct" Property of the "/oic/sec/doxm" Resource. The DOTS and CMS provision credentials according to the credential types supported.

Figure 15 depicts new Device discovery sequence.

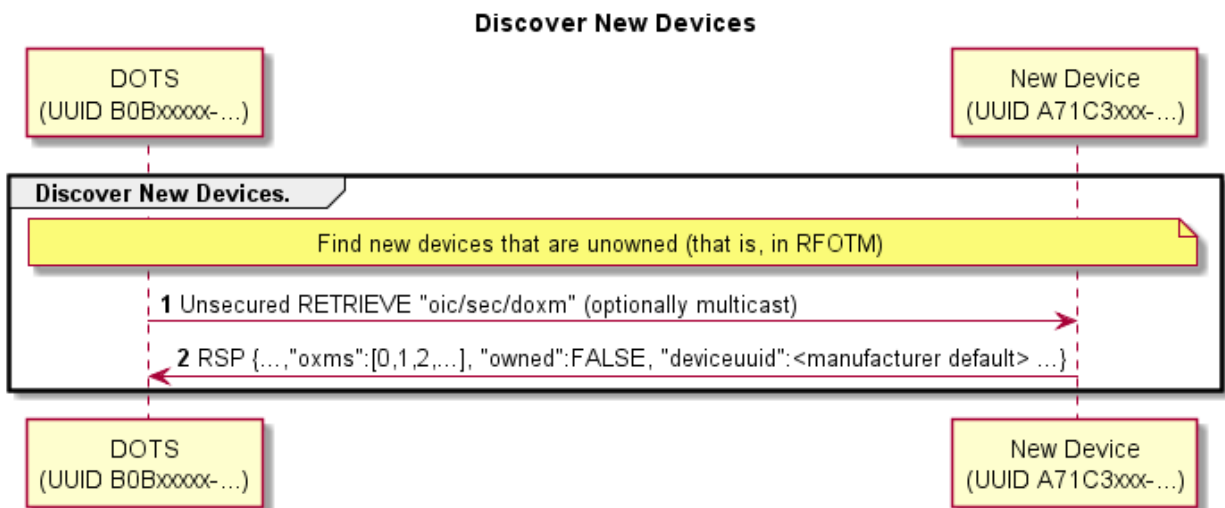


Figure 15 – Discover New Device Sequence

Table 1 – Discover New Device Details

Step	Description
1	The DOTS queries to see if the new device is not yet owned.
2	The new device returns the "/oic/sec/doxm" Resource containing ownership status and supported OTMs. It also contains a temporal Device UUID that may change subsequent to successful owner transfer. The device should supply a temporal ID to facilitate discovery as a guest device. Refer to OCF Onboarding Tool Specification for security considerations regarding selecting an OTM.

A Device shall support selective use of unsecured multicast to receive RETRIEVE requests to the Device "/oic/sec/doxm" Resource, as shown in Figure 15. Clause 10.4 of the ISO/IEC 30118-1 provides the generic details for using CoAP multicast requests in OCF. Multicast retrieval of the "/oic/sec/doxm" Resource supports filtering using the "owned" query parameter. When a multicast RETRIEVE request omits the "owned" query parameter or includes the "owned" query parameter set to "false", then the Device shall respond only if the Device is in RFOTM and there is no open Device Onboarding Connection. Otherwise the request shall be ignored by the Device, regardless of ACE configuration.

Vendor-specific device OTMs shall adhere to the "/oic/sec/doxm" Resource Specification for OCs that results from vendor-specific device OTM. Vendor-specific OTM should include provisions for establishing trust in the new Device by the DOTS and optionally establishing trust in the OBT by the new Device.

The new device may have to perform some initialization steps at the beginning of an OTM. For example, if the Random PIN Based OTM is initiated, the new device may generate a random PIN value. The DOTS updates the oxmsel property of "/oic/sec/doxm" to the value corresponding to the OTM being used, before performing other OTM steps. This update notifies the new device that ownership transfer is starting.

The end state of a vendor-specific OTM shall allow the new Device to authenticate to the OBT and the OBT to authenticate to the new device.

Additional provisioning steps may be performed subsequent to owner transfer success leveraging the established OTM session.

7.3.2 SharedKey Credential Calculation

The SharedKey credential is derived using a PRF that accepts the key_block value resulting from the DTLS handshake used for onboarding. The new Device shall use the following calculation to ensure interoperability across vendor products (the DOTS performs the same calculation):

SharedKey = *PRF*(Secret, Message);

Where:

- PRF shall use TLS 1.2 PRF defined by IETF RFC 5246 clause 5.
- Secret is the key_block resulting from the DTLS handshake
 - See IETF RFC 5246 clause 6.3
 - The length of key_block depends on cipher suite.
 - (e.g. 96 bytes for TLS_ECDHE_ECDSA_WITH_AES_128_CBC_SHA256
40 bytes for TLS_PSK_WITH_AES_128_CCM_8)
- Message is a concatenation of the following:
 - DoxmType string for the current onboarding method (e.g. "oic.sec.doxm.jw")
 - See clause 13.2.2 for specific DoxmTypes

- 1428 ▪ Owner ID is a UUID identifying the device owner identifier and the device that maintains SharedKey.
- 1429 • Use raw bytes as specified in IETF RFC 4122 clause 4.1.2
- 1430 ▪ Device UUID is new device's UUID
- 1431 • Use raw bytes as specified in IETF RFC 4122 clause 4.1.2
- 1432 - SharedKey Length will be 32 octets.
- 1433 ▪ If subsequent DTLS sessions use 128 bit encryption cipher suites the left most 16 octets will be used.
- 1434 DTLS sessions using 256-bit encryption cipher suites will use all 32 octets.

1435 **7.3.3 Certificate Credential Generation**

1436 The Certificate Credential will be used by Devices for secure bidirectional communication. The
1437 certificates will be issued by a CMS or an external certificate authority (CA). This CA will be used
1438 to mutually establish the authenticity of the Device.

1439 **7.3.4 Just-Works OTM**

1440 **7.3.4.1 Just-Works OTM General**

1441 Just-works OTM creates a symmetric key credential that is a pre-shared key used to establish a
1442 secure connection through which a device should be provisioned for use within the owner's OCF
1443 Security Domain. Provisioning additional credentials and Resources is a typical step following
1444 ownership establishment. The pre-shared key is called SharedKey.

1445 The DOTS selects the Just-works OTM using the "oxmsel" Property of the "/oic/sec/doxm"
1446 Resource and establishes a DTLS session using a cipher suite defined for the Just-works OTM.

1447 Just Works OTM sequence is shown in Figure 16 and steps described in Table 2.

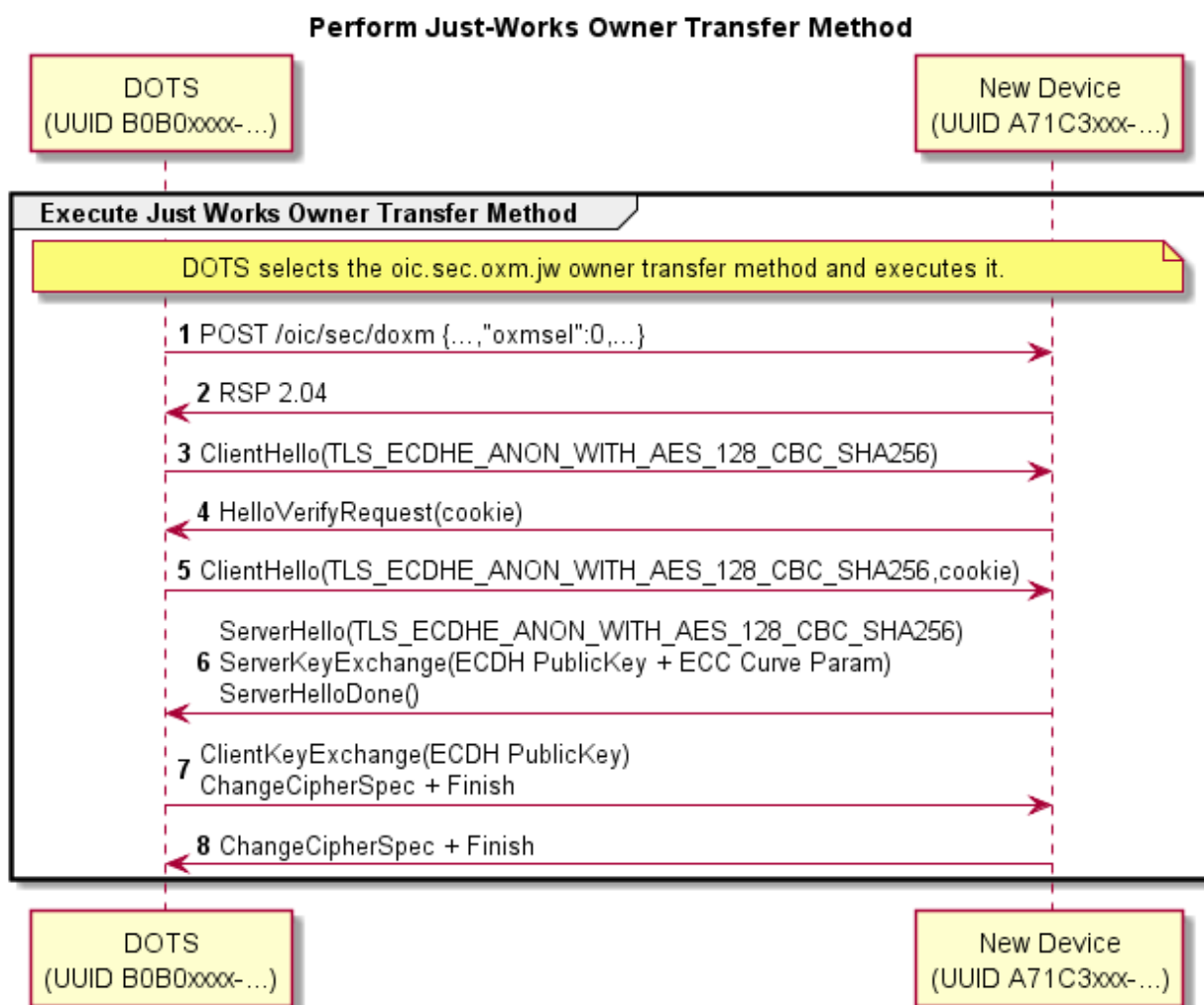


Figure 16 – A Just Works OTM

Table 2 – A Just Works OTM Details

Step	Description
1, 2	The DOTS notifies the Device that it selected the "Just Works" method.
3 - 8	A DTLS session is established using anonymous Diffie-Hellman. ^a
^a This method assumes the operator is aware of the potential for man-in-the-middle attack and has taken precautions to perform the method in a clean-room network.	

7.3.4.2 Security Considerations

Anonymous Diffie-Hellman key agreement is subject to a man-in-the-middle attacker. Use of this method presumes that both the DOTS and the new device perform the "just-works" method assumes onboarding happens in a relatively safe environment absent of an attack device.

This method doesn't have a trustworthy way to prove the Device UUID asserted is reliably bound to the device.

1458 The new device should use a temporal Device UUID prior to transitioning to an owned device while
1459 it is considered a guest device to prevent privacy sensitive tracking. The device asserts a non-
1460 temporal Device UUID that could differ from the temporal value during the secure session in which
1461 owner transfer exchange takes place. The DOTS verifies the asserted Device UUID does not
1462 conflict with a Device UUID already in use. If it is already in use the existing credentials are used
1463 to establish a secure session.

1464 An un-owned Device that also has established device credentials might be an indication of a
1465 corrupted or compromised device.

1466 **7.3.5 Random PIN based OTM**

1467 **7.3.5.1 Random PIN based OTM General**

1468 The Random PIN method establishes physical proximity between the new device and the OBT can
1469 prevent man-in-the-middle attacks. The Device generates a random number that is communicated
1470 to the DOTS over an Out of Band Communication Channel. The definition of an Out of Band
1471 Communication Channel is outside the scope of the definition of device OTMs. The DOTS and new
1472 Device use the PIN in a key exchange as evidence that an End User authorized the transfer of
1473 ownership by having physical access to the new Device via the Out-of-Band Communication
1474 Channel.

1475 **7.3.5.2 Random PIN based Owner Transfer Sequence**

1476 Random PIN-based OTM sequence is shown in Figure 17 and steps described in Table 3.

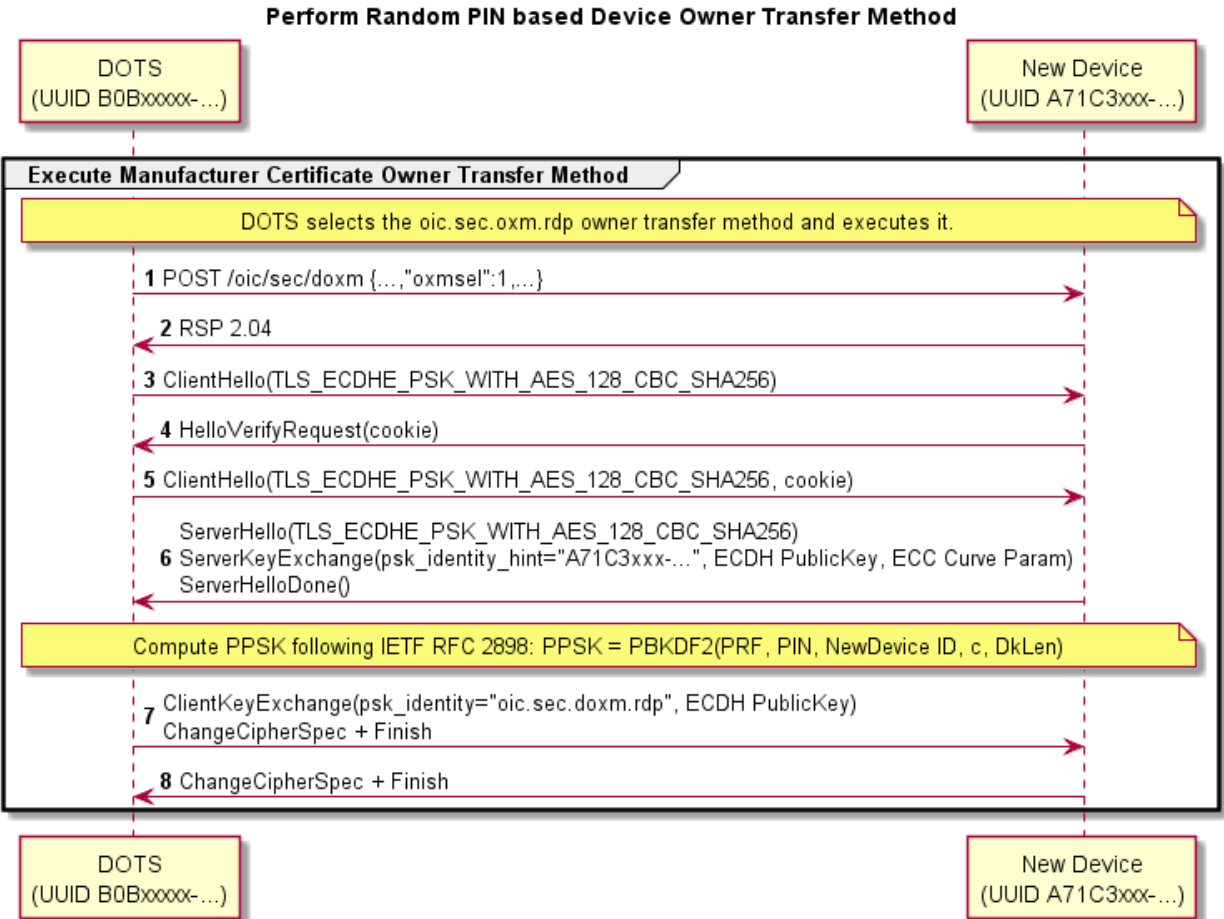


Figure 17 – Random PIN-based OTM

Table 3 – Random PIN-based OTM Details

Step	Description
1, 2	The DOTS notifies the Device that it selected the "Random PIN" method.
3 - 8	A DTLS session is established using PSK-based Diffie-Hellman cipher suite. The PIN is supplied as the PSK parameter. The PIN is randomly generated by the new device then communicated via an Out of Band Communication Channel that establishes proximal context between the new device and the DOTS. The security principle is the attack device will be unable to intercept the PIN due to a lack of proximity.

- The following requirements apply to the DTLS handshake messages for this OTM:
- At step 6:
 - The Server shall only use a DTLS ciphersuite supported by the Random PIN Based OTM (see clause 11.3.2.2),

- 1486 – The new Device shall set the "psk_identity_hint" field of the ServerKeyExchange message
- 1487 to the concatenation of
- 1488 – the string "oic.sec.doxm.rdp";
- 1489 – the colon character ':';
- 1490 – The "deviceuuid" Property of the "/oic/sec/doxm" Resource being sent in responses when
- 1491 the new Device is in RFOTM and when a Device Onboarding Connection is not currently
- 1492 established.
- 1493 – At step 7:
- 1494 – If the new Device determines that the "psk_identity" field of the ClientKeyExchange
- 1495 message does not match the string "oic.sec.doxm.rdp", then the new Device shall reject
- 1496 the DTLS Handshake.

- 1497 – the new Device shall apply the key derivation below.

1498 NOTE The string "oic.sec.doxm.rdp" is the URN defined for the Random PIN-based OTM in Table 19 and is included to
 1499 allow future OTMs to re-use the DTLS cipher suites without confusion about which OTM should be applied.

1500 This OTM uses a pseudo-random function (PBKDF2) defined by IETF RFC 2898 and a PIN
 1501 exchanged via an Out of Band Communication Channel to generate a pre-shared key. The PIN-
 1502 authenticated pre-shared key (PPSK) is supplied to TLS cipher suites that accept a PSK.

- 1503 – PPSK = PBKDF2(PRF, PIN, Device UUID, c, dkLen)

1504 The PBKDF2 function has the following parameters:

- 1505 – PRF – Uses the TLS 1.2 PRF defined by IETF RFC 5246.
- 1506 – PIN – obtained via Out of Band Communication Channel.
- 1507 – Device UUID – the "deviceuuid" Property of the "/oic/sec/doxm" Resource being sent in
- 1508 responses when the new Device is in RFOTM and when a Device Onboarding Connection is
- 1509 not currently established.

1510 Use raw bytes as specified in IETF RFC 4122 clause 4.1.2

- 1511 – c – Iteration count initialized to 1000
- 1512 – dkLen – Desired length of the derived PSK in octets.

1513 **7.3.5.3 Security Considerations**

1514 Security of the Random PIN mechanism depends on the entropy of the PIN. Using a PIN with
 1515 insufficient entropy may allow a man-in-the-middle attack to recover any long-term credentials
 1516 provisioned as a part of onboarding. In particular, learning the provisioned symmetric key
 1517 credentials allows an attacker to masquerade as the onboarded device.

1518 It is recommended that the entropy of the PIN be enough to withstand an online brute-force attack,
 1519 40 bits or more. For example, a 12-digit numeric PIN, or an 8-character alphanumeric (0-9a-z), or
 1520 a 7-character case-sensitive alphanumeric PIN (0-9a-zA-Z). A man-in-the-middle attack is when
 1521 the attacker is active on the network and can intercept and modify messages between the DOTS
 1522 and device. In the man-in-the-middle attack, the attacker must recover the PIN from the key
 1523 exchange messages in "real time", i.e., before the peer's time out and abort the connection attempt.
 1524 Having recovered the PIN, he can complete the authentication step of key exchange. The guidance
 1525 given here calls for a minimum of 40 bits of entropy, however, the assurance this provides depends
 1526 on the resources available to the attacker. Given the parallelizable nature of a brute force guessing
 1527 attack, the attack enjoys a linear speedup as more cores/threads are added. A more conservative
 1528 amount of entropy would be 64 bits. Since the Random PIN OTM requires using a DTLS cipher
 1529 suite that includes an ECDHE key exchange, the security of the Random PIN OTM is always at
 1530 least equivalent to the security of the JustWorks OTM.

The Random PIN OTM also has an option to use PBKDF2 to derive key material from the PIN. The rationale is to increase the cost of a brute force attack, by increasing the cost of each guess in the attack by a tuneable amount (the number of PBKDF2 iterations). In theory, this is an effective way to reduce the entropy requirement of the PIN. Unfortunately, it is difficult to quantify the reduction, since an X-fold increase in time spent by the honest peers does not directly translate to an X-fold increase in time by the attacker. This asymmetry is because the attacker may use specialized implementations and hardware not available to honest peers. For this reason, when deciding how much entropy to use for a PIN, it is recommended that implementers assume PBKDF2 provides no security, and ensure the PIN has sufficient entropy.

The Random PIN device OTM security depends on an assumption that a secure Out of Band Communication Channel for communicating a randomly generated PIN from the new device to the OBT exists. If the Out of Band Communication Channel leaks some or the entire PIN to an attacker, this reduces the entropy of the PIN, and the attacks described above apply. The Out of Band Communication Channel should be chosen such that it requires proximity between the DOTS and the new device. The attacker is assumed to not have compromised the Out of Band Communication Channel. As an example Out of Band Communication Channel, the device may display a PIN to be entered into the OBT software. Another example is for the device to encode the PIN as a 2D barcode and display it for a camera on the DOTS device to capture and decode.

7.3.6 Manufacturer Certificate Based OTM

7.3.6.1 Manufacturer Certificate Based OTM General

The manufacturer certificate-based OTM shall use a certificate embedded into the device by the manufacturer and may use a signed OBT, which determines the Trust Anchor between the device and the DOTS.

Manufacturer embedded certificates do not necessarily need to chain to an OCF Root CA trust anchor.

For some environments, policies or administrators, additional information about device characteristics may be sought. This list of additional attestations that OCF may or may not have tested (understanding that some attestations are incapable of testing or for which testing may be infeasible or economically unviable) can be found under the OCF Security Claims x509.v3 extension described in 9.4.2.2.6.

When utilizing certificate-based ownership transfer, devices shall utilize asymmetric keys with certificate data to authenticate their identities with the DOTS in the process of bringing a new device into operation on an OCF Security Domain. The onboarding process involves several discrete steps:

1) Pre-on-board conditions

- a) The credential element of the Device's credential Resource ("/oic/sec/cred") containing the manufacturer certificate shall be identified by the "credusage" Property containing the string "oic.sec.cred.mfgcert" to indicate that the credential contains a manufacturer certificate.
- b) The manufacturer certificate chain shall be contained in the identified credential element's "publicdata" Property.
- c) The device shall contain a unique and immutable ECC asymmetric key pair.
- d) If the device requires authentication of the DOTS as part of ownership transfer, it is presumed that the DOTS has been registered and has obtained a certificate for its unique and immutable ECC asymmetric key pair signed by the predetermined Trust Anchor.
- e) An End User has configured the DOTS app with network access info and account info (if any).

2) The DOTS authenticates the Device using ECDSA to verify the signature. Additionally, the Device may authenticate the DOTS to verify the DOTS signature.

1579 3) If authentication fails, the Device shall indicate the reason for failure and return to the RFOTM.
1580 If authentication succeeds, the Device shall establish an encrypted link with the DOTS in
1581 accordance with the negotiated cipher suite.

1582 **7.3.6.2 Certificate Profiles**

1583 See 9.4.2 for details.

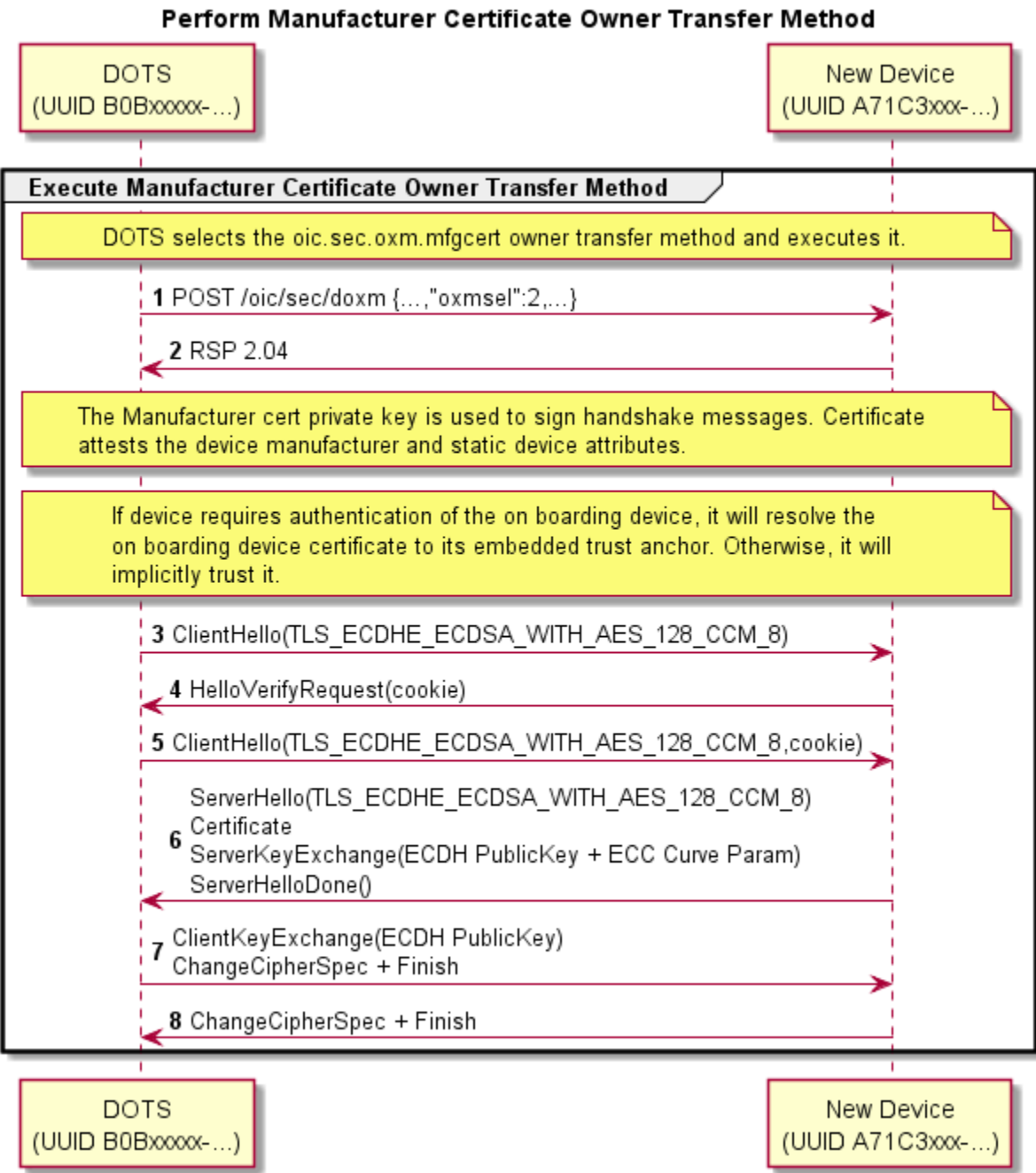
1584 **7.3.6.3 Certificate Owner Transfer Sequence Security Considerations**

1585

1586 The OBT shall authenticate the device during onboarding. The device will not authenticate the OBT.
1587 During the DTLS handshake the server shall not send a Certificate Request.

1588 **7.3.6.4 Manufacturer Certificate Based OTM Sequence**

1589 Manufacturer Certificate Based OTM sequence is shown in Figure 18 and steps described in
1590 Table 4.



1592

1593

1594

1595

Figure 18 – Manufacturer Certificate Based OTM Sequence

Table 4 – Manufacturer Certificate Based OTM Details

Step	Description
1, 2	The DOTS notifies the Device that it selected the "Manufacturer Certificate" method.

3 - 8	A DTLS session is established using the device's manufacturer certificate. The device's manufacturer certificate may contain data attesting to the Device hardening and security properties.
-------	----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------

1596 If the Manufacturer Certificate Based OTM is selected at step 1, then the following requirements
1597 apply:

1598 – At step 6:

1599 – The new Device shall use a DTLS ciphersuite supported for use with the Manufacturer
1600 Certificate Based OTM (see clause 11.3.2.3),

1601 – The new Device shall not send a CertificateRequest message.

1602 NOTE: CertificateRequest message is sent when establishing the DTLS connection for Device authentication using
1603 certificates (clause 10.4.1).

1604 **7.3.6.5 Security Considerations**

1605 The manufacturer certificate private key is embedded in the Platform with a sufficient degree of
1606 assurance that the private key cannot be compromised.

1607 The Platform manufacturer issues the manufacturer certificate and attests the private key
1608 protection mechanism.

1609 **7.3.7 Vendor Specific OTMs**

1610 **7.3.7.1 Vendor Specific OTM General**

1611 The OCF anticipates situations where a vendor will need to implement an OTM that accommodates
1612 manufacturing or Device constraints. The Device OTM Resource is extensible for this purpose.
1613 Vendor-specific OTMs must adhere to a set of conventions that all OTMs follow.

1614 – The OBT must determine which credential types are supported by the Device. This is
1615 accomplished by querying the Device's "/oic/sec/doxm" Resource to identify supported
1616 credential types.

1617 – The OBT provisions the Device with OC(s).

1618 – The OBT supplies the Device UUID and credentials for subsequent access to the OBT.

1619 – The OBT will supply second carrier settings sufficient for accessing the owner's OCF Security
1620 Domain subsequent to ownership establishment.

1621 – The OBT may perform additional provisioning steps but must not invalidate provisioning tasks
1622 to be performed by a security service.

1623 **7.3.7.2 Vendor-specific Owner Transfer Sequence Example**

1624 Vendor-specific OTM sequence example is shown in Figure 19 and steps described in Table 5.

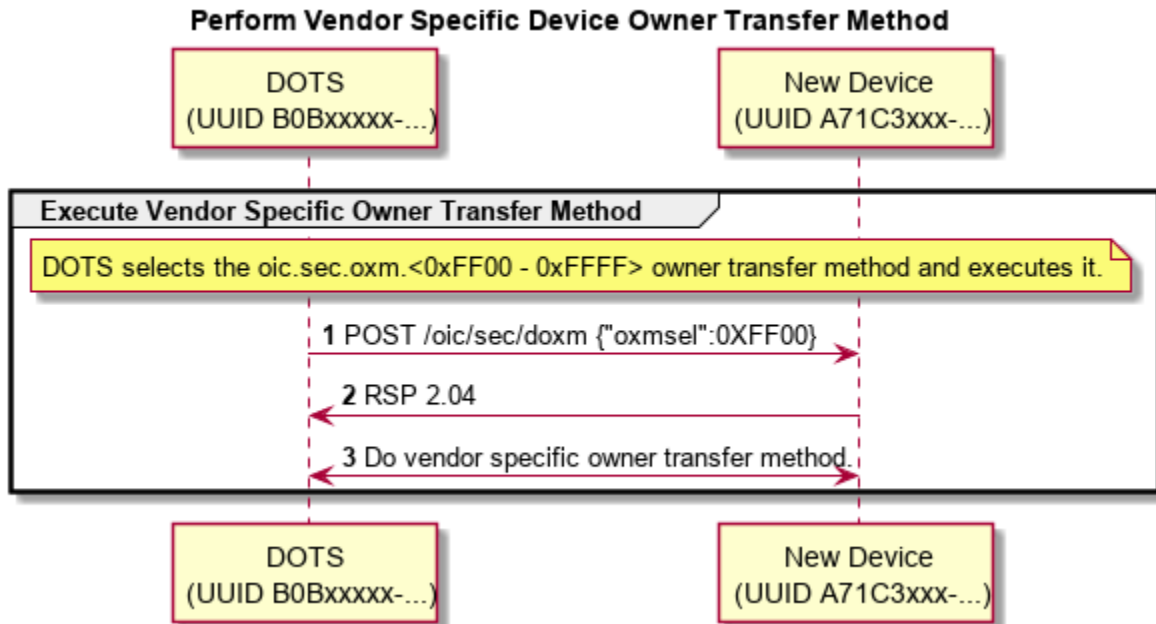


Figure 19 – Vendor-specific Owner Transfer Sequence

Table 5 – Vendor-specific Owner Transfer Details

Step	Description
1, 2	The DOTS selects a vendor-specific OTM.
3	The vendor-specific OTM is applied

7.3.7.3 Security Considerations

The vendor is responsible for considering security threats and mitigation strategies.

7.3.8 Establishing Owner Credentials

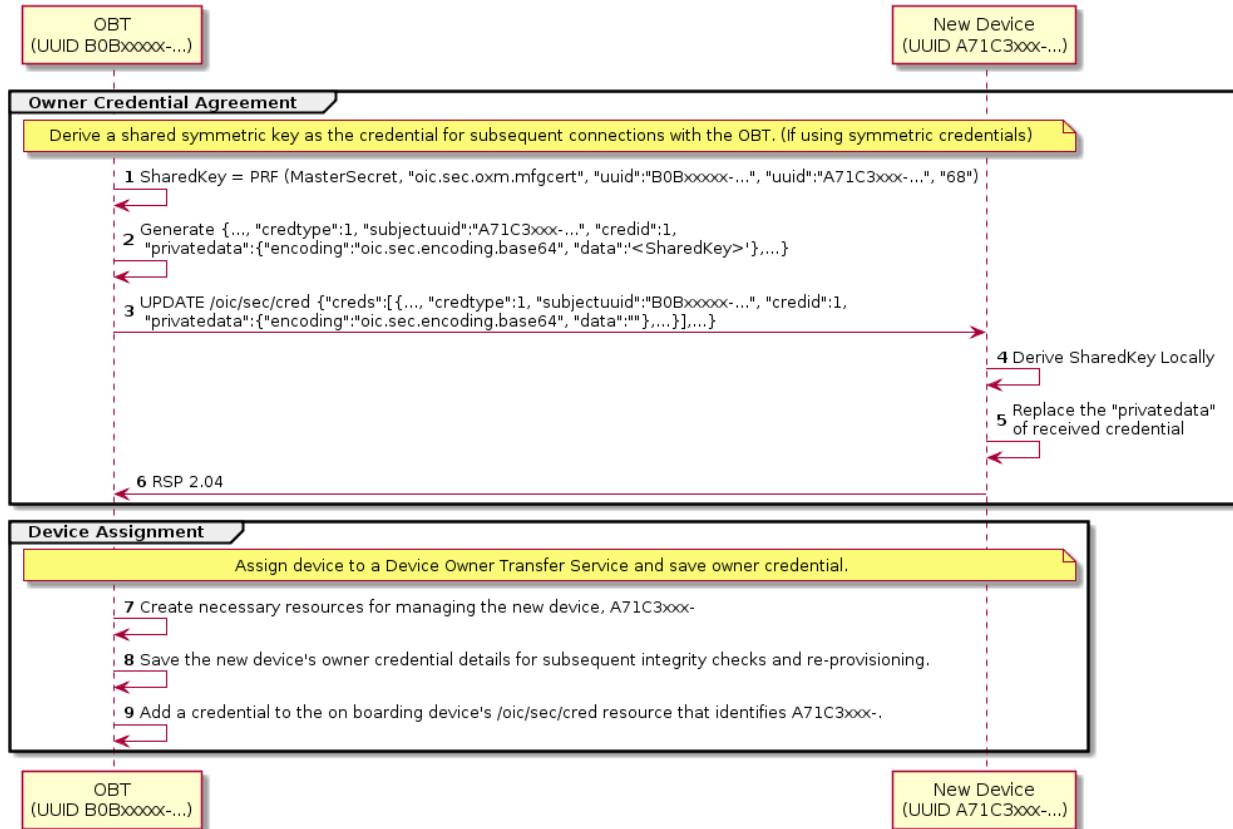
Once the OBT and the new Device have authenticated and established an encrypted connection using one of the defined OTM methods, the Owner Credential(s) can be provisioned.

The Owner Credential is provisioned as part of Ownership Transfer Method, and may be provisioned directly by CMS.

The steps for establishing Device's owner credentials (OC) as part of OTM are:

- 1) The OBT establishes the Device UUID and Device Owner Id.
- 2) The OBT then establishes Device's symmetric OC - See Figure 20 and Table 6.
- 3) Configure Device services.
- 4) Configure Device for peer to peer interaction.

Symmetric Owner Credential (OC) Assignment Sequence



1642

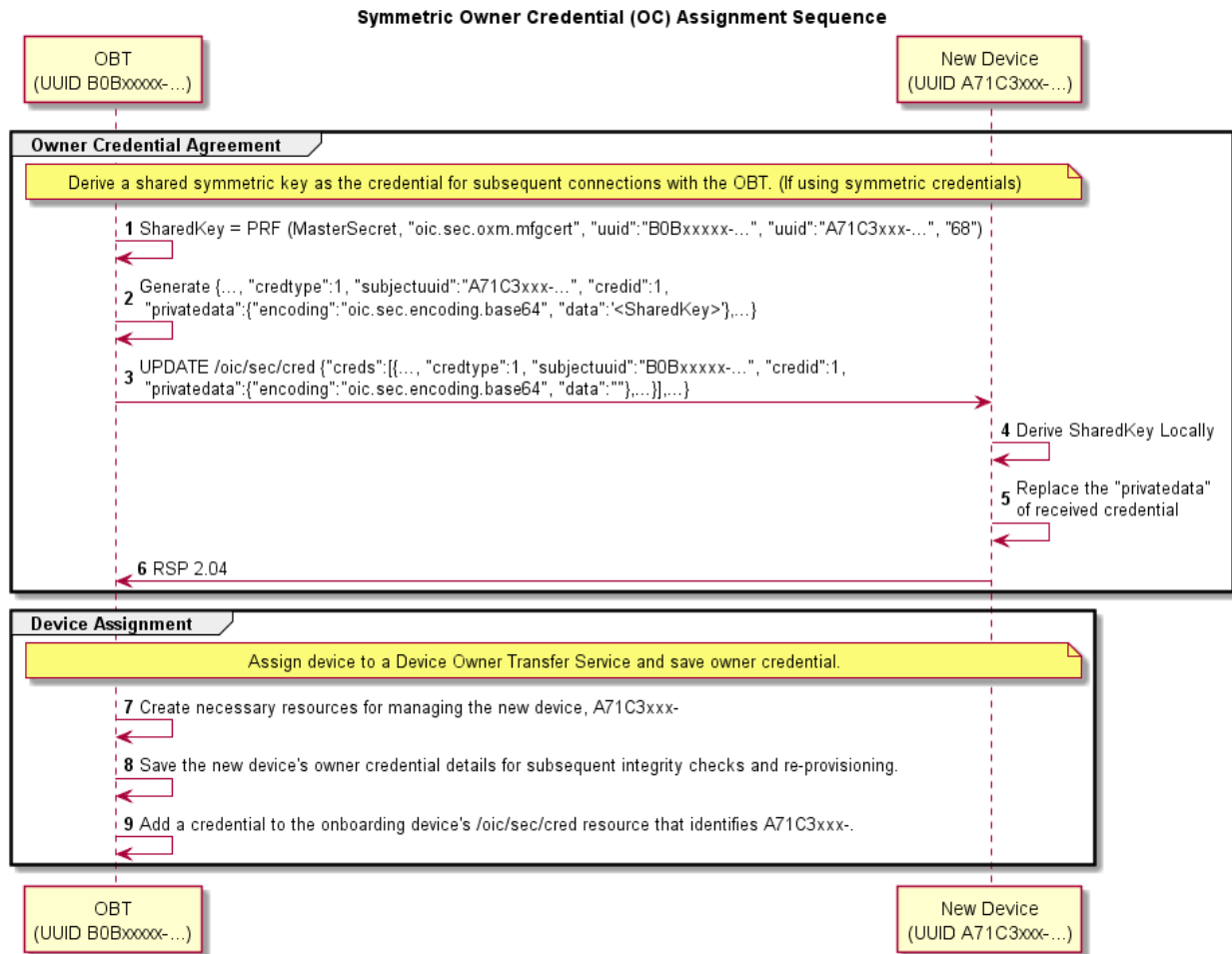


Figure 20 – Symmetric Owner Credential Provisioning Sequence

Table 6 – Symmetric Owner Credential Assignment Details

Step	Description
1, 2	The OBT uses a pseudo-random-function (PRF), the master secret resulting from the DTLS handshake, and other information to generate a symmetric key credential Resource Property - SharedKey.
3	The OBT creates a credential Resource Property set based on SharedKey and then sends the Resource Property set to the new Device with empty "privatedata" Property value.
4, 5	The new Device locally generates the SharedKey and updates it to the "privatedata" Property of the credential Resource Property set.
6	The new Device sends a success message.
7	The onboarding service creates a subjects Resource for the new device (e.g./A71C3xxx-...)
8	The onboarding service provisions its "/oic/svc/dots/subjects/A71C3xxx-/cred" Resource with

	the owner credential. Credential type is SYMMETRIC KEY.
9	(optional) The onboarding service provisions its own "/oic/sec/cred" Resource with the owner credential for new device. Credential type is SYMMETRIC KEY.

1647 In particular when OBT establishes symmetric owner credentials as part of OTM sequence:

- 1648 – The OBT generates a Shared Key using the SharedKey Credential Calculation method
1649 described in 7.3.2.
- 1650 – The OBT sends an empty key to the new Device's "/oic/sec/cred" Resource, identified as a
1651 symmetric pair-wise key. The Subject UUID of the "/oic/sec/cred" entry shall match the Device
1652 UUID of the OBT.
- 1653 – Upon receipt of the OBT's symmetric owner credential, the new Device shall independently
1654 generate the Shared Key using the SharedKey Credential Calculation method described in 7.3.2
1655 and store it with the owner credential.
- 1656 – The new Device shall use the Shared Key owner credential(s) stored via the "/oic/sec/cred"
1657 Resource to authenticate the owner during subsequent connections.

1658 **7.3.9 Security Profile Assignment**

1659 OCF Devices may have been evaluated according to an OCF Security Profile. Evaluation results
1660 could be accessed from a manufacturer's certificate, OCF web server or other public repository.
1661 The DOTS reviews evaluation results to determine which OCF Security Profiles the OCF Device is
1662 authorized to possess and configures the Device with the subset of evaluated security profiles best
1663 suited for the OCF Security Domain owner's intended segmentation strategy.

1664 The OCF Device vendor shall set a manufacturer default value for the "supportedprofiles" Property
1665 of the "/oic/sec/sp" Resource to match those approved by OCF's testing and certification process.
1666 The "currentprofile" Property of the "/oic/sec/sp" Resource shall be set to one of the values
1667 contained in the "supportedprofiles". The manufacturer default value shall be re-asserted when the
1668 Device transitions to RESET.

1669 The OCF Device shall only allow the "/oic/sec/sp" Resource to be updated when the Device is in
1670 one of the following Device States: RFOTM, RFPRO, SRESET and may not allow any update as
1671 directed by a Security Profile.

1672 The DOTS may update the "supportedprofiles" Property of the "/oic/sec/sp" Resource with a subset
1673 of the OCF Security Profiles values the Device achieved as part of OCF Conformance testing. The
1674 DOTS may locate conformance results by inspecting manufacturer certificates supplied with the
1675 OCF Device by selecting the "credusage" Property of the "/oic/sec/cred" Resource having the value
1676 of "oic.sec.cred.mfgcert". The DOTS may further locate conformance results by visiting a well-
1677 known OCF web site URI corresponding to the ocfCPLAttributes extension fields (clause 9.4.2.2.7).
1678 The DOTS may select a subset of Security Profiles (from those evaluated by OCF conformance
1679 testing) based on a local policy.

1680 As part of onboarding (while the OTM session is active) the DOTS should configure ACE entries to
1681 allow DOTS access subsequent to onboarding.

1682 The DOTS should update the "currentprofile" Property of the "/oic/sec/sp" Resource with the value
1683 that most correctly depicts the OCF Security Domain owner's intended Device deployment strategy.

1684 The CMS may issue role credentials using the Security Profile value (e.g. the "sp-blue-v0 OID") to
1685 indicate the OCF Security Domain owner's intention to segment the OCF Security Domain
1686 according to a Security Profile. The CMS retrieves the supportedprofiles Property of the
1687 "/oic/sec/sp" Resource to select role names corroborated with the Device's supported Security
1688 Profiles when issuing role credentials.

If the CMS issues role credentials based on a Security Profile, the AMS supplies access control entries that include the role designation(s).

7.4 Provisioning

7.4.1 Provisioning Flows

7.4.1.1 Provisioning Flows General

As part of onboarding a new Device a secure channel is formed between the new Device and the OBT. Subsequent to the Device ownership status being changed to "owned", there is an opportunity to begin provisioning. The OBT provisions the support services that should be subsequently used to complete Device provisioning and on-going Device management.

The Device employs a Client-directed provisioning strategy. The "/oic/sec/pstat" Resource identifies the provisioning strategy and current provisioning status. The provisioning service should determine which provisioning strategy is most appropriate for the OCF Security Domain. See 13.8 for additional detail.

7.4.1.2 Client-directed Provisioning

Client-directed provisioning relies on a provisioning service that identifies Servers in need of provisioning then performs all necessary provisioning duties.

An example of Client-directed provisioning is shown in Figure 21 and steps described in Table 7.

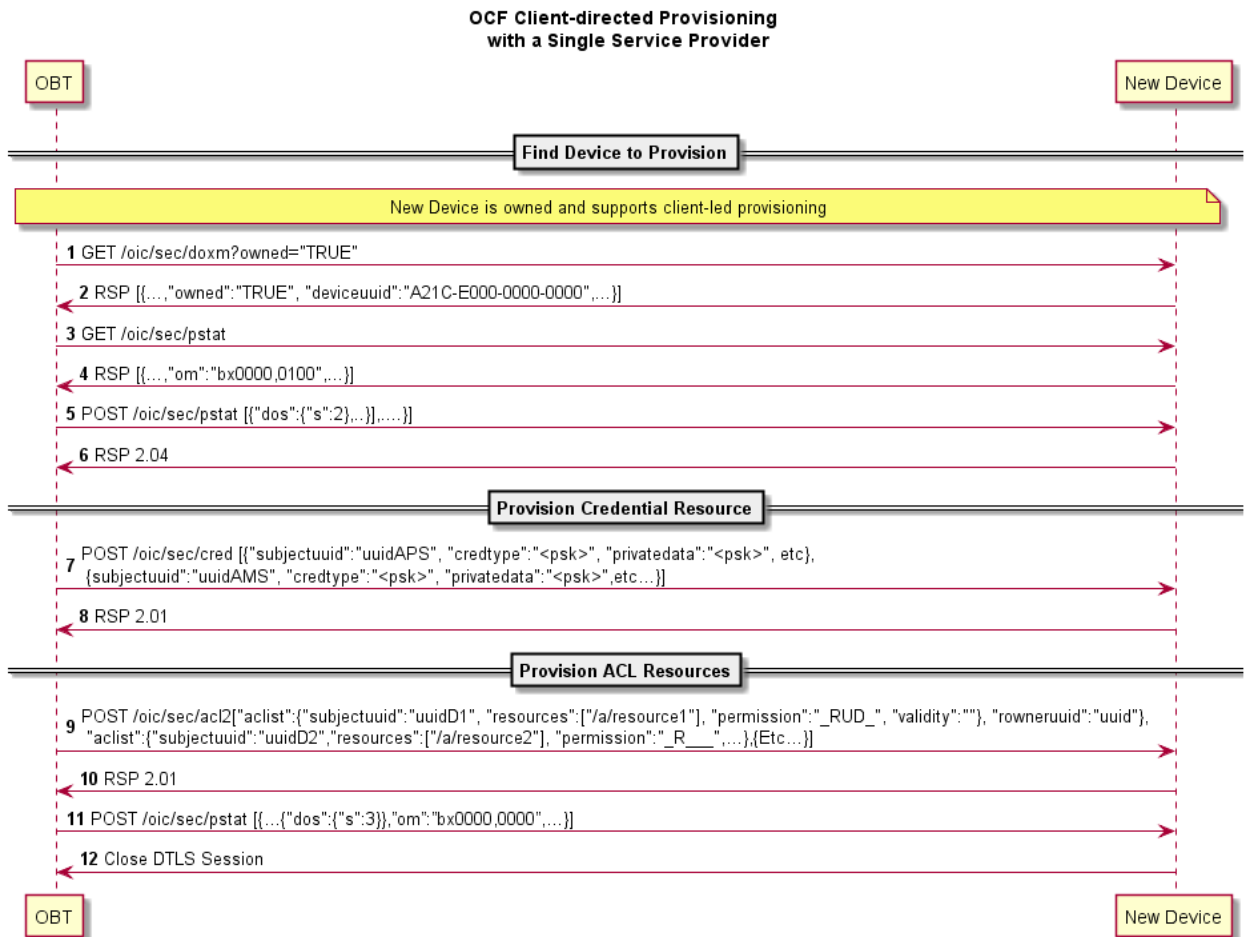


Figure 21 – Example of Client-directed provisioning

1708

1709

Table 7 – Steps describing Client -directed provisioning

Step	Description
1	Discover Devices that are owned and support Client-directed provisioning.
2	The "/oic/sec/doxm" Resource identifies the Device and it's owned status.
3	DOTS (on OBT) obtains the new Device's provisioning status found in "/oic/sec/pstat" Resource
4	The "pstat" Resource describes the types of provisioning modes supported and which is currently configured. A Device manufacturer should set a default current operational mode ("om"). If the "om" isn't configured for Client-directed provisioning, its "om" value can be changed.
5 - 6	Change Device state to RFPRO.
7 - 8	CMS (on OBT) instantiates the "/oic/sec/cred" Resource. It contains credentials for the provisioned services and other Devices
9 - 10	AMS (on OBT) instantiates "/oic/sec/acl2" Resource.
11	The new Device provisioning status mode is updated to reflect that ACLs have been configured. (RFNOP).
12	The secure session is closed.

1710 **7.4.1.3 Server-directed Provisioning [DEPRECATED]**

1711 This clause is intentionally left blank.

1712 **7.4.1.4 Server-directed Provisioning Involving Multiple Support Services** 1713 **[DEPRECATED]**

1714 This clause is intentionally left blank.

1715 **Device Onboarding State Definitions**

1716 **8.1 Device Onboarding General**

1717 As explained in 5.3, the process of onboarding completes after the ownership of the Device has
1718 been transferred and the Device has been provisioned with relevant configuration/services as
1719 explained in 5.4. The Figure 22 shows the various states a Device can be in during the Device
1720 lifecycle. Device shall reject any requests to perform a state transition not shown on Figure 22.

1721 The "/pstat.dos.s" Property is RW by the "/oic/sec/pstat" Resource owner (e.g. "doxs" service) so
1722 that the Resource owner can remotely update the Device state. When the Device is in RFNOP or
1723 RFPRO, ACLs can be used to allow remote control of Device state by other Devices. When the
1724 Device state is SRESET the Device OC may be the only indication of authorization to access the
1725 Device. The Device owner may perform low-level consistency checks and re-provisioning to get
1726 the Device suitable for a transition to RFPRO.

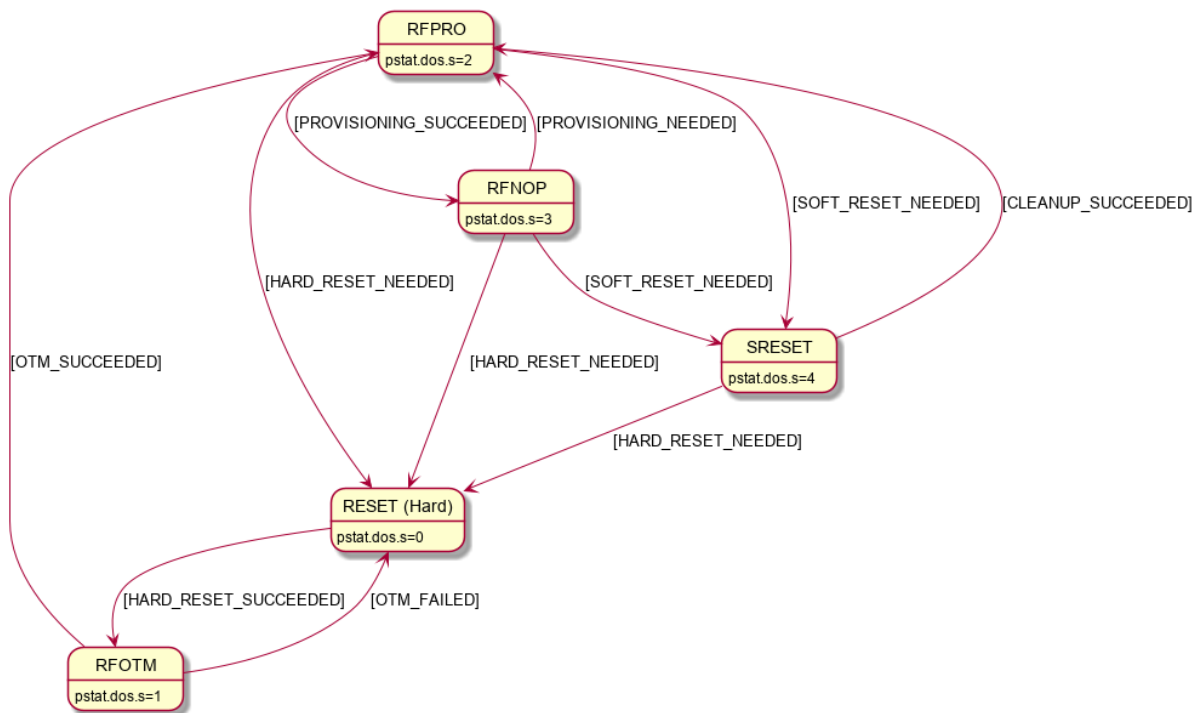


Figure 22 – Device state model

As shown in the diagram, at the conclusion of the provisioning step, the Device comes in RFNOP where it has all it needs in order to start interoperating with other Devices. Clause 8.5 specifies the minimum mandatory configuration that a Device shall hold in order to be considered as RFNOP.

In the event of power loss or Device failure, the Device should remain in the same state that it was in prior to the power loss / failure

If a Device or Resource owner OBSERVES "/pstat.dos.s", then transitions to SRESET will give early warning notification of Devices that may require SVR consistency checking.

In order for onboarding to function, the Device shall have the following Resources installed:

- 1) "/oic/sec/doxm" Resource
- 2) "/oic/sec/pstat" Resource
- 3) "/oic/sec/cred" Resource

The values contained in these Resources are specified in the state definitions in 8.2, 8.3, 8.4, 8.5 and 8.6. Access policy for these and other SVRs are also described.

8.2 Device Reset State Definition

The /pstat.dos.s = RESET is defined as a "hard" reset to manufacturer defaults. Hard reset also defines a state where the Device asset is ready to be transferred to another party.

The Platform manufacturer should provide a physical mechanism (e.g. button) that forces Platform reset. All Devices hosted on the same Platform transition their Device states to RESET when the Platform reset is asserted.

The following Resources and their specific properties shall have the value as specified:

- The "owned" Property of the "/oic/sec/doxm" Resource shall transition to FALSE.
- The "devowneruid" Property of the "/oic/sec/doxm" Resource shall be nil UUID.

- 1751 – The "deviceuuid" Property of the "/oic/sec/doxm" Resource shall be set to the manufacturer
1752 default value.
- 1753 – The "sct" Property of the "/oic/sec/doxm" Resource shall be reset to the manufacturer's default
1754 value.
- 1755 – The "oxmsel" Property of the "/oic/sec/doxm" Resource shall be reset to the manufacturer's
1756 default value.
- 1757 – The "isop" Property of the "/oic/sec/pstat" Resource shall be FALSE.
- 1758 – The "dos" Property of the "/oic/sec/pstat" Resource shall be updated: dos.s shall equal "RESET".
- 1759 – The "om" (operational modes) Property of the "/oic/sec/pstat" Resource shall be set to the
1760 manufacturer default value.
- 1761 – The "sm" (supported operational modes) Property of the "/oic/sec/pstat" Resource shall be set
1762 to the manufacturer default value.
- 1763 – The "creds" Property of the "/oic/sec/cred" Resource shall be set to the manufacturer default
1764 value.
- 1765 – The "aclist2" Property of the "/oic/sec/acl2" Resource shall be set to the manufacturer default
1766 value.
- 1767 – The "rowneruuid" Property of "/oic/sec/pstat", "/oic/sec/doxm", "/oic/sec/acl2", and
1768 "/oic/sec/cred" Resources shall be nil UUID.
- 1769 – The "usedspace" Property of the "/oic/sec/ael" Resource shall be set to 0.
- 1770 – The "categoryfilter" Property of the "/oic/sec/ael" Resource shall be set to the manufacturer's
1771 default value.
- 1772 – The "priorityfilter" Property of the "/oic/sec/ael" Resource shall be set to the manufacturer's
1773 default value.
- 1774 – The "events" Property of the "/oic/sec/ael" Resource shall be set to an empty array.
- 1775 – The "supportedprofiles" Property of the "/oic/sec/sp" Resource shall be set to the manufacturer
1776 default value.
- 1777 – The "currentprofile" Property of the "/oic/sec/sp" Resource shall be set to the manufacturer
1778 default value.
- 1779 – If "/oic/sec/sdi" Resource is exposed by a Device:
- 1780 – The "uuid" Property of the Resource shall be set to nil UUID
- 1781 – The "name" Property of the Resource shall be set to the empty string
- 1782 – The "priv" Property of the Resource shall be set to FALSE
- 1783 – The Device shall not accept DTLS connection attempts nor TLS connection attempts nor any
1784 other requests, including discovery requests.
- 1785 – Any existing DTLS or TLS Connections shall be closed.

1786 **8.3 Device Ready For Owner Transfer Mechanism State Definition**

1787 The following Resources and their specific properties shall have the value as specified when the
1788 Device enters ready for ownership transfer:

- 1789 – The "owned" Property of the "/oic/sec/doxm" Resource shall be FALSE and will transition to
1790 TRUE.
- 1791 – The "devowneruuid" Property of the "/oic/sec/doxm" Resource shall be nil UUID.
- 1792 – The "deviceuuid" Property of the "/oic/sec/doxm" Resource shall be set to the manufacturer
1793 default value.
- 1794 – The "isop" Property of the "/oic/sec/pstat" Resource shall be FALSE.

- 1795 – The "dos" of the "/oic/sec/pstat" Resource shall be updated: "dos.s" shall equal "RFOTM".
- 1796 – The "/oic/sec/cred" Resource shall contain credential(s) if required by the selected OTM
- 1797 – If there is no open Device Onboarding Connection, then
 - 1798 – The Device shall expose an unsecured OCF Endpoint for the Resources "/oic/sec/doxm"
 - 1799 and "/oic/sec/pstat".
 - 1800 – For all SVRs other than "/oic/sec/doxm" and "/oic/sec/pstat":
 - 1801 – The SVR shall not expose an Unsecured OCF Endpoint.
 - 1802 – Anonymous Retrieve and Updates requests (those arriving over unauthenticated channel
 - 1803 such as CoAP) for the "/oic/sec/doxm" Resource shall be granted.
 - 1804 – If an anonymous request to Update the "/oic/sec/doxm" Resource attempts to update
 - 1805 "oxmsel" to a value that is not indicated as supported by the Device in "oxms", then the
 - 1806 Device shall reject the request with an appropriate error message (e.g. bad request).
 - 1807 – All Retrieve requests to the "/oic/sec/pstat" Resource shall be granted.
 - 1808 – All other requests, with the exception of Retrieve requests to the Discovery Resources
 - 1809 ("/oic/res", "/oic/d" and "/oic/p"), shall be rejected with an appropriate error message (e.g.
 - 1810 forbidden).
 - 1811 – Prior to a successful anonymous Update of "oxmsel" in "/oic/sec/doxm", all attempts to
 - 1812 establish new DTLS connections shall be rejected.
 - 1813 – After a successful anonymous Update of "oxmsel" in "/oic/sec/doxm",
 - 1814 – The Device shall allow establishing a Device Onboarding Connection (DOC) matching the
 - 1815 "oxmsel" Property of the "/oic/sec/doxm" Resource (as specified in clause 7.3) , and shall
 - 1816 reject attempts to establish other DTLS connections.
- 1817 – If there is an open DOC, then
 - 1818 – For all SVRs:
 - 1819 – The Device shall not expose an Unsecured OCF Endpoint for the SVR.
 - 1820 – All requests received over the DOC which target DCRs shall be granted, regardless of the
 - 1821 configuration of the ACEs in the "/oic/sec/acl2" Resource.
 - 1822 – All unicast requests which are not received over the open Device DOC shall be rejected
 - 1823 with an appropriate error message (e.g. forbidden), regardless of the configuration of the
 - 1824 ACEs in the "/oic/sec/acl2" Resource.
 - 1825 – All attempts to establish new DTLS connections shall be rejected.
- 1826 – If the DOC is closed in RFOTM, then the Device shall transition to RESET.

1827 **8.4 Device Ready For Provisioning State Definition**

1828 The following Resources and their specific properties shall have the value as specified when the
 1829 Device enters ready for provisioning:

- 1830 – The "owned" Property of the "/oic/sec/doxm" Resource shall be TRUE.
- 1831 – The "devowneruuid" Property of the "/oic/sec/doxm" Resource shall not be nil UUID.
- 1832 – The "deviceuuid" Property of the "/oic/sec/doxm" Resource shall not be nil UUID and shall be
- 1833 set to the value that was determined during RFOTM processing.
- 1834 – The "oxmsel" Property of the "/oic/sec/doxm" Resource shall have the value of the actual OTM
- 1835 used during ownership transfer.
- 1836 – The "isop" Property of the "/oic/sec/pstat" Resource shall be FALSE.
- 1837 – The "dos" of the "/oic/sec/pstat" Resource shall be updated: "dos.s" shall equal "RFPRO".

- 1838 – The "rowneruuid" Property of every installed Resource shall be set to a valid Resource owner
1839 (i.e. an entity that is authorized to instantiate or update the given Resource). Failure to set a
1840 "rowneruuid" may result in an orphan Resource.
- 1841 – The "/oic/sec/cred" Resource shall contain credentials for each entity referenced by
1842 "rowneruuid" and "devowneruuid" Properties.
- 1843 – All requests to the "/oic/sec/roles" Resource received over a mutually-authenticated connection
1844 established using an identity certificate shall be granted, regardless of the configuration of the
1845 ACEs in the "/oic/sec/acl2" Resource, subject to the conditions in clause 10.4.2.
- 1846 – If there is an open DOC, then all requests received over the DOC which target a DCR shall be
1847 granted, regardless of the configuration of the ACEs in the "/oic/sec/acl2" Resource.
- 1848 – The Device shall allow establishing DTLS connections authenticated with locally issued
1849 credentials (clauses 10.2 and 10.4) and shall reject attempts to establish other DTLS
1850 connections.
- 1851 – For all SVRs:
 - 1852 – The SVR shall not expose an Unsecured OCF Endpoint.
 - 1853 – The Device shall ignore all ACEs with "subject" matching either {"conntype": "anon-clear"}
1854 or {"conntype": "auth-crypt"} when making access decisions for requests to the SVR.

1855 **8.5 Device Ready For Normal Operation State Definition**

1856 The following Resources and their specific properties shall have the value as specified when the
1857 Device enters ready for normal operation:

- 1858 – The "owned" Property of the "/oic/sec/doxm" Resource shall be TRUE.
- 1859 – The "devowneruuid" Property of the "/oic/sec/doxm" Resource shall not be nil UUID.
- 1860 – The "deviceuuid" Property of the "/oic/sec/doxm" Resource shall not be nil UUID and shall be
1861 set to the ID that was configured during OTM. Also the value of the "di" Property in "/oic/d" shall
1862 be the same as the deviceuuid.
- 1863 – The "oxmsel" Property of the "/oic/sec/doxm" Resource shall have the value of the actual OTM
1864 used during ownership transfer.
- 1865 – The "isop" Property of the "/oic/sec/pstat" Resource shall be set to TRUE by the Server once
1866 transition to RFNOP is otherwise complete.
- 1867 – The "dos" of the "/oic/sec/pstat" Resource shall be updated: "dos.s" shall equal "RFNOP".
- 1868 – The "rowneruuid" Property of every installed Resource shall be set to a valid Resource owner
1869 (i.e. an entity that is authorized to instantiate or update the given Resource). Failure to set a
1870 "rowneruuid" results in an orphan Resource.
- 1871 – The "/oic/sec/cred" Resource shall contain credentials for each service referenced by
1872 "rowneruuid" and "devowneruuid" Properties.
- 1873 – All requests to the "/oic/sec/roles" Resource received over a mutually-authenticated connection
1874 established using an identity certificate shall be granted, regardless of the configuration of the
1875 ACEs in the "/oic/sec/acl2" Resource, subject to the conditions in clause 10.4.2.
- 1876 – If there is an open DOC, then requests received over the DOC shall have access decisions
1877 determined as follows:
 - 1878 – A request which targets a DCR shall be granted, regardless of the configuration of the ACEs
1879 in the "/oic/sec/acl2" Resource.
 - 1880 – A request which targets an NCR shall be granted by matching an ACE as per normal request
1881 authorization, with "subject" matching the "anon-clear" connection type.
- 1882 – The Device shall allow establishing DTLS connections authenticated with locally issued
1883 credentials and shall reject attempts to establish other DTLS connections.

- 1884 – For all SVRs:
- 1885 – The SVR shall not expose an Unsecured OCF Endpoint.
- 1886 – The Device shall ignore all ACEs with "subject" matching either {"conntype": "anon-clear"}
- 1887 or {"conntype": "auth-crypt"} when making access decisions for requests to the SVR.

1888 8.6 Device Soft Reset State Definition

1889 The soft reset state is defined (e.g. "/pstat.dos.s" = SRESET) where entrance into this state means
1890 the Device is not operational but remains owned by the current owner. The Device may exit
1891 SRESET by authenticating to a DOTS (e.g. "rt" = "oic.r.doxs") using the OC provided during original
1892 onboarding (but should not require use of an OTM /doxm.oxms).

1893 If the DOTS credential cannot be found or is determined to be corrupted, the Device state
1894 transitions to RESET. The Device should remain in SRESET if the DOTS credential fails to validate
1895 the DOTS. This mitigates denial-of-service attacks that may be attempted by non-DOTS Devices.

1896 When in SRESET, the following Resources and their specific Properties shall have the values as
1897 specified.

- 1898 – The "owned" Property of the "/oic/sec/doxm" Resource shall be TRUE.
- 1899 – The "devowneruuid" Property of the "/oic/sec/doxm" Resource shall remain non-null.
- 1900 – The "deviceuuid" Property of the "/oic/sec/doxm" Resource shall remain non-null.
- 1901 – The "sct" Property of the "/oic/sec/doxm" Resource shall retain its value.
- 1902 – The "oxmsel" Property of the "/oic/sec/doxm" Resource shall retain its value.
- 1903 – The "isop" Property of the "/oic/sec/pstat" Resource shall be FALSE.
- 1904 – The "/oic/sec/pstat.dos.s" Property shall be SRESET.
- 1905 – The "om" (operational modes) Property of the "/oic/sec/pstat" Resource shall be "client-directed
- 1906 mode".
- 1907 – The "sm" (supported operational modes) Property of "/oic/sec/pstat" Resource may be updated
- 1908 by the Device owner (aka DOTS).
- 1909 – The "rowneruuid" Property of "/oic/sec/pstat", "/oic/sec/doxm", "/oic/sec/acl2", and
- 1910 "/oic/sec/cred" Resources may be reset by the Device owner (aka DOTS) and re-provisioned.
- 1911 – All requests to the "/oic/sec/roles" Resource received over a mutually-authenticated connection
- 1912 established using an identity certificate shall be granted, regardless of the configuration of the
- 1913 ACEs in the "/oic/sec/acl2" Resource, subject to the conditions in clause 10.4.2.
- 1914 – If there is an open DOC, then all requests received over the DOC which target a DCR shall be
- 1915 granted, regardless of the configuration of the ACEs in the "/oic/sec/acl2" Resource.
- 1916 – The Device shall allow establishing DTLS connections authenticated with locally issued
- 1917 credentials and shall reject attempts to establish other DTLS connections.
- 1918 – For all SVRs:
- 1919 – The SVR shall not expose an Unsecured OCF Endpoint.
- 1920 – The Device shall ignore all ACEs with "subject" matching either {"conntype": "anon-clear"}
- 1921 or {"conntype": "auth-crypt"} when making access decisions for requests to the SVR.

1922

Security Credential Management

9.1 Preamble

This clause provides an overview of the credential types in OCF, along with details of credential use, provisioning and ongoing management.

9.2 Credential Lifecycle

9.2.1 Credential Lifecycle General

OCF credential lifecycle has the following phases: (1) creation, (2) deletion, (3) refresh and (4) revocation.

9.2.2 Creation

The CMS can provision credentials to the credential Resource onto the Device. The Device shall verify the CMS is authorized by matching the rowneruuid Property of the "/oic/sec/cred" Resource to the DeviceID of the credential the CMS used to establish the secure connection.

Credential Resources created using a CMS may involve specialized credential issuance protocols and messages. These may involve the use of public key infrastructure (PKI) such as a certificate authority (CA), symmetric key management such as a key distribution centre (KDC) or as part of a provisioning action by a DOTS, CMS or AMS.

9.2.3 Deletion

The CMS can delete credentials from the credential Resource. The Device (e.g. the Device where the credential Resource is hosted) should delete credential Resources that have expired.

An expired credential Resource may be deleted to manage memory and storage space.

Deletion in OCF key management is equivalent to credential suspension.

9.2.4 Refresh

Credential refresh may be performed before it expires. The CMS performs credential refresh.

The "/oic/sec/cred" Resource supports expiry using the Period Property. Credential refresh may be applied when a credential is about to expire or is about to exceed a maximum threshold for bytes encrypted.

A credential refresh method specifies the options available when performing key refresh. The Period Property informs when the credential should expire. The Device may proactively obtain a new credential using a credential refresh method using current unexpired credentials to refresh the existing credential. If the Device does not have an internal time source, the current time should be obtained from a CMS at regular intervals.

If the onboarding established credentials are allowed to expire the DOTS shall re-onboard the Device to re-apply device owner transfer steps.

All Devices shall support at least one credential refresh method.

9.2.5 Revocation

Credentials issued by a CMS may be equipped with revocation capabilities. In situations where the revocation method involves provisioning of a revocation object that identifies a credential that is to be revoked prior to its normal expiration period, a credential Resource is created containing the revocation information that supersedes the originally issued credential. The revocation object expiration should match that of the revoked credential so that the revocation object is cleaned up upon expiry.

1964 It is conceptually reasonable to consider revocation applying to a credential or to a Device. Device
1965 revocation asserts all credentials associated with the revoked Device should be considered for
1966 revocation. Device revocation is necessary when a Device is lost, stolen or compromised. Deletion
1967 of credentials on a revoked Device might not be possible or reliable.

1968 **9.3 Credential Types**

1969 **9.3.1 Preamble**

1970 The "/oic/sec/cred" Resource maintains a credential type Property that supports several
1971 cryptographic keys and other information used for authentication and data protection. The
1972 credential types supported include symmetric pair-wise key, group symmetric group key,
1973 asymmetric signing key, asymmetric signing key with certificate and shared-secret (i.e. PIN or
1974 password). The Device shall always support symmetric pair-wise key and asymmetric signing key
1975 with certificate credential types. Other credential types are optional.

1976 **9.3.2 Pair-wise Symmetric Key Credentials**

1977 The CMS shall provision exactly one other pair-wise symmetric credential to a peer Device. The
1978 CMS should not store pair-wise symmetric keys it provisions to managed Devices.

1979 Pair-wise keys could be established through ad-hoc key agreement protocols.

1980 The "PrivateData" Property in the "/oic/sec/cred" Resource contains the symmetric key.

1981 The "PublicData" Property may contain a token encrypted to the peer Device containing the pair-
1982 wise key.

1983 The "OptionalData" Property may contain revocation status.

1984 The Device implementer should apply hardened key storage techniques that ensure the
1985 "PrivateData" remains private.

1986 The Device implementer should apply appropriate integrity, confidentiality and access protection
1987 of the "/oic/sec/cred", "/oic/sec/roles", "/oic/sec/csr" Resources to prevent unauthorized
1988 modifications.

1989 **9.3.3 Group Symmetric Key Credentials**

1990 Group keys are symmetric keys shared among a group of Devices (3 or more). Group keys are
1991 used for efficient sharing of data among group participants.

1992 Group keys do not provide authentication of Devices but only establish membership in a group.

1993 The CMS shall provision group symmetric key credentials to the group members. The CMS
1994 maintains the group memberships.

1995 The "PrivateData" Property in the "/oic/sec/cred" Resource contains the symmetric key.

1996 The "PublicData" Property may contain the group name.

1997 The "OptionalData" Property may contain revocation status.

1998 The Device implementer should apply hardened key storage techniques that ensure the
1999 "PrivateData" remains private.

2000 The Device implementer should apply appropriate integrity, confidentiality and access protection
2001 of the "/oic/sec/cred", "/oic/sec/roles", "/oic/sec/csr" Resources to prevent unauthorized
2002 modifications.

2003 **9.3.4 Asymmetric Authentication Key Credentials**

2004 **9.3.4.1 Asymmetric Authentication Key Credentials General**

2005 Asymmetric authentication key credentials contain either a public and private key pair or only a
2006 public key. The private key is used to sign Device authentication challenges. The public key is used
2007 to verify a device authentication challenge-response.

2008 The "PrivateData" Property in the "/oic/sec/cred" Resource contains the private key.

2009 The "PublicData" Property contains the public key.

2010 The "OptionalData" Property may contain revocation status.

2011 The Device implementer should apply hardened key storage techniques that ensure the
2012 "PrivateData" remains private.

2013 Devices should generate asymmetric authentication key pairs internally to ensure the private key
2014 is only known by the Device. See 9.3.4.2 for when it is necessary to transport private key material
2015 between Devices.

2016 The Device implementer should apply appropriate integrity, confidentiality and access protection
2017 of the "/oic/sec/cred", "/oic/sec/roles", "/oic/sec/csr" Resources to prevent unauthorized
2018 modifications.

2019 **9.3.4.2 External Creation of Asymmetric Authentication Key Credentials**

2020 Devices should employ industry-standard high-assurance techniques when allowing off-device key
2021 pair creation and provisioning. Use of such key pairs should be minimized, particularly if the key
2022 pair is immutable and cannot be changed or replaced after provisioning.

2023 When used as part of onboarding, these key pairs can be used to prove the Device possesses the
2024 manufacturer-asserted properties in a certificate to convince a DOTS or a user to accept
2025 onboarding the Device. See 7.3.3 for the OTM that uses such a certificate to authenticate the
2026 Device, and then provisions new OCF Security Domain credentials for use.

2027 **9.3.5 Asymmetric Key Encryption Key Credentials**

2028 The asymmetric key-encryption-key (KEK) credentials are used to wrap symmetric keys when
2029 distributing or storing the key.

2030 The "PrivateData" Property in the "/oic/sec/cred" Resource contains the private key.

2031 The "PublicData" Property contains the public key.

2032 The "OptionalData" Property may contain revocation status.

2033 The Device implementer should apply hardened key storage techniques that ensure the
2034 "PrivateData" remains private.

2035 The Device implementer should apply appropriate integrity, confidentiality and access protection
2036 of the "/oic/sec/cred", "/oic/sec/roles", "/oic/sec/csr" Resources to prevent unauthorized
2037 modifications.

2038 **9.3.6 Certificate Credentials**

2039 Certificate credentials are asymmetric keys that are accompanied by a certificate issued by a CMS
2040 or an external certificate authority (CA).

2041 A certificate enrolment protocol is used to obtain a certificate and establish proof-of-possession.

2042 The issued certificate is stored with the asymmetric key credential Resource.

2043 Other objects useful in managing certificate lifecycle such as certificate revocation status are
2044 associated with the credential Resource.

2045 Either an asymmetric key credential Resource or a self-signed certificate credential is used to
2046 terminate a path validation.

2047 The "PrivateData" Property in the "/oic/sec/cred" Resource contains the private key.

2048 The "PublicData" Property contains the issued certificate.

2049 The "OptionalData" Property may contain revocation status.

2050 The Device implementer should apply hardened key storage techniques that ensure the
2051 PrivateData remains private.

2052 The Device implementer should apply appropriate integrity, confidentiality and access protection
2053 of the "/oic/sec/cred", "/oic/sec/roles", "/oic/sec/csr" Resources to prevent unauthorized
2054 modifications.

2055 **9.3.7 Password Credentials**

2056 The "PrivateData" Property in the "/oic/sec/cred" Resource contains the PIN, password and other
2057 values useful for changing and verifying the password.

2058 The "PublicData" Property may contain the user or account name if applicable.

2059 The "OptionalData" Property may contain revocation status.

2060 The Device implementer should apply hardened key storage techniques that ensure the
2061 "PrivateData" remains private.

2062 The Device implementer should apply appropriate integrity, confidentiality and access protection
2063 of the "/oic/sec/cred", "/oic/sec/roles", "/oic/sec/csr" Resources to prevent unauthorized
2064 modifications.

2065 **9.3.8 Credentials for direct provisioning an OSCORE Security Context**

2066 A credential entry with the credential type 64 is used for direct provisioning of OSCORE Security
2067 Context parameters for use in End-to-End Security of Unicast Messages.

2068 The "privatedata" Property of the credential entry with the credential type 64 in the "/oic/sec/cred"
2069 Resource contains the OSCORE Master Key.

2070 A credential entry with the credential type 64 shall expose the OSCORE Configuration ("oscore")
2071 Property, which includes:

- 2072 – The "senderid" Property containing the OSCORE Sender ID parameter.
- 2073 – The "recipientid" Property containing the OSCORE Recipient ID parameter.
- 2074 – The "ssn" Property contains a read-only value used to store the OSCORE Sender Sequence
2075 Number.

2076 NOTE: values of "senderid" and "recipientid" are expected to be lowercase hexadecimal encoded with "0x" encoding
2077 prefix omitted.

2078 See clause 16.2 for description of the OSCORE parameters.

2079 **9.3.9 Credentials for Simple Secure Multicast**

2080 There are two distinct credential types used for provisioning OSCORE Security Context parameters
2081 used in Simple Secure Multicast (SSM): one for the SSM Client Context identified using
2082 "credtype" : "128"; and one for the SSM Server Context identified using "credtype" : "256". In a

2083 Client of an SSM Group, the Client's OSCORE Security Context (Sender context) is derived from
2084 a provisioned SSM Client Context. In the Servers of an SSM Group, the Server's OSCORE Security
2085 Context (Recipient Context) is derived from a provisioned SSM Server Context.

2086 For both of these credential types, the "privatedata" Property of the credential entry in the
2087 "/oic/sec/cred" Resource contains the value of the OSCORE Master Secret of the SSM Group,
2088 which is generated by the OBT.

2089 A SSM Client Context credential entry shall expose the OSCORE Configuration ("oscore") Property,
2090 which for this credential type shall include:

- 2091 – The "senderid" Property containing the OSCORE Sender ID parameter.
- 2092 – This value is selected and provisioned by the OBT.
- 2093 – The "desc" Property containing a description of the usage of the security context
- 2094 – This Property contains a human-readable description intended for identifying the
- 2095 corresponding SSM Group when a Security Domain contains multiple SSM Groups.
- 2096 – This value is selected and provisioned by the OBT
- 2097 – The "ssn" Property contains a read-only value used to store the OSCORE Sender Sequence
- 2098 Number.

2099 NOTE 1: The value of "senderid" is expected to be lowercase hexadecimal encoded with "0x" encoding prefix omitted.

2100 An SSM Server Context credential entry shall include the OSCORE Configuration ("oscore")
2101 Property, which shall include:

- 2102 – The "recipientid" Property containing the OSCORE Group Recipient ID parameter.
- 2103 – This value is equal for all Servers in the SSM Group, and is the same as the value of the
- 2104 "senderid" of the Client Context for the SSM Group
- 2105 – This value is selected and provisioned by the OBT
- 2106 – The "desc" Property containing a description of the usage of the security context
- 2107 – This Property contains a human-readable description intended for identifying the
- 2108 corresponding SSM Group when a Security Domain contains multiple SSM Groups.
- 2109 – This value is selected and provisioned by the OBT

2110 NOTE 2: The value of "recipientid" is expected to be lowercase hexadecimal encoded with "0x" encoding prefix omitted.

2111 See clause 16.3.3 for description of the OSCORE parameters used in SSM.

2112 **9.4 Certificate Based Key Management**

2113 **9.4.1 Overview**

2114 To achieve authentication and transport security during communications in OCF Security Domain,
2115 certificates containing public keys of communicating parties and private keys can be used.

2116 The certificate and private key may be issued by a local or remote certificate authority (CA).

2117 The OCF certificate format is a subset of X.509 format, only elliptic curve algorithm and PEM
2118 encoding format are allowed, most of optional fields in X.509 are not supported so that the format
2119 intends to meet the constrained Device's requirement.

2120 The CMS manages the certificate lifecycle for certificates it issues. The DOTS assigns a CMS to a
2121 Device when it is newly onboarded.

9.4.2 X.509 Digital Certificate Profiles

9.4.2.1 Digital Certificate Profile General

An OCF certificate format is a subset of X.509 format (version 3 or above) as defined in IETF RFC 5280.

This clause develops a profile to facilitate the use of X.509 certificates within OCF applications for those communities wishing to make use of X.509 technology. The X.509 v3 certificate format is described in detail, with additional information regarding the format and semantics of OCF specific extension(s). The supported standard certificate extensions are also listed.

Certificate Format: The OCF certificate profile is derived from IETF RFC 5280. However, this document does not support the "issuerUniqueID" and "subjectUniqueID" fields which are deprecated and shall not be used in the context of OCF. If these fields are present in a certificate, compliant entities shall ignore their contents.

Certificate Encoding: Conforming entities shall use the Privacy-Enhanced Mail (PEM) to encode certificates.

Certificates Hierarchy and Crypto Parameters. OCF supports a three-tier hierarchy for its Public Key Infrastructure (i.e., a Root CA, an Intermediate CA, and EE certificates). OCF accredited CAs SHALL use Elliptic Curve Cryptography (ECC) keys (secp256r1 – OID:1.2.840.10045.3.1.7) and use the ecdsaWithSHA256 (OID:1.2.840.10045.4.3.2) algorithm for certificate signatures. Elliptic Curve Cryptography public keys shall be encoded using uncompressed Elliptic Curve points.

The following clauses specify the supported standard and custom extensions for the OCF certificates profile.

9.4.2.2 Certificate Profile and Fields

9.4.2.2.1 Root CA Certificate Profile

Table 8 describes X.509 v1 fields required for Root CA Certificates.

Table 8 – X.509 v1 fields for Root CA Certificates

V1 Field	Value / Remarks
signatureAlgorithm	ecdsa-with-SHA256 (OID: 1.2.840.10045.4.3.2)
Version	v3 (value is 2)
SerialNumber	SHALL be a positive integer, unique among all certificates issued by a given CA
Issuer	SHALL match the Subject field
Subject	SHALL match the Issuer field
notBefore	The time at which the Root CA Certificate was generated. See 10.4.5 for details around IETF RFC 5280-compliant validity field formatting.
notAfter	No stipulation for expiry date. See 10.4.5 for details around IETF RFC 5280-compliant validity field formatting.
Subject Public Key Info	id-ecPublicKey (OID: 1.2.840.10045.2.1) secp256r1 (OID:1.2.840.10045.3.1.7) Elliptic Curve Cryptography public keys shall be encoded using uncompressed Elliptic Curve points.

Table 9 describes X.509 v3 extensions required for Root CA Certificates.

Table 9 - X.509 v3 extensions for Root CA Certificates

Extension	Required/Optional	Criticality	Value / Remarks
authorityKeyIdentifier	OPTIONAL	Non-critical	N/A
subjectKeyIdentifier	OPTIONAL	Non-critical	N/A
keyUsage	REQUIRED	Critical	keyCertSign (5) & cRLSign (6) bits shall be enabled. digitalSignature(0) bit may be enabled. All other bits shall not be enabled.
basicConstraints	REQUIRED	Critical	cA = TRUE pathLenConstraint = not present (unlimited)

2149 9.4.2.2.2 Intermediate CA Certificate Profile

2150 Table 10 describes X.509 v1 fields required for Intermediate CA Certificates.

2151 **Table 10 - X.509 v1 fields for Intermediate CA Certificates**

V1 Field	Value / Remarks
signatureAlgorithm	ecdsa-with-SHA256 (OID: 1.2.840.10045.4.3.2)
Version	v3 (value is 2)
SerialNumber	SHALL be a positive integer, unique among all certificates issued by Root CA
Issuer	SHALL match the Subject field of the issuing Root CA
Subject	(no stipulation)
notBefore	The time at which the Intermediate CA Certificate was generated. See clause 10.4.5 for details around IETF RFC 5280-compliant validity field formatting.
notAfter	No stipulation for expiry date. See clause 10.4.5 for details around IETF RFC 5280-compliant validity field formatting.
Subject Public Key Info	id-ecPublicKey (OID: 1.2.840.10045.2.1) secp256r1 (OID: 1.2.840.10045.3.1.7) Elliptic Curve Cryptography public keys shall be encoded using uncompressed Elliptic Curve points.

2152 Table 11 **describes** X.509 v3 extensions required for Intermediate CA Certificates.

2153 **Table 11 – X.509 v3 extensions for Intermediate CA Certificates**

Extension	Required/Optional	Criticality	Value / Remarks
authorityKeyIdentifier	OPTIONAL	Non-critical	N/A
subjectKeyIdentifier	OPTIONAL	Non-critical	N/A
keyUsage	REQUIRED	Critical	keyCertSign (5) & cRLSign (6) bits shall be enabled. digitalSignature (0) bit may be enabled All other bits shall not be enabled.
basicConstraints	REQUIRED	Critical	cA = TRUE

			pathLenConstraint = 0 (can only sign End-Entity certs)
certificatePolicies	OPTIONAL	Non-critical	(no stipulation)
cRLDistributionPoints	OPTIONAL	Non-critical	1 or more URIs where the Certificate Revocation List (CRL) from the Root can be obtained.
authorityInformationAccess	OPTIONAL	Non-critical	OCSP URI – the URI of the Root CA's OCSP Responder

9.4.2.2.3 End-Entity Black Certificate Profile

Table 12 describes X.509 v1 fields required for End-Entity Certificates used for Black security profile.

Table 12 – X.509 v1 fields for End-Entity Certificates

V1 Field	Value / Remarks
signatureAlgorithm	ecdsa-with-SHA256 (OID: 1.2.840.10045.4.3.2)
Version	v3 (value is 2)
SerialNumber	SHALL be a positive integer, unique among all certificates issued by the Intermediate CA
Issuer	SHALL match the Subject field of the issuing Intermediate CA
Subject	Subject DN shall include: o=OCF-verified device manufacturer organization name. The Subject DN may include other attributes (e.g. cn, c, ou, etc.) with no stipulation by OCF.
notBefore	The time at which the End-Entity Certificate was generated. See clause 10.4.5 for details around IETF RFC 5280-compliant validity field formatting.
notAfter	No stipulation. See clause 10.4.5 for details around IETF RFC 5280-compliant validity field formatting.
Subject Public Key Info	id-ecPublicKey (OID: 1.2.840.10045.2.1) secp256r1 (OID: 1.2.840.10045.3.1.7) Elliptic Curve Cryptography public keys shall be encoded using uncompressed Elliptic Curve points.

Table 13 describes X.509 v3 extensions required for End-Entity Certificates.

Table 13 – X.509 v3 extensions for End-Entity Certificates

Extension	Required/ Optional	Criticality	Value / Remarks
authorityKeyIdentifier	OPTIONAL	Non-critical	N/A
subjectKeyIdentifier	OPTIONAL	Non-critical	N/A
keyUsage	REQUIRED	Critical	digitalSignature (0) and keyAgreement(4) bits SHALL be the only bits enabled
basicConstraints	OPTIONAL	Non-Critical	cA = FALSE

			pathLenConstraint = not present
certificatePolicies	OPTIONAL	Non-critical	<p>End-Entity certificates chaining to an OCF Root CA SHOULD contain at least one PolicyIdentifierId set to the OCF Certificate Policy OID – (1.3.6.1.4.1.51414.0.1.2) corresponding to the version of the OCF Certificate Policy under which it was issued. Additional manufacturer-specific CP OIDs may also be populated.</p>
extendedKeyUsage	REQUIRED	Non-critical	<p>The following extendedKeyUsage (EKU) OIDs SHALL both be present:</p> <ul style="list-style-type: none"> • serverAuthentication - 1.3.6.1.5.5.7.3.1 • clientAuthentication - 1.3.6.1.5.5.7.3.2 <p>Exactly ONE of the following OIDs SHALL be present:</p> <ul style="list-style-type: none"> • Identity certificate - 1.3.6.1.4.1.44924.1.6 • Role certificate - 1.3.6.1.4.1.44924.1.7 <p>End-Entity certificates SHALL NOT contain the anyExtendedKeyUsage OID (2.5.29.37.0)</p>
subjectAlternativeName	REQUIRED UNDER CERTAIN CONDITIONS	Non-critical	<p>The subjectAltName extension is used to encode one or more Role ID values in role certificates, binding the roles to the subject public key.</p> <p>When the extendedKeyUsage (EKU) extension contains the Identity Certificate OID (1.3.6.1.4.1.44924.1.6), the subjectAltName extension SHOULD NOT be present.</p> <p>If the EKU extension contains the Role Certificate OID (1.3.6.1.4.1.44924.1.7), the subjectAltName extension SHALL be present and populated as follows:</p> <p>Each GeneralName in the GeneralNames SEQUENCE which encodes a role shall be a directoryName, which is of type Name. Name is an X.501 Distinguished Name. Each Name shall contain exactly one CN (Common Name) component, and zero or one OU (Organizational Unit) components. The OU component, if present, shall</p>

			specify the authority that defined the semantics of the role. If the OU component is absent, the certificate issuer has defined the role. The CN component shall encode the role ID. Other GeneralName types in the SEQUENCE may be present, but shall not be interpreted as roles. The role, and authority shall be encoded as ASN.1 PrintableString type, the restricted character set [0-9a-z-A-z '()+,./:=?].
cRLDistributionPoints	OPTIONAL	Non-critical	1 or more URIs where the Certificate Revocation List (CRL) from the Intermediate CA can be obtained.
authorityInformationAccess	OPTIONAL	Non-critical	OCSP URI – the URI of the Intermediate CA's OCSP Responder
OCF Compliance	OPTIONAL	Non-critical	See 9.4.2.2.4
Manufacturer Usage Description (MUD)	OPTIONAL	Non-critical	Contains a single Uniform Resource Locator (URL) that points to an on-line Manufacturer Usage Description concerning the certificate subject. See 9.4.2.2.5
OCF Security Claims	OPTIONAL	Non-critical	Contains a list of security claims above those required by this OCF Compliance version or Security Profile. See 9.4.2.2.6
OCF CPL Attributes	OPTIONAL	Non-critical	Contains the list of OCF Attributes used to perform OCF Certified Product List lookups

9.4.2.2.4 OCF Compliance X.509v3 Extension

The OCF Compliance Extension defines required parameters to correctly identify the type of Device, its manufacturer, its OCF Version, and the Security Profile compliance of the device.

The extension carries an "ocfVersion" field which provides the specific base version of the OCF documents the device implements. The "ocfVersion" field shall contain a sequence of three integers ("major", "minor", and "build"). For example, if an entity is certified to be compliant with OCF specifications 1.3.2, then the "major", "minor", and "build" fields of the "ocfVersion" will be set to "1", "3", and "2" respectively. The "ocfVersion" may be used by Security Profiles to denote compliance to a specified base version of the OCF documents.

The "securityProfile" field shall carry the ocfSecurityProfile OID(s) (clause 14.8.3) of one or more supported Security Profiles associated with the certificate in string form (UTF-8). All Security Profiles associated with the certificate should be identified by this field.

The extension shall also carry two string fields (UTF-8): "DeviceName" and "deviceManufacturer". The fields carry human-readable descriptions of the Device's name and manufacturer, respectively.

The ASN.1 definition of the OCFCCompliance extension (OID – 1.3.6.1.4.1.51414.1.0) is defined as follows:

```
id-OCF OBJECT IDENTIFIER ::= { iso(1) identified-organization(3) dod(6) internet(1)
```

```

2177         private(4) enterprise(1) OCF(51414) }
2178
2179     id-ocfX509Extensions OBJECT IDENTIFIER ::= { id-OCF 1 }
2180
2181     id-ocfCompliance OBJECT IDENTIFIER ::= { id-ocfX509Extensions 0 }
2182
2183     ocfVersion ::= SEQUENCE {
2184         major    INTEGER,
2185             --Major version number
2186         minor    INTEGER,
2187             --Minor version number
2188         build    INTEGER,
2189             --Build/Micro version number
2190     }
2191
2192     ocfCompliance ::= SEQUENCE {
2193         version          ocfVersion,
2194             --Device/OCF version
2195         securityProfile  SEQUENCE SIZE (1..MAX) OF ocfSecurityProfileOID,
2196             --Sequence of OCF Security Profile OID strings
2197             --Clause 14.8.2 defines valid ocfSecurityProfileOIDs
2198         deviceName       UTF8String,
2199             --Name of the device
2200         deviceManufacturer UTF8String,
2201             --Human-Readable Manufacturer
2202             --of the device
2203     }

```

2204 **9.4.2.2.5 Manufacturer Usage Description (MUD) X.509v3 Extension**

2205 The goal of the Manufacturer Usage Description (MUD) extension is to provide a means for devices
2206 to signal to the network the access and network functionality they require to properly function.
2207 Access controls can be more easily achieved and deployed at scale when the MUD extension is
2208 used.

2209 The MUD X.509 v3 extension is specified in IETF RFC 8520 with the full ASN.1 definition in clause
2210 11.

2211 **9.4.2.2.6 OCF Security Claims X.509v3 Extension**

2212 The OCF Security Claims Extension defines a list of OIDs representing security claims that the
2213 manufacturer/integrator is making as to the security posture of the device above those required by
2214 the OCF Compliance version or that of the OCF Security Profile being indicated by the device.

2215 The purpose of this extension is to allow for programmatic evaluation of assertions made about
2216 security to enable some platforms/policies/administrators to better understand what is being
2217 onboarded or challenged.

2218 The ASN.1 definition of the OCF Security Claims extension (OID – 1.3.6.1.4.1.51414.1.1) is defined
2219 as follows:

```

2220 id-OCF OBJECT IDENTIFIER ::= { iso(1) identified-organization(3) dod(6) internet(1)
2221     private(4) enterprise(1) OCF(51414) }
2222
2223     id-ocfX509Extensions OBJECT IDENTIFIER ::= { id-OCF 1 }
2224
2225     id-ocfSecurityClaims OBJECT IDENTIFIER ::= { id-ocfX509Extensions 1 }
2226
2227     claim-secure-boot ::= ocfSecurityClaimsOID { id-ocfSecurityClaims 0 }
2228     --Device claims that the boot process follows a procedure trusted
2229     --by the firmware and the BIOS
2230
2231     claim-hw-backed-cred-storage ::= ocfSecurityClaimsOID { id-ocfSecurityClaims 1 }

```

```

2232         --Device claims that credentials are stored in a specialized hardware
2233         --protection environment such as a Trusted Platform Module (TPM) or
2234         --similar mechanism.
2235
2236         ocfSecurityClaimsOID ::= OBJECT IDENTIFIER
2237
2238         ocfSecurityClaims ::= SEQUENCE SIZE (1..MAX) of ocfSecurityClaimsOID
2239
2240 9.4.2.2.7 OCF Certified Product List Attributes X.509v3 Extension
2241 The OCF Certified Product List Extension defines required parameters to utilize the OCF
2242 Compliance Management System Certified Product List (OCMS-CPL). This clause is only
2243 applicable if you plan to utilize the OCMS-CPL. The OBT may make use of these attributes to verify
2244 the compliance level of a device.
2245
2246 The extension carries the OCF CPL Attributes: IANA Private Enterprise Number (PEN), Model and
2247 Version.
2248
2249 The 'cpl-at-IANAPen' IANA Private Enterprise Number (PEN) provides the manufacturer's unique
2250 PEN established in the IANA PEN list located at: https://www.iana.org/assignments/enterprise-
2251 numbers. The 'cpl-at-IANAPen' field found in end-products shall be the same information as
2252 reported during OCF Certification.
2253
2254 The 'cpl-at-model' represents an OCF-Certified product's model name. The 'cpl-at-model' field
2255 found in end-products shall be the same information as reported during OCF Certification.
2256
2257 The 'cpl-at-version' represents an OCF-Certified product's version. The 'cpl-at-version' field found
2258 in end-products shall be the same information as reported during OCF Certification.
2259
2260 The ASN.1 definition of the OCF CPL Attributes extension (OID – 1.3.6.1.4.1.51414.1.2) is defined
2261 as follows:
2262
2263 id-OCF OBJECT IDENTIFIER ::= { iso(1) identified-organization(3) dod(6) internet(1)
2264                                private(4) enterprise(1) OCF(51414) }
2265
2266 id-ocfX509Extensions OBJECT IDENTIFIER ::= { id-OCF 1 }
2267
2268 id-ocfCPLAttributes OBJECT IDENTIFIER ::= { id-ocfX509Extensions 2 }
2269
2270 cpl-at-IANAPen ::= OBJECT IDENTIFIER { id-ocfCPLAttributes 0 }
2271 cpl-at-model ::= OBJECT IDENTIFIER { id-ocfCPLAttributes 1 }
2272 cpl-at-version ::= OBJECT IDENTIFIER { id-ocfCPLAttributes 2 }
2273
2274 ocfCPLAttributes ::= SEQUENCE {
2275     cpl-at-IANAPen UTF8String,
2276     --Manufacturer's registered IANA Private Enterprise Number
2277     cpl-at-model UTF8String,
2278     --Device OCF Security Profile
2279     cpl-at-version UTF8String
2280     --Name of the device
2281 }
2282
2283 9.4.2.3 Supported Certificate Extensions
2284 As these certificate extensions are a standard part of IETF RFC 5280, this document includes the
2285 clause number from that RFC to include it by reference. Each extension is summarized here, and
2286 any modifications to the RFC definition are listed. Devices MUST implement and understand the
2287 extensions listed here; other extensions from the RFC are not included in this document and
2288 therefore are not required. 10.4 describes what Devices must implement when validating certificate
2289 chains, including processing of extensions, and actions to take when certain extensions are absent.

```


2283 – Authority Key Identifier (4.2.1.1)

2284 The Authority Key Identifier (AKI) extension provides a means of identifying the public key
2285 corresponding to the private key used to sign a certificate. This document makes the following
2286 modifications to the referenced definition of this extension:

2287 The "authorityCertIssuer" or "authorityCertSerialNumber" fields of the "AuthorityKeyIdentifier"
2288 sequence are not permitted; only "keyIdentifier" is allowed. This results in the following
2289 grammar definition:

2290 id-ce-authorityKeyIdentifier OBJECT IDENTIFIER ::= { id-ce 35 }

2291

2292 AuthorityKeyIdentifier ::= SEQUENCE {
2293 keyIdentifier [0] KeyIdentifier }
2294

2295 KeyIdentifier ::= OCTET STRING

2296 – Subject Key Identifier (4.2.1.2)

2297 The Subject Key Identifier (SKI) extension provides a means of identifying certificates that
2298 contain a particular public key.

2299 This document makes the following modification to the referenced definition of this extension:

2300 Subject Key Identifiers SHOULD be derived from the public key contained in the certificate's
2301 "SubjectPublicKeyInfo" field or a method that generates unique values. This document
2302 RECOMMENDS the 256-bit SHA-2 hash of the value of the BIT STRING "subjectPublicKey"
2303 (excluding the tag, length, and number of unused bits). Devices verifying certificate chains must
2304 not assume any particular method of computing key identifiers, however, and must only base
2305 matching AKI's and SKI's in certification path constructions on key identifiers seen in certificates.

2306 – Subject Alternative Name

2307 If the EKU extension is present, and has the value XXXXXX, indicating that this is a role
2308 certificate, the Subject Alternative Name (subjectAltName) extension shall be present and
2309 interpreted as described below. When no EKU is present, or has another value, the
2310 "subjectAltName" extension SHOULD be absent. The "subjectAltName" extension is used to
2311 encode one or more Role ID values in role certificates, binding the roles to the subject public
2312 key. The "subjectAltName" extension is defined in IETF RFC 5280 (See 4.2.1.6):

2313 id-ce-subjectAltName OBJECT IDENTIFIER ::= { id-ce 17 }

2314

2315 SubjectAltName ::= GeneralNames

2316

2317 GeneralNames ::= SEQUENCE SIZE (1..MAX) OF GeneralName

2318

2319 GeneralName ::= CHOICE {

2320	otherName	[0]	OtherName,
2321	rfc5322Name	[1]	IA5String,
2322	dNSName	[2]	IA5String,
2323	x400Address	[3]	ORAddress,
2324	directoryName	[4]	Name,
2325	ediPartyName	[5]	EDIPartyName,
2326	uniformResourceIdentifier	[6]	IA5String,
2327	iPAddress	[7]	OCTET STRING,
2328	registeredID	[8]	OBJECT IDENTIFIER }

2329

2330 EDIPartyName ::= SEQUENCE {
2331 nameAssigner [0] DirectoryString OPTIONAL,
2332 partyName [1] DirectoryString }
2333

2334 Each "GeneralName" in the "GeneralNames" SEQUENCE which encodes a role shall be a
2335 "directoryName", which is of type Name. Name is an X.501 Distinguished Name. Each Name
2336 shall contain exactly one CN (Common Name) component, and zero or one OU (Organizational
2337 Unit) components. The OU component, if present, shall specify the authority that defined the

2338 semantics of the role. If the OU component is absent, the certificate issuer has defined the role.
 2339 The CN component shall encode the role ID. Other "GeneralName" types in the SEQUENCE
 2340 may be present, but shall not be interpreted as roles. Therefore, if the certificate issuer includes
 2341 non-role names in the "subjectAltName" extension, the extension should not be marked critical.

2342 The role, and authority need to be encoded as ASN.1 "PrintableString" type, the restricted
 2343 character set [0-9a-z-A-z '()+, -./:=?].

2344 – Key Usage (4.2.1.3)

2345 The key usage extension defines the purpose (e.g., encipherment, signature, certificate signing)
 2346 of the key contained in the certificate. The usage restriction might be employed when a key that
 2347 could be used for more than one operation is to be restricted.

2348 This document does not modify the referenced definition of this extension.

2349 – Basic Constraints (4.2.1.9)

2350 The basic constraints extension identifies whether the subject of the certificate is a CA and the
 2351 maximum depth of valid certification paths that include this certificate. Without this extension,
 2352 a certificate cannot be an issuer of other certificates.

2353 This document does not modify the referenced definition of this extension.

2354 – Extended Key Usage (4.2.1.12)

2355

2356 Extended Key Usage describes allowed purposes for which the certified public key may can be
 2357 used. When a Device receives a certificate, it determines the purpose based on the context of
 2358 the interaction in which the certificate is presented, and verifies the certificate can be used for
 2359 that purpose.

2360 This document makes the following modifications to the referenced definition of this extension:

2361 CAs SHOULD mark this extension as critical.

2362 CAs MUST NOT issue certificates with the anyExtendedKeyUsage OID (2.5.29.37.0).

2363

2364 The list of OCF-specific purposes and the assigned OIDs to represent them are:

2365 – Identity certificate 1.3.6.1.4.1.44924.1.6

2366 – Role certificate 1.3.6.1.4.1.44924.1.7

2367 **9.4.2.4 Cipher Suite for Authentication, Confidentiality and Integrity**

2368 OCF compliant entities shall support TLS version 1.2. Compliant entities shall support
 2369 TLS_ECDHE_ECDSA_WITH_AES_128_CCM_8 cipher suite as defined in IETF RFC 7251 and may
 2370 support additional ciphers as defined in the TLS v1.2 specifications.

2371 **9.4.2.5 Encoding of Certificate**

2372 See 9.4.2 for details.

2373 **9.4.3 Certificate Revocation List (CRL) Profile [Deprecated]**

2374 This clause is intentionally left blank.

2375 **9.4.4 Resource Model**

2376 Device certificates and private keys are kept in "cred" Resource.

2377 The "cred" Resource contains the certificate information pertaining to the Device. The "PublicData"
 2378 Property holds the device certificate and CA certificate chain. "PrivateData" Property holds the
 2379 Device private key paired to the certificate. (See 13.3 for additional detail regarding the
 2380 "/oic/sec/cred" Resource).

9.4.5 Certificate Provisioning

The CMS (e.g. a hub or a smart phone) issues certificates for new Devices.

The CA in the CMS retrieves a Device's public key and proof of possession of the private key, generates a Device's certificate signed by this CA certificate, and then the CMS transfers them to the Device including its CA certificate chain. Optionally, the CMS can also transfer one or more role certificates, which shall have the format described in clause 9.4.2. The "subjectPublicKey" of each role certificate shall match the "subjectPublicKey" in the Device certificate.

In the sequence in Figure 23, the Certificate Signing Request (CSR) is defined by PKCS#10 in IETF RFC 2986, and is included here by reference.

The sequence flow of a certificate transfer for a Client-directed model is described in Figure 23.

- 1) The CMS retrieves a CSR from the Device that requests a certificate. In this CSR, the Device shall place its requested UUID into the subject and its public key in the "SubjectPublicKeyInfo". The Device determines the public key to present; this may be an already-provisioned key it has selected for use with authentication, or if none is present, it may generate a new key pair internally and provide the public part. The key pair shall be compatible with the allowed cipher suites listed in 9.4.2.4 and 11.3.4, since the certificate will be restricted for use in OCF authentication.
- 2) Alternatively, the CMS generates and provisions a private key and corresponding certificate directly to the Device.
- 3) The CMS transfers the issued certificate and CA chain to the designated Device using the same credid, to maintain the association with the private key. The credential type ("oic.sec.cred") used to transfer certificates in Figure 23 is also used to transfer role certificates, by including multiple credentials in the POST from CMS to Device. Identity certificates shall be stored with the credusage Property set to "oic.sec.cred.cert" and role certificates shall be stored with the credusage Property set to "oic.sec.cred.rolecert".

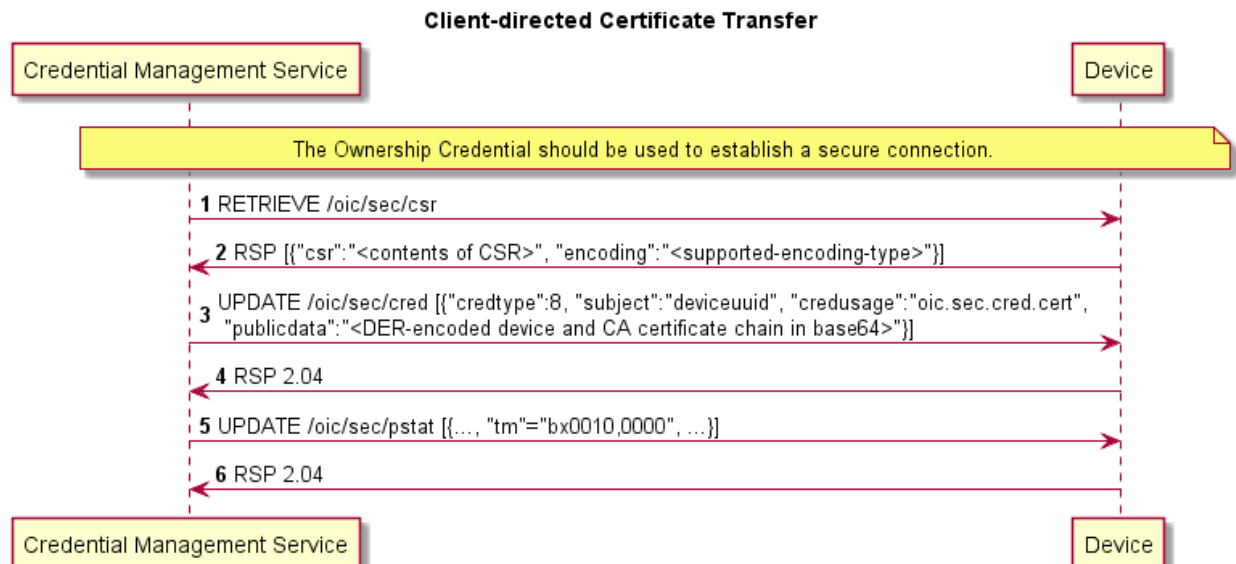


Figure 23 – Client-directed Certificate Transfer

9.4.6 CRL Provisioning [Deprecated]

This clause is intentionally left blank.

9.4.7 Role and Identity Certificate Profile

During onboarding, identity and optional role certificate is generated by the OBT and distributed to the Device. Table 14 is the list of required and optional fields of the certificate. If optional fields are used (from Table 14) then the device might refuse the certificate due to its size and the OBT will create a certificate that will not use the optional fields.

Table 14 - X.509 v3 extensions for Role and Identity Certificates

Extension	Required/Optional	Criticality	Value / Remarks
keyUsage	REQUIRED	Critical	digitalSignature (0) and keyAgreement(4) bits SHALL be the only bits enabled
certificatePolicies	OPTIONAL	Non-critical	End-Entity certificates chaining to an OCF Root CA SHOULD contain at least one PolicyIdentifierId set to the OCF Certificate Policy OID – (1.3.6.1.4.1.51414.0.1.2) corresponding to the version of the OCF Certificate Policy under which it was issued. Additional manufacturer-specific CP OIDs may also be populated
extendedKeyUsage	REQUIRED	Non-critical	The following extendedKeyUsage (EKU) OIDs SHALL both be present: <ul style="list-style-type: none"> • serverAuthentication - 1.3.6.1.5.5.7.3.1 • clientAuthentication - 1.3.6.1.5.5.7.3.2 Exactly ONE of the following OIDs SHALL be present: <ul style="list-style-type: none"> • Identity certificate - 1.3.6.1.4.1.44924.1.6 • Role certificate - 1.3.6.1.4.1.44924.1.7 End-Entity certificates SHALL NOT contain the anyExtendedKeyUsage OID (2.5.29.37.0)
subjectAlternativeName	REQUIRED	Non-critical	The subjectAltName extension is used to encode one or more Role ID values in role certificates, binding the roles to the subject public key. When the extendedKeyUsage (EKU) extension contains the Identity Certificate OID (1.3.6.1.4.1.44924.1.6), the subjectAltName

			<p>extension SHOULD NOT be present.</p> <p>If the EKU extension contains the Role Certificate OID (1.3.6.1.4.1.44924.1.7), the subjectAltName extension SHALL be present and populated as follows:</p> <p>Each GeneralName in the GeneralNames SEQUENCE which encodes a role shall be a directoryName, which is of type Name. Name is an X.501 Distinguished Name. Each Name shall contain exactly one CN (Common Name) component, and zero or one OU (Organizational Unit) components. The OU component, if present, shall specify the authority that defined the semantics of the role. If the OU component is absent, the certificate issuer has defined the role. The CN component shall encode the role ID. Other GeneralName types in the SEQUENCE may be present, but shall not be interpreted as roles.</p> <p>The role, and authority shall be encoded as ASN.1 PrintableString type, the restricted character set [0-9a-z-A-z '()+,-./:=?].</p>
--	--	--	-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------

2417

Device Authentication

10.1 Device Authentication General

When a Client is accessing a restricted Resource on a Server, the Server shall authenticate the Client. Clients shall authenticate Servers while requesting access. Clients may also assert one or more roles that the server can use in access control decisions. Roles may be asserted when the Device authentication is done with certificates.

10.2 Device Authentication with Symmetric Key Credentials

When using symmetric keys to authenticate, the Server Device shall include the "ServerKeyExchange" message and set "psk_identity_hint" to the Server's Device UUID. The Client shall validate that it has a credential with the Subject UUID set to the Server's Device UUID, and a credential type of PSK. If it does not, the Client shall respond with an unknown_psk_identity error or other suitable error.

If the Client finds a suitable PSK credential, it shall reply with a "ClientKeyExchange" message that includes a "psk_identity" set to the Client's Device UUID. The Server shall verify that it has a credential with the matching Subject UUID and type. If it does not, the Server shall respond with an "unknown_psk_identity" or other suitable error code. If it does, then it shall continue with the DTLS protocol, and both Client and Server shall compute the resulting premaster secret.

10.3 Device Authentication with Raw Asymmetric Key Credentials

When using raw asymmetric keys to authenticate, the Client and the Server shall include a suitable public key from a credential that is bound to their Device. Each Device shall verify that the provided public key matches the Public Data field of a credential they have, and use the corresponding Subject UUID of the credential to identify the peer Device.

10.4 Device Authentication with Certificates

10.4.1 Device Authentication with Certificates General

When using certificates to authenticate, the Client and Server shall each include their certificate chain, as stored in the appropriate credential, as part of the selected authentication cipher suite. Each Device shall validate the certificate chain presented by the peer Device. Each certificate signature shall be verified until a public key is found within the "/oic/sec/cred" Resource with the "oic.sec.cred.trustca" credusage.

Devices shall follow the certificate path validation algorithm in clause 6 of IETF RFC 5280. In addition:

- For both End-Entity certificates and non-End-Entity certificates, Devices shall verify that "notBefore" and "notAfter" fields in the certificates conform to IETF RFC 5280 clauses 4.1.2.5, 4.1.2.5.1, and 4.1.2.5.2.
- For non-End-Entity certificates, Devices shall verify that the Basic Constraints extension is present, and that the "cA" boolean in the extension is TRUE. If any of these are false, the certificate chain shall be rejected. If the pathLenConstraint field is present, Devices shall verify that the number of certificates between this certificate and the End-Entity certificate is less than or equal to "pathLenConstraint". In particular, if "pathLenConstraint" is zero, only an End-Entity certificate can be issued by this certificate. If the "pathLenConstraint" field is absent, there is no limit to the chain length.
- For End-Entity certificates, Devices shall verify that the Basic Constraints extension (if present) has a "cA" boolean value of FALSE, and does not contain a "pathLenConstraint" ASN.1 sequence.
- For non-End-Entity certificates, Devices shall verify that the Key Usage extension is present, and that the "keyCertSign" (5) bit is asserted.

- 2464 – For End-Entity certificates, Devices shall verify that the Key Usage extension is present and
2465 that "digitalSignature" (0) and "keyAgreement" (4) bits are asserted.
- 2466 – For End-Entity certificates, Devices shall verify that the Extended Key Usage (EKU) extension
2467 is present and suitable to the purpose for which it is being presented: Identity
2468 ("1.3.6.1.4.1.44924.1.6") or Role ("1.3.6.1.4.1.44924.1.7"). An End-Entity certificate which
2469 contains no EKU extension, or presents both identity and role OIDs is not valid and shall be
2470 rejected. Any certificate which contains the "anyExtendedKeyUsage" purpose ("2.5.29.37.0")
2471 shall be rejected, even if other valid EKUs are also present. For End-Entity certificates, Devices
2472 shall verify that the EKU extension also contains OIDs for "serverAuthentication"
2473 ("1.3.6.1.5.5.7.3.1") and "clientAuthentication" ("1.3.6.1.5.5.7.3.2") for compatibility with
2474 various TLS implementations.
- 2475 – For End-Entity certificates which chain to an OCF Root CA, the Devices should verify that they
2476 contain at least one "PolicyIdentifierId" set to the OCF Certificate Policy OID –
2477 ("1.3.6.1.4.1.51414.0.1.2") corresponding to the version of the OCF Certificate Policy under
2478 which it was issued. Additional manufacturer-specific CP OIDs may also be populated.

2479 If the Device does not recognize an extension, it shall examine the "critical" field. If the field is
2480 TRUE, the Device shall reject the certificate. If the field is FALSE, the Device shall treat the
2481 certificate as if the extension were absent and proceed accordingly. This applies to all certificates
2482 in a chain.

2483 A Device retrieves the Subject UUID from the "Common Name" component of the "Subject Name"
2484 property of the End-Entity certificate which has the following format: "uuid: X",, where X is
2485 provisioned by the CMS to match the "deviceuuid" Property of the "/oic/sec/doxm" Resource. The
2486 Device treats all requests arriving over a connection authenticated by this End-Entity certificate as
2487 having originated from the Device with this Subject UUID. The Device shall use this Subject UUID
2488 to match against the "subjectuuid" Property of the provisioned ACL entries to perform access
2489 control checks.

2490 **10.4.2 Role Assertion with Certificates**

2491 This clause describes role assertion by a client to a server using a certificate role credential.

2492 Following authentication with a certificate, an OCF Client shall assert Roles by updating the
2493 Server's "/oic/sec/roles" Resource with all the Role certificates it possesses, unless the device
2494 manufacturer provides a vendor-specific mechanism for End User to select which roles to assert.
2495 The Role credentials shall be certificate credentials and shall include a certificate chain. The Server
2496 shall validate each certificate chain as specified in clause 10.3. Additionally, the public key in the
2497 End-Entity certificate used for Device authentication shall be identical to the public key in all Role
2498 (End-Entity) certificates. Also, the common name component of the subject name for both Role
2499 certificates and identity certificates shall include a string of format "uuid:X" where X matches the
2500 "deviceuuid" Property of the "oic.sec.doxm" Resource.

2501 Furthermore, a Client is prohibited from adding Role certificates for other Clients. The Server shall
2502 reject Clients' request to add Role certificates if either (1) the request was received over an un-
2503 secured connection or (2) the request was received over a secured connection but the public key
2504 in the Role certificate does not match the public key in the identity certificate, which was used to
2505 establish the secured connection.

2506 The Roles asserted are encoded in the "subjectAltName" extension in the certificate. The
2507 "subjectAltName" field can have multiple values, allowing a single certificate to encode multiple
2508 Roles that apply to the Client. The Server shall also check that the EKU extension of the Role
2509 certificate(s) contains the value "1.3.6.1.4.1.44924.1.7" (see clause 9.4.2.2) indicating the
2510 certificate may be used to assert Roles. Figure 24 describes how a Client Device asserts Roles to
2511 a Server.

Asserting Certificate Role Credentials

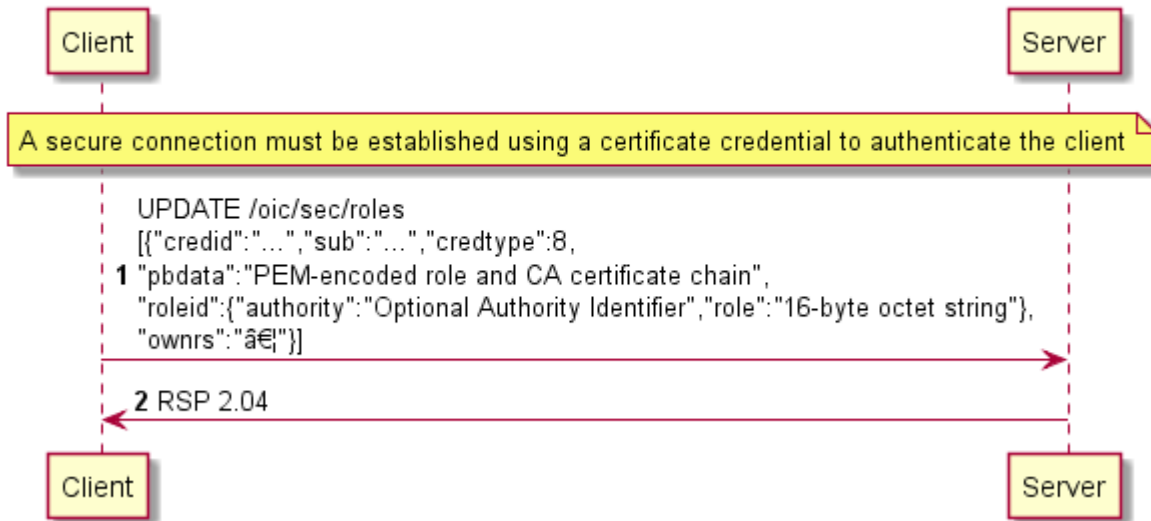


Figure 24 – Asserting a role with a certificate role credential.

Additional comments for Figure 24

- 1) The response shall contain "204 No Content" to indicate success or 4xx to indicate an error. If the server does not support certificate credentials, it should return "501 Not Implemented"
- 2) Roles asserted by the client may be kept for a duration chosen by the server. The duration shall not exceed the validity period of the role certificate.
- 3) Servers should choose a nonzero duration to avoid the cost of frequent re-assertion of a role by a client. It is recommended that servers use the validity period of the certificate as a duration, effectively allowing the CMS to decide the duration.
- 4) The format of the data sent in the create call shall be a list of credentials ("oic.sec.cred", see Table 20). They shall have "credtype" 8 (indicating certificates) and "PrivateData" field shall not be present. For fields that are duplicated in the "oic.sec.cred" object and the certificate, the value in the certificate shall be used for validation. For example, if the "Period" field is set in the credential, the server shall treat the validity period in the certificate as authoritative. Similar for the roleid data (authority, role).
- 5) Certificates shall be encoded as in Figure 23 (PEM-encoded certificate chain).
- 6) Clients may GET the "/oic/sec/roles" Resource to determine the roles that have been previously asserted. An array of credential objects shall be returned. If there are no valid certificates corresponding to the currently connected and authenticated Client's identity, then an empty array (i.e. []) shall be returned.

10.4.3 OCF PKI Roots

This clause intentionally left empty.

10.4.4 PKI Trust Store

Each Device using a certificate chained to an OCF Root CA trust anchor SHALL securely store the OCF Root CA certificates in the "oic/sec/cred" Resource and SHOULD physically store this Resource in a hardened memory location where the certificates cannot be tampered with.

10.4.5 Path Validation and extension processing

See clause 10.3.

2542 **Message Integrity and Confidentiality**

2543 **11.1 Preamble**

2544 Secured communications between Clients and Servers are protected against eavesdropping,
2545 tampering, or message replay, using security mechanisms that provide message confidentiality and
2546 integrity.

2547 **11.2 Session Protection with DTLS**

2548 **11.2.1 DTLS Protection General**

2549 Devices shall support DTLS for secured communications as defined in IETF RFC 6347. Devices
2550 using TCP shall support TLS v1.2 for secured communications as defined in IETF RFC 5246. See
2551 11.3 for a list of required and optional cipher suites for message communication.

2552 OCF Devices MUST support (D)TLS version 1.2 or greater and MUST NOT support versions 1.1
2553 or lower.

2554 Multicast session semantics are not yet defined in this version of the security document.

2555 **11.2.2 Unicast Session Semantics**

2556 For unicast messages between a Client and a Server, both Devices shall authenticate each other.
2557 See clause 9.4.7 for details on Device Authentication.

2558 Secured unicast messages between a Client and a Server shall employ a cipher suite from 11.3.
2559 The sending Device shall encrypt and authenticate messages as defined by the selected cipher
2560 suite and the receiving Device shall verify and decrypt the messages before processing them.

2561 **11.3 Cipher Suites**

2562 **11.3.1 Cipher Suites General**

2563 The cipher suites allowed for use can vary depending on the context. This clause lists the cipher
2564 suites allowed during ownership transfer and normal operation. The following RFCs provide
2565 additional information about the cipher suites used in OCF.

2566 IETF RFC 4279: Specifies use of pre-shared keys (PSK) in (D)TLS

2567 IETF RFC 4492: Specifies use of elliptic curve cryptography in (D)TLS

2568 IETF RFC 5489: Specifies use of cipher suites that use elliptic curve Diffie-Hellman (ECDHE) and
2569 PSKs

2570 IETF RFC 6655 and IETF RFC 7251: Specifies AES-CCM mode cipher suites, with ECDHE

2571 **11.3.2 Cipher Suites for Device Ownership Transfer**

2572 **11.3.2.1 Just Works Method Cipher Suites**

2573 The Just Works OTM may use the following (D)TLS cipher suites.

2574 TLS_ECDH_ANON_WITH_AES_128_CBC_SHA256

2575 All Devices supporting Just Works OTM shall implement:

2576 TLS_ECDH_ANON_WITH_AES_128_CBC_SHA256 (with the value 0xFF00)

2577 **11.3.2.2 Random PIN Method Cipher Suites**

2578 The Random PIN Based OTM may use the following (D)TLS cipher suites.

2579 TLS_ECDHE_PSK_WITH_AES_128_CBC_SHA256

2580 All Devices supporting Random Pin Based OTM shall implement:

2581 TLS_ECDHE_PSK_WITH_AES_128_CBC_SHA256

2582 **11.3.2.3 Certificate Method Cipher Suites**

2583 The Manufacturer Certificate Based OTM may use the following (D)TLS cipher suites.

2584 TLS_ECDHE_ECDSA_WITH_AES_128_CCM_8,

2585 TLS_ECDHE_ECDSA_WITH_AES_256_CCM_8,

2586 TLS_ECDHE_ECDSA_WITH_AES_128_CCM,

2587 TLS_ECDHE_ECDSA_WITH_AES_256_CCM

2588 Using the following curve:

2589 secp256r1 (See IETF RFC 4492)

2590 All Devices supporting Manufacturer Certificate Based OTM shall implement:

2591 TLS_ECDHE_ECDSA_WITH_AES_128_CCM_8

2592 Devices supporting Manufacturer Certificate Based OTM should implement:

2593 TLS_ECDHE_ECDSA_WITH_AES_256_CCM_8,

2594 TLS_ECDHE_ECDSA_WITH_AES_128_CCM,

2595 TLS_ECDHE_ECDSA_WITH_AES_256_CCM

2596 **11.3.3 Cipher Suites for Symmetric Keys**

2597 The following cipher suites are defined for (D)TLS communication using PSKs:

2598 TLS_ECDHE_PSK_WITH_AES_128_CBC_SHA256,

2599 TLS_PSK_WITH_AES_128_CCM_8, (* 8 OCTET Authentication tag *)

2600 TLS_PSK_WITH_AES_256_CCM_8,

2601 TLS_PSK_WITH_AES_128_CCM, (* 16 OCTET Authentication tag *)

2602 TLS_PSK_WITH_AES_256_CCM,

2603 All CCM based cipher suites also use HMAC-SHA-256 for authentication.

2604 All Devices shall implement the following:

2605 TLS_ECDHE_PSK_WITH_AES_128_CBC_SHA256,

2606

2607 Devices should implement the following:

2608 TLS_ECDHE_PSK_WITH_AES_128_CBC_SHA256,

2609 TLS_PSK_WITH_AES_128_CCM_8,

2610 TLS_PSK_WITH_AES_256_CCM_8,

2611 TLS_PSK_WITH_AES_128_CCM,

2612 TLS_PSK_WITH_AES_256_CCM

2613 **11.3.4 Cipher Suites for Asymmetric Credentials**

2614 The following cipher suites are defined for (D)TLS communication with asymmetric keys or
2615 certificates:

2616 TLS_ECDHE_ECDSA_WITH_AES_128_CCM_8,

2617 TLS_ECDHE_ECDSA_WITH_AES_256_CCM_8,
2618 TLS_ECDHE_ECDSA_WITH_AES_128_CCM,
2619 TLS_ECDHE_ECDSA_WITH_AES_256_CCM
2620 Using the following curve:
2621 secp256r1 (See IETF RFC 4492)
2622 All Devices supporting Asymmetric Credentials shall implement:
2623 TLS_ECDHE_ECDSA_WITH_AES_128_CCM_8
2624 All Devices supporting Asymmetric Credentials should implement:
2625 TLS_ECDHE_ECDSA_WITH_AES_256_CCM_8,
2626 TLS_ECDHE_ECDSA_WITH_AES_128_CCM,
2627 TLS_ECDHE_ECDSA_WITH_AES_256_CCM
2628

Access Control

12.1 ACL Generation and Management

This clause intentionally left empty.

12.2 ACL Evaluation and Enforcement

12.2.1 ACL Evaluation and Enforcement General

The Server enforces access control over application Resources before exposing them to the requestor. The Security Layer in the Server authenticates the requestor when access is received via the secure port. Authenticated requestors, known as the "subject" can be used to match ACL entries that specify the requestor's identity, role or may match authenticated requestors using a subject wildcard.

If the request arrives over the unsecured port, the only ACL policies allowed are those that use a subject wildcard match of anonymous requestors.

Access is denied if a requested Resource is not matched by an ACL entry.

NOTE There are documented exceptions pertaining to Device onboarding where access to Security Virtual Resources may be granted prior to provisioning of ACL Resources.

The second generation ACL (i.e. `/oic/sec/acl2`) contains an array of Access Control Entries (ACE2) that employ a Resource matching algorithm that uses an array of Resource references to match Resources to which the ACE2 access policy applies. Matching consists of comparing the values of the ACE2 "resources" Property (see clause 13) to the requested Resource. Resources are matched in two ways:

- 1) host reference (`"href"`)
- 2) Resource wildcard (`"wc"`).

12.2.2 Host Reference Matching

When present in an ACE2 matching element, the Host Reference (`href`) Property shall be used for Resource matching.

- The `href` Property shall be used to find an exact match of the Resource name if present.

12.2.3 Resource Wildcard Matching

When present, a wildcard (`"wc"`) expression shall be used to match multiple Resources using a wildcard Property contained in the `"oic.sec.ace2.resource-ref"` structure.

A wildcard expression may be used to match multiple Resources using a wildcard Property contained in the `"oic.sec.ace2.resource-ref"` structure. The wildcard matching strings are defined in Table 15.

Table 15 – ACE2 Wildcard Matching Strings Description

String	Description
"+"	Shall match all Discoverable Non-Configuration Resources which expose at least one Secure OCF Endpoint.
"_"	Shall match all Discoverable Non-Configuration Resources which expose at least one Unsecure OCF Endpoint.
***	Shall match all Non-Configuration Resources.

NOTE Discoverable Resources appear in the `/oic/res` Resource, while non-discoverable Resources may appear in other collection Resources but do not appear in the `/res` collection.

12.2.4 Multiple Criteria Matching

If the ACE2 "resources" Property contains multiple entries, then a logical OR shall be applied for each array element. For example, if a first array element of the "resources" Property contains "href="/a/light" and the second array element of the "resources" Property contains "href="/a/led", then Resources that match either of the two "href" criteria shall be included in the set of matched Resources.

Example 1 JSON for Resource matching

```
{
  //Matches Resources named "/x/door1" or "/x/door2"
  "resources":[
    {
      "href":"/x/door1"
    },
    {
      "href":"/x/door2"
    },
  ]
}
```

Example 2 JSON for Resource matching

```
{
  // Matches all Resources
  "resources":[
    {
      "wc":"*"
    }
  ]
}
```

12.2.5 Subject Matching using Wildcards

When the ACE subject is specified as the wildcard string "*" any requestor is matched. The OCF server may authenticate the OCF client, but is not required to.

Examples: JSON for subject wildcard matching

```
//matches all subjects that have authenticated and confidentiality protections in place.
"subject" : {
  "conntype" : "auth-crypt"
}

//matches all subjects that have NOT authenticated and have NO confidentiality protections in place.
"subject" : {
  "conntype" : "anon-clear"
}
```

12.2.6 Subject Matching using Roles

When the ACE subject is specified as a role, a requestor shall be matched if either:

- 1) The requestor authenticated with a symmetric key credential, and the role is present in the "roleid" Property of the credential's entry in the "credential" Resource, or

2707 2) The requestor authenticated with a certificate, and a valid role certificate is present in the roles
2708 Resource with the requestor's certificate's public key at the time of evaluation. Validating role
2709 certificates is defined in 10.3.1.

2710 **12.2.7 ACL Evaluation**

2711 **12.2.7.1 ACE2 matching algorithm**

2712 The OCF Server shall apply an ACE2 matching algorithm that matches in the following sequence :

- 2713 1) The local "/oic/sec/acl2" Resource contributes its ACE2 entries for matching.
- 2714 2) Access shall be granted when all these criteria are met:
- 2715 a) The requestor is matched by the ACE2 "subject" Property.
 - 2716 b) The requested Resource is matched by the ACE2 "resources" Property and the requested
2717 Resource shall exist on the local Server.
 - 2718 c) The "period" Property constraint shall be satisfied.
 - 2719 d) The "permission" Property constraint shall be applied.

2720 If multiple ACE2 entries match the Resource request, the union of permissions, for all matching
2721 ACEs, defines the effective permission granted. E.g. If Perm1=CR---; Perm2=--UDN; Then UNION
2722 (Perm1, Perm2)=CRUDN.

2723 The Server shall enforce access based on the effective permissions granted.

2724 Batch requests to Resource containing Links require additional considerations when accessing the
2725 linked Resources. ACL considerations for batch request to the Atomic Measurement Resource
2726 Type are provided in clause 12.2.7.2. ACL considerations for batch request to the Collection
2727 Resource Type are provided in clause 12.2.7.3.

2728 Clause 12.2.7.4 provides ACL considerations when a new Resource is created on a Server in
2729 response to a CREATE request.

2730 **12.2.7.2 ACL considerations for batch request to the Atomic Measurement Resource Type**

2731 The present clause shall apply to any Resource Type based on the Atomic Measurement Resource
2732 Type.

2733 If an OCF Server receives a batch OCF Interface request to an Atomic Measurement Resource and
2734 there is an ACE matching the Atomic Measurement Resource which permits the request, then the
2735 corresponding requests to the linked Resources of the Atomic Measurement Resource shall be
2736 permitted by the OCF Server. That is, the request to each linked Resource is permitted regardless
2737 of whether there is an ACE configured on the OCF Server which would permit a corresponding
2738 request from the OCF Client (which sent the batch OCF Interface request to the Atomic
2739 Measurement Resource) addressing the linked Resource.

2740 NOTE As specified in ISO/IEC 30118-1, the linked Resources of an Atomic Measurement Resource are hosted on the
2741 same Device as the Atomic Measurement Resource.

2742 **12.2.7.3 ACL considerations for a batch OCF Interface request to a Collection**

2743 This clause addresses the additional authorization processes which take place when a Server
2744 receives a batch OCF Interface request from a Client to a Collection hosted on that Server,
2745 assuming there is an ACE matching the Collection which permits the original Client request. For
2746 the purposes of this clause, the Server hosting this Collection is called the "Collection host". The
2747 additional authorization process is dependent on whether the linked Resource is hosted on the
2748 Collection host or the linked Resource is hosted on another Server:

- 2749 – For each generated request to a linked Resource hosted on the Collection host, the Collection
2750 host shall apply the ACE2 matching algorithm in clause 12.2.7.1 to determine whether the linked
2751 Resource is permitted to process the generated request, with the following clarifications:

- 2752 – The requestor in clause 12.2.7.1 shall be the Client which sent the original Client request.
- 2753 – The requested Resource in clause 12.2.7.1 shall be the linked Resource, which shall be
- 2754 matched using at least one of:
- 2755 – a Resource Wildcard matching the linked Resource, or
- 2756 – an exact match of the local path of the linked Resource with a "href" Property in the
- 2757 "resources" array in the ACE2.
- 2758 – an exact match of the full URI of the linked Resource with a "href" Property in the
- 2759 "resources" array in the ACE2.

2760 NOTE The full URI of a linked Resource is obtained by concatenating the "anchor" Property of the Link, if present, and

2761 the "href" Property of the Link. The local path can then be determined from the full URI.

2762 If the linked Resource is not permitted to process the generated request, then the Collection host

2763 shall treat such cases as a linked Resource which cannot process the request when composing the

2764 aggregated response to the original Client Request, as specified for the batch OCF Interface in the

2765 ISO/IEC 30118-1.

2766 **12.2.7.4 ACL Considerations on creation of a new Resource**

2767 When a new Resource is created on a Server in response to a CREATE request, there might be

2768 no ACEs permitting access to the newly created Resource. The present clause describes how the

2769 Server autonomously modifies the "/oic/sec/acl2" Resource to provide some initial authorizations

2770 for accessing the newly created Resource. The purpose of this autonomous modification is to avoid

2771 relying on the AMS update the "/oic/sec/acl2" Resource after every new Resource is created.

2772 Subsequent to a Server creating a Collection inside another Collection in response to a CREATE

2773 request from a Client, and prior to sending a response to the Client:

- 2774 – If there is an ACE with "subject" containing the UUID of the Client, and "permissions" exactly
- 2775 matching the CREATE, RETRIEVE, UPDATE and DELETE operations, then the Server shall
- 2776 autonomously add an "href" entry to "resources" with the URI of the newly created Collection.
- 2777 – Otherwise, the Server shall autonomously add an ACE with "subject" containing the UUID
- 2778 of the Client, "resources" containing an "href" entry with the URI of the newly created
- 2779 Collection, and "permissions" exactly matching the CREATE, RETRIEVE, UPDATE and
- 2780 DELETE operations.

2781 Subsequent to a Server creating a non-Collection Resource inside another Collection in response

2782 to a CREATE request from a Client, and prior to sending a response to the Client:

- 2783 – If there is an ACE with "subject" containing the UUID of the Client, and "permissions" exactly
- 2784 matching the RETRIEVE, UPDATE and DELETE operations, then the Server shall
- 2785 autonomously add an "href" entry to "resources" with the URI of the newly created Resource.
- 2786 – Otherwise, the Server shall autonomously add an ACE with "subject" containing the UUID
- 2787 of the Client, "resources" containing an "href" entry with the URI of the newly created, and
- 2788 "permissions" exactly matching the RETRIEVE, UPDATE and DELETE operations.

2789

Security Resources

13.1 Security Resources General

OCF Security Resources are shown in Figure 25.

"/oic/sec/cred" Resource and Properties are shown in Figure 26.

"/oic/sec/acl2" Resource and Properties are shown in Figure 27.

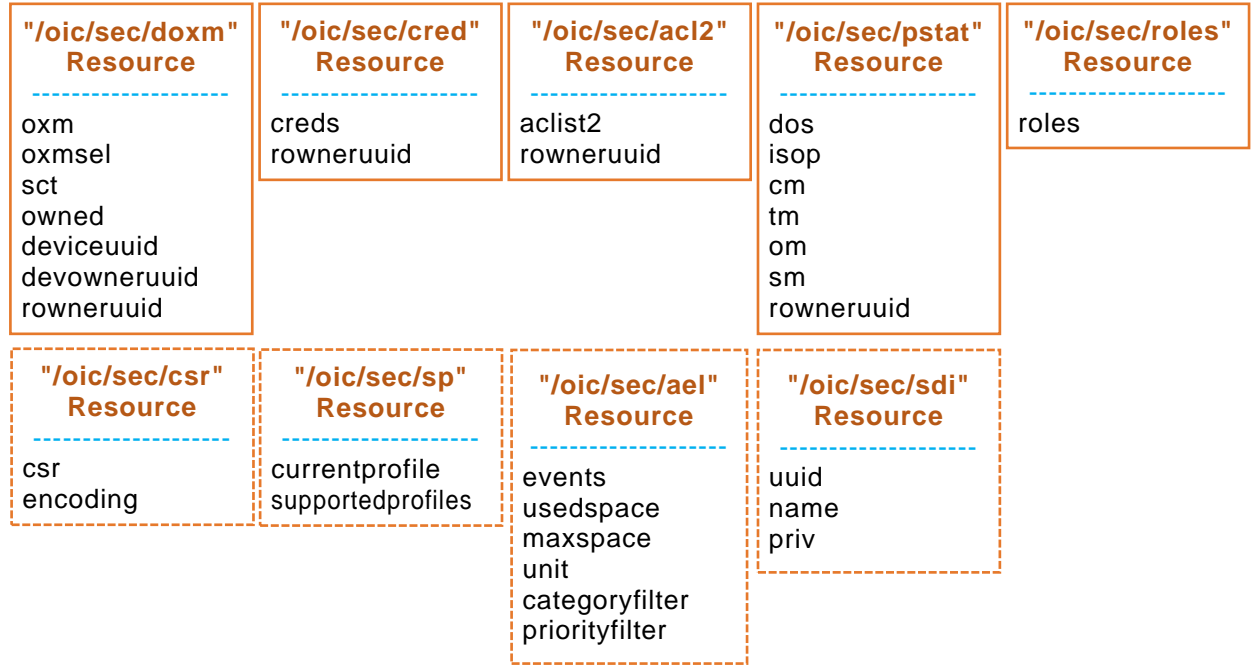


Figure 25 – OCF Security Resources

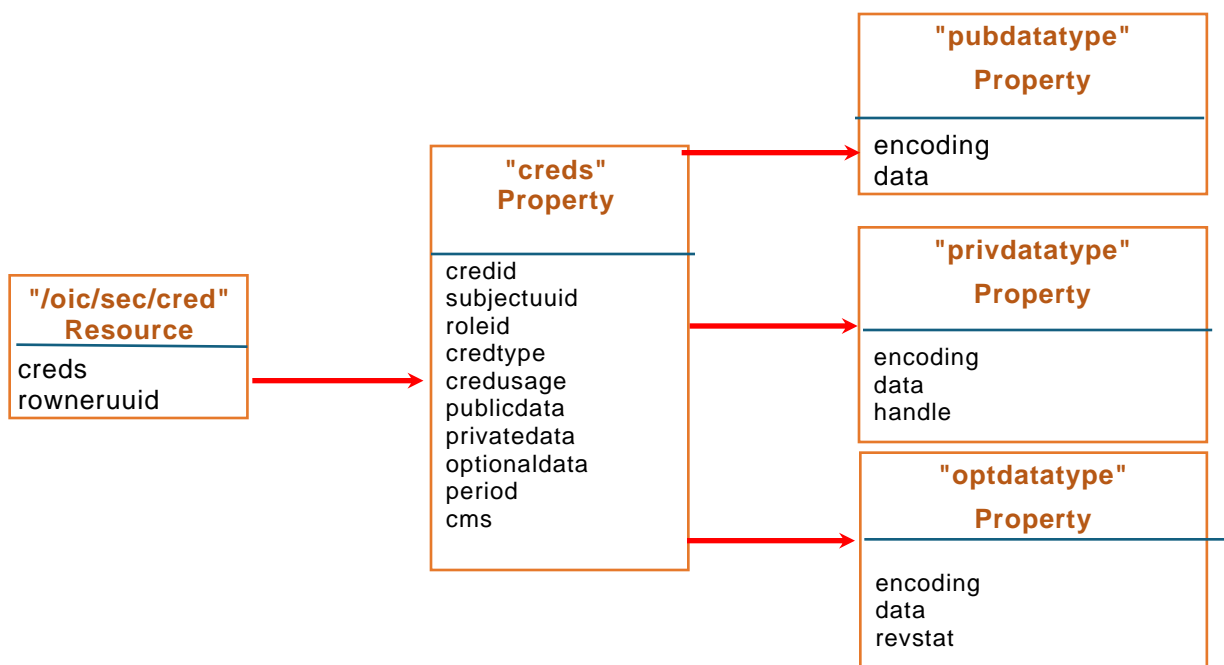


Figure 26 – "/oic/sec/cred" Resource and Properties

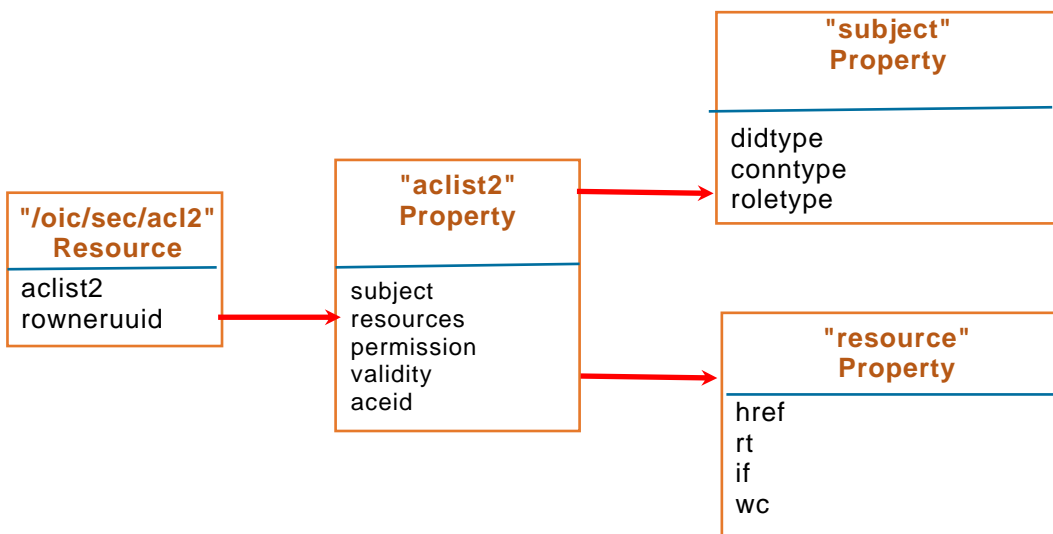


Figure 27 – "/oic/sec/acl2" Resource and Properties

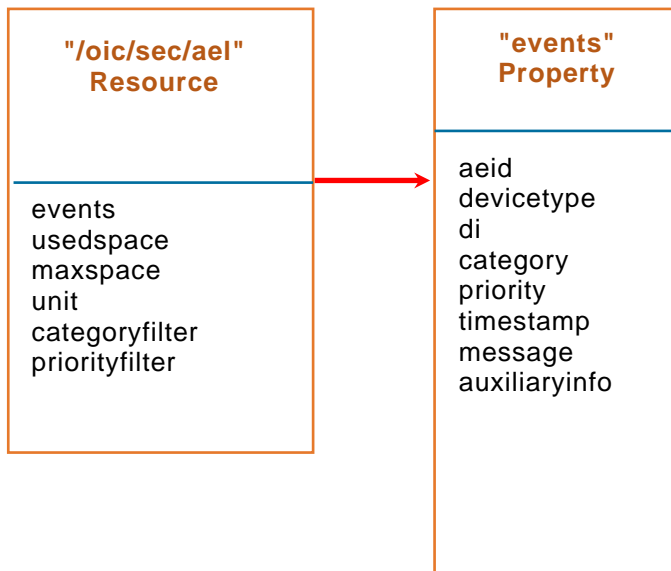


Figure 28 – "/oic/sec/ael" Resource and Properties

13.2 Device Owner Transfer Resource

13.2.1 Device Owner Transfer Resource General

The "/oic/sec/doxm" Resource contains the set of supported Device OTMs.

Resource discovery processing respects the CRUDN constraints supplied as part of the security Resource definitions contained in this document.

"/oic/sec/doxm" Resource is defined in Table 16.

Table 16 – Definition of the "/oic/sec/doxm" Resource

Fixed URI	Resource Type Title	Resource Type ID ("rt" value)	OCF Interfaces	Description	Related Functional Interaction
/oic/sec/doxm	Device OTMs	oic.r.doxm	oic.if.baselin e, oic.if.rw	Resource for supporting Device owner transfer	Configuration

Table 17 defines the Properties of the "/oic/sec/doxm" Resource.

Table 17 – Properties of the "/oic/sec/doxm" Resource

Property Title	Property Name	Value Type	Value Rule	Mandat ory	Device State	Access Mode	Description
OTM	oxms	oic.sec.doxm type	array	Yes		R	Value identifying the owner-transfer-method and the organization that defined the method.
OTM Selection	oxmsel	oic.sec.doxm type	UINT16	Yes	RESET	R	Server shall set to (4) "oic.sec.oxm.self"
					RFOTM (no open DOC)	RW	DOTS shall set to its selected DOTS and both parties execute the DOTS. After secure owner transfer session is established DOTS shall update the oxmsel again making it permanent. If the

							DOTS fails the Server shall transition device state to RESET.
					RFOTM (open DOC)	R	n/a
					RFPRO	R	n/a
					RFNOP	R	n/a
					SRESET	R	n/a
Supported Credential Types	sct	oic.sec.credtype	bitmask	Yes		R	Identifies the types of credentials the Device supports. The Server sets this value at framework initialization after determining security capabilities. The Device always supports symmetric pair-wise key and asymmetric signing key with certificate (bit positions 0x1 and 0x8 respectively). Other credential types are optional as per clause 9.3
Device Ownership Status	owned	Boolean	T F	Yes	RESET	R	Server shall set to FALSE.
					RFOTM (no open DOC)	R	FALSE
					RFOTM (open DOC)	RW	DOTS (Device communicating over DOC) shall set to TRUE after secure owner transfer session is established.
					RFPRO	R	TRUE
					RFNOP	R	TRUE
					SRESET	R	TRUE
Device UUID	deviceuuid	String	oic.sec.didtype	Yes	RESET	R	No stipulation.
					RFOTM (no open DOC)	R	n/a
					RFOTM (open DOC)	RW	DOTS (Device communicating over DOC) updates to a value it has selected after secure owner transfer session is established.
					RFPRO	R	n/a
					RFNOP	R	n/a
					SRESET	R	n/a
Device Owner Id	devowneruid	String	uid	Yes	RESET	R	Server shall set to the nil uid value (e.g. "00000000-0000-0000-0000-000000000000")
					RFOTM (no open DOC)	R	n/a
					RFOTM (open DOC)	RW	DOTS (Device communicating over DOC) shall set value after secure owner transfer session is established.
					RFPRO	R	n/a
					RFNOP	R	n/a
					SRESET	R	n/a

Resource Owner Id	rowneruuid	String	uuid	Yes	RESET	R	Server shall set to the nil uuid value (e.g. "00000000-0000-0000-0000-000000000000")
					RFOTM (no open DOC)	R	n/a
					RFOTM (open DOC)	RW	The DOTS (Device communicating over DOC) shall configure the rowneruuid Property when a successful owner transfer session is established.
					RFPRO	R	n/a
					RFNOP	R	n/a
					SRESET	RW	The DOTS (referenced via devowneruuid Property) should verify and if needed, update the Resource owner Property when a mutually authenticated secure session is established. If the rowneruuid does not refer to a valid DOTS device identifier the Server shall transition to RESET.

Table 18 defines the Properties of the "oic.sec.didtype".

Table 18 – Properties of the "oic.sec.didtype" type

Property Title	Property Name	Value Type	Value Rule	Mandatory	Device State	Access Mode	Description
Device UUID	uuid	String	uuid	Yes	RW	-	A uuid value

The "oxms" Property contains a list of OTM where the entries appear in the order of preference. This Property contains the higher priority methods appearing before the lower priority methods. The DOTS queries this list at the time of onboarding and selects the most appropriate method.

OTMs consist of two parts, a URI identifying the vendor or organization and the specific method.

```

<DoxmType> ::= <NSS>
<NSS> ::= <Identifier> | {{<NID>"."} <NameSpaceQualifier> "."} <Method>
<NID> ::= <Vendor-or-Organization>
<Identifier> ::= INTEGER
<NameSpaceQualifier> ::= String
<Method> ::= String
<Vendor-Organization> ::= String

```

When an OTM successfully completes, the "owned" Property is set to "1" (TRUE). Consequently, subsequent attempts to take ownership of the Device will fail.

There are four device identifiers:

- 1) "deviceuuid" Property of "/oic/sec/doxm" Resource - random DOTS-provisioned value unique for a given security domain, used as a device identity for access control, mapped internally to a device-owned credential.
- 2) "di" Property of "/oic/d" Resource - mirroring the value of "deviceuuid" Property of "/oic/sec/doxm" Resource.
- 3) "piid" Property of "/oic/d" Resource - defined in ISO/IEC 30118-1.
- 4) "pi" Property of "/oic/p" Resource - defined in ISO/IEC 30118-1.

The "/oic/sec/doxm" Resource supports CoAP multicast requests in certain cases. For details see clause 7.3.1

13.2.2 OCF defined OTMs

Table 19 defines the Properties of the "oic.sec.doxmtype".

Table 19 – Properties of the "oic.sec.doxmtype" type

Value Type Name	Value Type URN (optional)	Enumeration Value (mandatory)	Description
OCFJustWorks	oic.sec.doxm.jw	0	The just-works method relies on anonymous Diffie-Hellman key agreement protocol to allow a DOTS to assert ownership of the new Device. The first DOTS to make the assertion is accepted as the Device owner. The just-works method results in a shared secret that is used to authenticate the Device to the DOTS and likewise authenticates the DOTS to the Device. The Device permits the DOTS to take ownership of the Device, after which a second attempt to take ownership by a different DOTS will fail ^a .
OCFSharedPin	oic.sec.doxm.rdp	1	The new Device randomly generates a PIN that is communicated via an Out Of Band Communication Channel to a DOTS. An in-band Diffie-Hellman key agreement protocol establishes that both endpoints possess the PIN. Possession of the PIN by the DOTS signals the new Device that device ownership can be asserted.
OCFMfgCert	oic.sec.doxm.mfgcert	2	The new Device is presumed to have been manufactured with an embedded asymmetric private key that is used to sign a Diffie-Hellman exchange at Device onboarding. The manufacturer certificate should contain Platform hardening information and other security assurances assertions.
OCF Reserved	<Reserved>	3	Reserved
OCFSelf	oic.sec.oxm.self	4	The manufacturer shall set the "/doxm.oxmsel" value to (4). The Server shall reset this value to (4) upon entering RESET.
OCF Reserved	<Reserved>	5~0xFEFF	Reserved for OCF use
Vendor-defined Value Type Name	<Reserved>	0xFF00~0xFFFF	Reserved for vendor-specific OTM use
^a The just-works method is subject to a man-in-the-middle attacker. Precautions should be taken to provide physical security when this method is used.			

13.3 Credential Resource

13.3.1 Credential Resource General

The "/oic/sec/cred" Resource maintains credentials used to authenticate the Server to Clients and support services as well as credentials used to verify Clients and support services.

Multiple credential types are anticipated by the OCF framework, including pair-wise pre-shared keys, asymmetric keys, certificates and others. The credential Resource uses a Subject UUID to distinguish the Clients and support services it recognizes by verifying an authentication challenge.

In order to provide an interface which allows management of the "creds" Array Property, the RETRIEVE, UPDATE and DELETE operations on the "/oic/sec/cred" Resource shall behave as follows:

- 1) A RETRIEVE shall return the full Resource representation, except that any write-only Properties shall be omitted (e.g. private key data).
- 2) An UPDATE shall replace or add to the Properties included in the representation sent with the UPDATE request, as follows:

- 2852 a) If an UPDATE representation includes the "creds" array Property, then:
- 2853 i) Supplied "creds" with a "credid" that matches an existing "credid" shall replace
- 2854 completely the corresponding "cred" in the existing "creds" array.
- 2855 ii) Supplied "creds" without a "credid" shall be appended to the existing "creds" array, and
- 2856 a unique (to the "cred" Resource) "credid" shall be created and assigned to the new
- 2857 "cred" by the Server. The "credid" of a deleted "cred" should not be reused, to improve
- 2858 the determinism of the interface and reduce opportunity for race conditions.
- 2859 iii) Supplied "creds" with a "credid" that does not match an existing "credid" shall be
- 2860 appended to the existing "creds" array, using the supplied "credid".
- 2861 iv) The rows in Table 21 corresponding to the "creds" array Property dictate the Device
- 2862 States in which an UPDATE of the "creds" array Property is always rejected. If OCF
- 2863 Device is in a Device State where the Access Mode in this row contains "R", then the
- 2864 OCF Device shall reject all UPDATES of the "creds" array Property.
- 2865 3) A DELETE without query parameters shall set the "creds" array to the empty array, but shall
- 2866 not remove the "/oic/sec/cred" Resource.
- 2867 4) A DELETE with one or more "credid" query parameters shall remove the "cred"(s) with the
- 2868 corresponding "credid"(s) from the "creds" array.
- 2869 5) The rows in Table 21 corresponding to the "creds" array Property dictate the Device States in
- 2870 which a DELETE is always rejected. If OCF Device is in a Device State where the Access Mode
- 2871 in this row contains "R", then the OCF Device shall reject all DELETES.
- 2872 NOTE The "/oic/sec/cred" Resource's use of the DELETE operation is not in accordance with the OCF Interfaces defined
- 2873 in ISO/IEC 30118-1.
- 2874 "/oic/sec/cred" Resource is defined in Table 20.

2875 **Table 20 – Definition of the "/oic /sec/cred" Resource**

Fixed URI	Resource Type Title	Resource Type ID ("rt" value)	OCF Interfaces	Description	Related Functional Interaction
/oic/sec/cred	Credentials	oic.r.cred	oic.if.baseline, oic.if.rw	Resource containing credentials for Device authentication, verification and data protection	Security

2876 Table 21 defines the Properties of the "/oic/sec/cred" Resource.

Table 21 – Properties of the "/oic/sec/cred" Resource

Property Title	Property Name	Value Type	Value Rule	Mandatory	Device State	Access Mode	Description
Credentials	creds	oic.sec.cred	array	Yes	RESET	R	Server shall set to manufacturer defaults.
					RFOTM	RW	Set by DOTS after successful OTM
					RFPRO	RW	Set by the CMS (referenced via the rowneruuid Property of "/oic/sec/cred" Resource) after successful authentication. Access to NCRs is prohibited.
					RFNOP	R	Access to NCRs is permitted after a matching ACE is found.
					SRESET	RW	The DOTS (referenced via devowneruuid Property of "/oic/sec/doxm" Resource or the rowneruuid Property of "/oic/sec/doxm" Resource) should evaluate the integrity of and may update creds entries when a secure session is established and the Server and DOTS are authenticated.
Resource Owner ID	rowneruuid	String	uuid	Yes	RESET	R	Server shall set to the nil uuid value (e.g. "00000000-0000-0000-0000-000000000000")
					RFOTM	RW	The DOTS shall configure the rowneruuid Property of "/oic/sec/cred" Resource when a successful owner transfer session is established.
					RFPRO	R	n/a
					RFNOP	R	n/a
					SRESET	RW	The DOTS (referenced via devowneruuid Property of "/oic/sec/doxm" Resource or the rowneruuid Property of "/oic/sec/doxm" Resource) should verify and if needed, update the Resource owner Property when a mutually authenticated secure session is established. If the "rowneruuid" Property does not refer to a valid DOTS the Server shall transition to RESET.

2878 All secure Device accesses shall have a "/oic/sec/cred" Resource that protects the end-to-end
 2879 interaction.

2880 The "/oic/sec/cred" Resource shall be updateable by the service named in its rowneruuid Property.

2881 ACLs naming "/oic/sec/cred" Resource should further restrict access beyond CRUDN access
 2882 modes.

2883 Table 22 defines the Properties of "oic.sec.creds".

Table 22 – Properties of the "oic.sec.creds" Property

Property Title	Property Name	Value Type	Value Rule	Mandatory	Access Mode	Device State	Description
Credential ID	credid	UINT16	0 – 64K-1	Yes	RW		Short credential ID for local references from other Resource
Subject UUID	subjectuuid	String	uuid	Yes	RW		A uuid that identifies the subject to which this credential applies or "" if any identity is acceptable
Role ID	roleid	oic.sec.roletype	-	No	RW		Identifies the role(s) the subject is authorized to assert.
Credential Type	credtype	oic.sec.credtype	bitmask	Yes	RW		Represents this credential's type. 0 – Used for testing 1 – Symmetric pair-wise key 2 – Symmetric group key 4 – Asymmetric signing key 8 – Asymmetric signing key with certificate 16 – PIN or password 32 – Asymmetric encryption key 64 – Directly Provisioned OSCORE Security Context 128 – Simple Secure Multicast Client Context 256 – Simple Secure Multicast Server Context
Credential Usage	credusage	oic.sec.credusage	String	No	RW		Used to resolve undecidability of the credential. Provides indication for how/where the cred is used "oic.sec.cred.trustca": certificate trust anchor "oic.sec.cred.cert": identity certificate "oic.sec.cred.rolecert": role certificate "oic.sec.cred.mfgtrustca": manufacturer certificate trust anchor "oic.sec.cred.mfgcert": manufacturer certificate
Public Data	publicdata	oic.sec.pubdatatype	-	No	RW		Credential Type dependent. Public credential information 1:2: ticket, public SKDC values 4, 32: Public key value 8: A chain of one or more certificate
Private Data	privatedata	oic.sec.privdatatype	-	No	-	RESET	Server shall set to manufacturer default
					RW	RFOTM	Set by DOTS after successful OTM
					W	RFPRO	Set by authenticated DOTS or CMS
					-	RFNOP	Not writable during normal operation.
					W	SRESET	DOTS may modify to enable transition to RFPRO.
Optional Data	optionaldata	oic.sec.optdatatype	-	No	RW		Credential Type dependent. Credential revocation status information 1, 2, 4, 32, 64: revocation status information 8: Revocation information

Period	period	String	-	No	RW		Period as defined by IETF RFC 5545. The credential should not be used if the current time is outside the Period window.
Credential Refresh Method	crms	oic.sec.crmtype	array	No	RW		Credentials with a Period Property are refreshed using the credential refresh method (crm) according to the type definitions for "oic.sec.crm".
OSCORE Configuration	oscore	oic.sec.oscoretype		No	RW		Contains parameters for use with credentials intended for use with OSCORE. See type definition for "oic.sec.oscoretype"

2885 Table 23 defines the Properties of "oic.sec.credusagetype".

2886 **Table 23: Properties of the "oic.sec.credusagetype" Property**

Value Type Name	Value Type URN (mandatory)
Trust Anchor	oic.sec.cred.trustca
Certificate	oic.sec.cred.cert
Role Certificate	oic.sec.cred.rolecert
Manufacturer Trust CA	oic.sec.cred.mfgtrustca
Manufacturer CA	oic.sec.cred.mfgcert

2887 Table 24 defines the Properties of "oic.sec.pubdatatype".

2888 **Table 24 – Properties of the "oic.sec.pubdatatype" Property**

Property Title	Property Name	Value Type	Value Rule	Access Mode	Mandatory	Description
Encoding format	encoding	String	N/A	RW	No	A string specifying the encoding format of the data contained in the pubdata "oic.sec.encoding.pem" – Encoding for PEM-encoded certificate or chain
Data	data	String	N/A	RW	No	The encoded value

2889 Table 25 defines the Properties of "oic.sec.privdatatype".

2890 **Table 25 – Properties of the "oic.sec.privdatatype" Property**

Property Title	Property Name	Value Type	Value Rule	Access Mode	Mandatory	Description
Encoding format	encoding	String	N/A	RW	Yes	A string specifying the encoding format of the data contained in the privdata "oic.sec.encoding.pem" – Encoding for PEM-encoded private key "oic.sec.encoding.base64" – Encoding of Base64 encoded PSK "oic.sec.encoding.handle" – Data is contained in a storage sub-system referenced using a handle "oic.sec.encoding.raw" – Raw hex encoded data
Data	data	String	N/A	W	No	The encoded value This value shall not be RETRIEVE-able.
Handle	handle	UINT16	N/A	RW	No	Handle to a key storage Resource

2891 Table 26 defines the Properties of "oic.sec.optdatatype".

2892

Table 26 – Properties of the "oic.sec.optdatatype" Property

Property Title	Property Name	Value Type	Value Rule	Access Mode	Mandatory	Description
Revocation status	revstat	Boolean	T F	RW	Yes	Revocation status flag True – revoked False – not revoked
Encoding format	encoding	String	N/A	RW	No	A string specifying the encoding format of the data contained in the optdata "oic.sec.encoding.pem" – Encoding for PEM-encoded certificate or chain
Data	data	String	N/A	RW	No	The encoded structure

2893 Table 27 defines the Properties of "oic.sec.roletype".

2894

Table 27 – Definition of the "oic.sec.roletype" type.

Property Title	Property Name	Value Type	Value Rule	Access Mode	Mandatory	Description
Authority	authority	String	N/A	R	No	A name for the authority that defined the role. If not present, the credential issuer defined the role. If present, must be expressible as an ASN.1 PrintableString.
Role	role	String	N/A -	R	Yes	An identifier for the role. Must be expressible as an ASN.1 PrintableString.

2895 Table 28 defines the Properties of "oic.sec.oscoretype".

2896

Table 28 – Definition of the "oic.sec.oscoretype" type.

Property Title	Property Name	Value Type	Value Rule	Access Mode	Mandatory	Description
OSCORE Sender ID	senderid	String	Hexadecimal encoding	RW	No	OSCORE Sender ID for this OSCORE Security Context.
OSCORE Recipient ID	recipientid	String		RW	No	OSCORE Recipient ID for this OSCORE Security Context.
OSCORE Sender Sequence Number 1	ssn	Integer		R	No	OSCORE Sender Sequence Number being stored in non volatile memory to handle the loss of mutable security context parameters. See clause 16.2.4.
OSCORE Security Context Description	desc	String		RW	No	Description of the usage of this OSCOE Security Context.

2897 **13.3.2 Properties of the Credential Resource**2898 **13.3.2.1 Credential ID**

2899 Credential ID ("credid") is a local reference to an entry in a "creds" Property array of the
 2900 "/oic/sec/cred" Resource. The SRM generates it. The "credid" Property shall be used to
 2901 disambiguate array elements of the "creds" Property.

2902 **13.3.2.2 Subject UUID**

2903 The "subjectuuid" Property identifies the Device to which an entry in a "creds" Property array of the
2904 "/oic/sec/cred" Resource shall be used to establish a secure session, verify an authentication
2905 challenge-response or to authenticate an authentication challenge.

2906 A "subjectuuid" Property that matches the Server's own "deviceuuid" Property, distinguishes the
2907 array entries in the "creds" Property that pertain to this Device.

2908 The "subjectuuid" Property shall be used to identify a group to which a group key is used to protect
2909 shared data.

2910 When certificate chain is used during secure connection establishment, the "subjectuuid" Property
2911 shall also be used to verify the identity of the responder. The presented certificate chain shall be
2912 accepted, if there is a matching Credential entry on the Device that satisfies all of the following:

- 2913 – Public Data of the entry contains trust anchor (root) of the presented chain.
- 2914 – Subject UUID of the entry matches UUID in the Common Name field of the End-Entity certificate
2915 in the presented chain. If Subject UUID of the entry is set as a wildcard "*", this condition is
2916 automatically satisfied.
- 2917 – Credential Usage of the entry is "oic.sec.cred.trustca".

2918 **13.3.2.3 Role ID**

2919 The "roleid" Property identifies a role that has been granted to the credential.

2920 **13.3.2.4 Credential Type**

2921 The "credtype" Property is used to interpret several of the other Property values whose contents
2922 can differ depending on credential type. These Properties include "publicdata", "privatedata" and
2923 "optionaldata". The "credtype" Property value of "0" ("no security mode") is reserved for testing and
2924 debugging circumstances. Production deployments shall not allow provisioning of credentials of
2925 type "0". The SRM should introduce checking code that prevents its use in production deployments.

2926 **13.3.2.5 Public Data**

2927 The "publicdata" Property contains information that provides additional context surrounding the
2928 issuance of the credential. For example, it might contain information included in a certificate or
2929 response data from a CMS. It might contain wrapped data.

2930 **13.3.2.6 Private Data**

2931 The "privatedata" Property contains secret information that is used to authenticate a Device, protect
2932 data or verify an authentication challenge-response.

2933 The "privatedata" Property shall not be disclosed outside of the SRM's trusted computing perimeter.
2934 A secure element (SE) or trusted execution environment (TEE) should be used to implement the
2935 SRM's trusted computing perimeter. The privatedata contents may be referenced using a handle;
2936 for example, if used with a secure storage sub-system.

2937 **13.3.2.7 Optional Data**

2938 The "optionaldata" Property contains information that is optionally supplied, but facilitates key
2939 management, scalability or performance optimization.

2940 **13.3.2.8 Period**

2941 The "period" Property identifies the validity period for the credential. If no validity period is specified,
2942 the credential lifetime is undetermined. Constrained devices that do not implement a date-time
2943 capability shall obtain current date-time information from its CMS.

13.3.2.9 Credential Refresh Method Type Definition [Deprecated]

This clause is intentionally left blank.

13.3.2.10 Credential Usage

Credential Usage indicates to the Device the circumstances in which a credential should be used. Five values are defined:

- "oic.sec.cred.trustca": This certificate is a trust anchor for the purposes of certificate chain validation, as defined in 10.4. OCF Server SHALL remove any "/oic/sec/cred" entries with an "oic.sec.cred.trustca" credusage upon transitioning to RFOTM. OCF Servers SHALL use "/oic/sec/cred" entries that have an "oic.sec.cred.trustca" Value of "credusage" Property only as trust anchors for post-onboarding (D)TLS session establishment in RFNOP; these entries are not to be used for onboarding (D)TLS sessions.
- "oic.sec.cred.cert": This "credusage" is used for certificates for which the Device possesses the private key and uses it for identity authentication in a secure session, as defined in clause 10.4.
- "oic.sec.cred.rolecert": This "credusage" is used for certificates for which the Device possesses the private key and uses to assert one or more roles, as defined in clause 10.4.2.
- "oic.sec.cred.mfgtrustca": This certificate is a trust anchor for the purposes of the Manufacturer Certificate Based OTM as defined in clause 7.3.6. OCF Servers SHALL use "/oic/sec/cred" entries that have an "oic.sec.cred.mfgtrustca" Value of "credusage" Property only as trust anchors for onboarding (D)TLS session establishment; these entries are not to be used for post-onboarding (D)TLS sessions.
- "oic.sec.cred.mfgcert": This certificate is used for certificates for which the Device possesses the private key and uses it for authentication in the Manufacturer Certificate Based OTM as defined in clause 7.3.6.

13.3.2.11 Resource Owner

The Resource Owner Property allows credential provisioning to occur soon after Device onboarding before access to support services has been established. It identifies the entity authorized to manage the "/oic/sec/cred" Resource in response to Device recovery situations.

13.3.3 Key Formatting

13.3.3.1 Symmetric Key Formatting

Symmetric keys shall have the format described in Table 29 and Table 30.

Table 29 – 128-bit symmetric key

Name	Value	Type	Description
Length	16	OCTET	Specifies the number of 8-bit octets following Length
Key	opaque	OCTET Array	16-byte array of octets. When used as input to a PSK function Length is omitted.

Table 30 – 256-bit symmetric key

Name	Value	Type	Description
Length	32	OCTET	Specifies the number of 8-bit octets following Length
Key	opaque	OCTET Array	32-byte array of octets. When used as input to a PSK function Length is omitted.

13.3.3.2 Asymmetric Keys

Asymmetric key formatting is not available in this revision of the document.

13.3.3.3 Asymmetric Keys with Certificate

Key formatting is defined by certificate definition.

13.3.3.4 Passwords

Password formatting is not available in this revision of the document.

13.3.4 Credential Refresh Method Details [Deprecated]

This clause is intentionally left blank.

13.4 Certificate Revocation List

13.4.1 CRL Resource Definition [Deprecated]

This clause is intentionally left blank.

13.5 ACL Resources

13.5.1 ACL Resources General

All Resource hosted by a Server are required to match an ACL policy. ACL policies can be expressed using "/oic/sec/acl2". The subject (e.g. "deviceuuid" of the Client) requesting access to a Resource shall be authenticated prior to applying the ACL check. Resources that are available to multiple Clients can be matched using a wildcard subject. All Resources accessible via the unsecured communication endpoint shall be matched using a wildcard subject.

13.5.2 OCF Access Control List (ACL) BNF defines ACL structures.

ACL structure in Backus-Naur Form (BNF) notation is defined in Table 31:

Table 31 – BNF Definition of OCF ACL

<ACL>	<ACE> {<ACE>}
<ACE>	<SubjectId> <ResourceRef> <Permission> {<Validity>}
<SubjectId>	<DeviceId> <Wildcard> <RoleId>
<DeviceId>	<UUID>
<RoleId>	<Character> <RoleName><Character>
<RoleName>	"" <Authority><Character>
<Authority>	<UUID>
<ResourceRef>	' (' <OIC_LINK> {',' {OIC_LINK}} ')'
<Permission>	('C' '-') ('R' '-') ('U' '-') ('D' '-') ('N' '-')
<Validity>	<Period> {<Recurrence>}
<Wildcard>	'*'
<URI>	IETF RFC 3986
<UUID>	IETF RFC 4122
<Period>	IETF RFC 5545 Period
<Recurrence>	IETF RFC 5545 Recurrence
<OIC_LINK>	ISO/IEC 30118-1 defined in JSON Schema
<Character>	<Any UTF8 printable character, excluding NUL>

The <DeviceId> token means the requestor must possess a credential that uses <UUID> as its identity in order to match the requestor to the <ACE> policy.

The <RoleId> token means the requestor must possess a role credential with <Character> as its role in order to match the requestor to the <ACE> policy.

3002 The <Wildcard> token "*" means any requestor is matched to the <ACE> policy, with or without
3003 authentication.

3004 When a <SubjectId> is matched to an <ACE> policy the <ResourceRef> is used to match the <ACE>
3005 policy to Resources.

3006 The <OIC_LINK> token contains values used to query existence of hosted Resources.

3007 The <Permission> token specifies the privilege granted by the <ACE> policy given the <SubjectId>
3008 and <ResourceRef> matching does not produce the empty set match.

3009 Permissions are defined in terms of CREATE ("C"), RETRIEVE ("R"), UPDATE ("U"), DELETE ("D"),
3010 NOTIFY ("N") and NIL ("-"). NIL is substituted for a permissions character that signifies the
3011 respective permission is not granted.

3012 The empty set match result defaults to a condition where no access rights are granted.

3013 If the <Validity> token exists, the <Permission> granted is constrained to the time <Period>.
3014 <Validity> may further be segmented into a <Recurrence> pattern where access may alternatively
3015 be granted and rescinded according to the pattern.

3016 **13.5.3 ACL Resource**

3017 An "acl2" is a list of type "ace2".

3018 In order to provide an interface which allows management of array elements of the "aclist2"
3019 Property associated with a "/oic/sec/acl2" Resource, the RETRIEVE, UPDATE and DELETE
3020 operations on the "/oic/sec/acl2" Resource SHALL behave as follows:

3021 1) A RETRIEVE shall return the full Resource representation.

3022 2) An UPDATE shall replace or add to the Properties included in the representation sent with the
3023 UPDATE request, as follows:

3024 a) If an UPDATE representation includes the "aclist2" array Property, then:

3025 i) Supplied ACEs with an "aceid" that matches an existing "aceid" shall replace completely
3026 the corresponding ACE in the existing "aclist2" array.

3027 ii) Supplied ACEs without an "aceid" shall be appended to the existing "aclist2" array, and
3028 a unique (to the "/oic/sec/acl2" Resource) "aceid" shall be created and assigned to the
3029 new ACE by the Server. The "aceid" of a deleted ACE should not be reused, to improve
3030 the determinism of the interface and reduce opportunity for race conditions.

3031 iii) Supplied ACEs with an "aceid" that does not match an existing "aceid" shall be
3032 appended to the existing "aclist2" array, using the supplied "aceid".

3033 iv) The rows in Table 34 corresponding to the "aclist2" array Property dictate the Device
3034 States in which an UPDATE of the "aclist2" array Property is always rejected. If OCF
3035 Device is in a Device State where the Access Mode in this row contains "R", then the
3036 OCF Device shall reject all UPDATES of the "aclist2" array Property.

3037 3) A DELETE without query parameters shall set the "aclist2" array to the empty array, but shall
3038 not remove the "oic/sec/ace2" Resource.

3039 4) A DELETE with one or more "aceid" query parameters shall remove the ACE(s) with the
3040 corresponding "aceid"(s) from the "aclist2" array.

3041 5) The rows in Table 34 corresponding to the "aclist2" array Property dictate the Device States in
3042 which a DELETE is always rejected. If OCF Device is in a Device State where the Access Mode
3043 in this row contains "R", then the OCF Device shall reject all DELETES.

3044 NOTE The "/oic/sec/acl2" Resource's use of the DELETE operation is not in accordance with the OCF Interfaces
3045 defined in ISO/IEC 30118-1.

3046 Evaluation of local ACL Resource completes when all ACL Resource have been queried and no
 3047 entry can be found for the requested Resource for the requestor – e.g. "/oic/sec/acl2" does not
 3048 match the subject and the requested Resource.

3049 Table 32 defines the values of "oic.sec.crudntype".

3050 **Table 32 – Value Definition of the "oic.sec.crudntype" Property**

Value	Access Policy	Description	RemarksNotes
bx0000,0000 (0)	No permissions	No permissions	N/A
bx0000,0001 (1)	C	CREATE	N/A
bx0000,0010 (2)	R	RETREIVE, OBSERVE, DISCOVER	The "R" permission bit covers both the Read permission and the Observe permission.
bx0000,0100 (4)	U	WRITE, UPDATE	N/A
bx0000,1000 (8)	D	DELETE	N/A
bx0001,0000 (16)	N	NOTIFY	The "N" permission bit is ignored in OCF 1.0, since "R" covers the Observe permission. It is documented for future versions

3051 "oic/sec/acl2" Resource is defined in Table 20.

3052 **Table 33 – Definition of the "oic/sec/acl2" Resource**

Fixed URI	Resource Type Title	Resource Type ID ("rt" value)	OCF Interfaces	Description	Related Functional Interaction
/oic/sec/acl2	ACL2	oic.r.acl2	oic.if.baseli ne, oic.if.rw	Resource for managing access	Security

3053 Table 34 defines the Properties of "oic.sec.acl2".

Table 34 – Properties of the "/oic/sec/acl2" Resource

Property Name	Value Type	Mandatory	Device State	Access Mode	Description
aclist2	array of oic.sec.ace2	Yes	N/A		The aclist2 Property is an array of ACE records of type "oic.sec.ace2". The Server uses this list to apply access control to its local Resources.
N/A	N/A	N/A	RESET	R	Server shall set to manufacturer defaults.
			RFOTM	RW	Set by DOTS after successful OTM
			RFPRO	RW	The AMS (referenced via rowneruuid property) shall update the aclist entries after mutually authenticated secure session is established. Access to NCRs is prohibited.
			RFNOP	R	Access to NCRs is permitted after a matching ACE2 is found.
			SRESET	RW	The DOTS (referenced via devowneruuid Property of "/oic/sec/doxm Resource") should evaluate the integrity of and may update aclist entries when a secure session is established and the Server and DOTS are authenticated.
rowneruuid	uuid	Yes	N/A		The Resource owner Property (rowneruuid) is used by the Server to reference a service provider trusted by the Server. Server shall verify the service provider is authorized to perform the requested action
			RESET	R	Server shall set to the nil uuid value (e.g. "00000000-0000-0000-0000-000000000000")
			RFOTM	RW	The DOTS should configure the rowneruuid Property of "/oic/sec/acl2" Resource when a successful owner transfer session is established.
			RFPRO	R	n/a
			RFNOP	R	n/a
			SRESET	RW	The DOTS (referenced via devowneruuid Property or rowneruuid Property of "/oic/sec/doxm" Resource) should verify and if needed, update the Resource owner Property when a mutually authenticated secure session is established. If the rowneruuid Property does not refer to a valid DOTS the Server shall transition to RESET.

3055

3056 Table 35 defines the Properties of "oic.sec.ace2".

3057

Table 35 – "oic.sec.ace2" data type definition.

Property Name	Value Type	Mandatory	Description
subject	oic.sec.roletype, oic.sec.didtype, oic.sec.conntype	Yes	The Client is the subject of the ACE when the roles, Device UUID, or connection type matches.
resources	array of oic.sec.ace2.resource -ref	Yes	The application's Resources to which a security policy applies
permission	oic.sec.crudntype.bitmask	Yes	Bitmask encoding of CRUDN permission
validity	array of oic.sec.time-pattern	No	An array of a tuple of period and recurrence. Each item in this array contains a string representing a period using the IETF RFC 5545 Period, and a string array representing a recurrence rule using the IETF RFC 5545 Recurrence.
aceid	integer	Yes	An aceid is unique with respect to the array entries in the aclist2 Property.

3058 Table 36 defines the Properties of "oic.sec.ace2.resource-ref".

3059

Table 36 – "oic.sec.ace2.resource-ref" data type definition.

Property Name	Value Type	Mandatory	Description
href	uri	No	A URI referring to a Resource to which the containing ACE applies
wc	string	No	Refer to Table 15.

3060 Table 37 defines the values of "oic.sec.ace2.resource-ref".

3061

Table 37 – Value definition "oic.sec.conntype" Property

Property Name	Value Type	Value Rule	Description
conntype	string	enum ["auth-crypt", "anon-clear"]	This Property allows an ACE to be matched based on the connection or message protection type
		auth-crypt	ACE applies if the Client is authenticated and the data channel or message is encrypted and integrity protected
		anon-clear	ACE applies if the Client is not authenticated and the data channel or message is not encrypted but may be integrity protected

3062 Local ACL Resources supply policy to a Resource access enforcement point within an OCF stack
 3063 instance. The OCF framework gates Client access to Server Resources. It evaluates the subject's
 3064 request using policies contained in ACL Resources.

3065 Resources named in the ACL policy can be fully qualified or partially qualified. Fully qualified
 3066 Resource references include the device identifier in the href Property that identifies the remote
 3067 Resource Server that hosts the Resource. Partially qualified references mean that the local
 3068 Resource Server hosts the Resource. If a fully qualified Resource reference is given, the
 3069 Intermediary enforcing access shall have a secure channel to the Resource Server and the
 3070 Resource Server shall verify the Intermediary is authorized to act on its behalf as a Resource
 3071 access enforcement point.

3072 Resource Servers should include references to Device and ACL Resources where access
3073 enforcement is to be applied. However, access enforcement logic shall not depend on these
3074 references for access control processing as access to Server Resources will have already been
3075 granted.

3076 Local ACL Resources identify a Resource Owner service that is authorized to instantiate and modify
3077 this Resource. This prevents non-terminating dependency on some other ACL Resource.
3078 Nevertheless, it should be desirable to grant access rights to ACL Resources using an ACL
3079 Resource.

3080 An ACE2 entry is considered "currently valid" if the validity period of the ACE2 entry includes the
3081 time of the request. The validity period in the ACE2 may be a recurring time period (e.g., daily from
3082 1:00-2:00). Matching the Resource(s) specified in a request to the "resource" Property of the ACE2
3083 is defined in clause 12.2. For example, one way they can match is if the Resource URI in the
3084 request exactly matches one of the Resource references in the ACE2 entries.

3085 A request will match an ACE2 if any of the following are true:

- 3086 1) The ACE2 "subject" Property is of type "oic.sec.didtype" has a UUID value that matches the
3087 "deviceuuid" Property associated with the secure session;
3088 AND the Resource of the request matches one of the "resources" Property of the ACE2
3089 "oic.sec.ace2.resource-ref";
3090 AND the ACE2 is currently valid.
- 3091 2) The ACE2 "subject" Property is of type "oic.sec.conntype" and has the wildcard value that
3092 matches the currently established connection type;
3093 AND the Resource of the request matches one of the "resources" Property of the ACE2
3094 "oic.sec.ace2.resource-ref";
3095 AND the ACE2 is currently valid.
- 3096 3) When Client authentication uses a certificate credential;
3097 AND one of the "roleid" values contained in the role certificate matches the "roleid" Property of
3098 the ACE2 "oic.sec.roletype";
3099 AND the role certificate public key matches the public key of the certificate used to establish
3100 the current secure session;
3101 AND the Resource of the request matches one of the array elements of the "resources"
3102 Property of the ACE2 "oic.sec.ace2.resource-ref";
3103 AND the ACE2 is currently valid.
- 3104 4) When Client authentication uses a certificate credential;
3105 AND the CoAP payload query string of the request specifies a role, which is member of the set
3106 of roles contained in the role certificate;
3107 AND the roleid values contained in the role certificate matches the "roleid" Property of the ACE2
3108 "oic.sec.roletype";
3109 AND the role certificate public key matches the public key of the certificate used to establish
3110 the current secure session;
3111 AND the Resource of the request matches one of the "resources" Property of the ACE2
3112 "oic.sec.ace2.resource-ref";
3113 AND the ACE2 is currently valid.
- 3114 5) When Client authentication uses a symmetric key credential;
3115 AND one of the "roleid" values associated with the symmetric key credential used in the secure
3116 session, matches the "roleid" Property of the ACE2 "oic.sec.roletype";

3117 AND the Resource of the request matches one of the array elements of the "resources"
 3118 Property of the ACE2 "oic.sec.ace2.resource-ref";
 3119 AND the ACE2 is currently valid.
 3120 6) When Client authentication uses a symmetric key credential;
 3121 AND the CoAP payload query string of the request specifies a role, which is contained in the
 3122 "oic.r.cred.creds.roleid" Property of the current secure session;
 3123 AND CoAP payload query string of the request specifies a role that matches the "roleid"
 3124 Property of the ACE2 "oic.sec.roletype";
 3125 AND the Resource of the request matches one of the array elements of the "resources"
 3126 Property of the ACE2 "oic.sec.ace2.resource-ref";
 3127 AND the ACE2 is currently valid.

3128 A request is granted if ANY of the 'matching' ACE2 entries contain the permission to allow the
 3129 request. Otherwise, the request is denied.

3130 There is no way for an ACE2 entry to explicitly deny permission to a Resource. Therefore, if one
 3131 Device with a given role should have slightly different permissions than another Device with the
 3132 same role, they must be provisioned with different roles.

3133 The Server is required to verify that any hosted Resource has authorized access by the Client
 3134 requesting access. The "/oic/sec/acl2" Resource is co-located on the Resource host so that the
 3135 Resource request processing should be applied securely and efficiently. See Annex A for example.

3136 13.6 Access Manager ACL Resource [Deprecated]

3137 This clause is intentionally left blank.

3138 13.7 Signed ACL Resource [Deprecated]

3139 This clause is intentionally left blank.

3140 13.8 Provisioning Status Resource

3141 The "/oic/sec/pstat" Resource maintains the Device provisioning status. Device provisioning should
 3142 be Client-directed or Server-directed. Client-directed provisioning relies on a Client device to
 3143 determine what, how and when Server Resources should be instantiated and updated. Server-
 3144 directed provisioning relies on the Server to seek provisioning when conditions dictate. Furthermore,
 3145 the "/oic/sec/cred" Resource should be provisioned at ownership transfer with credentials
 3146 necessary to open a secure connection with appropriate support service.

3147 "/oic/sec/pstat" Resource is defined in Table 38.

3148 **Table 38 – Definition of the "/oic/sec/pstat" Resource**

Fixed URI	Resource Type Title	Resource Type ID ("rt" value)	OCF Interfaces	Description	Related Functional Interaction
/oic/sec/pstat	Provisioning Status	oic.r.pstat	oic.if.baseline, oic.if.rw	Resource for managing Device provisioning status	Configuration

3149 Table 39 defines the Properties of "/oic/sec/pstat".

Table 39 – Properties of the "/oic/sec/pstat" Resource

Property Title	Property Name	Value Type	Value Rule	Mandatory	Access Mode	Device State	Description
Device Onboarding State	dos	oic.sec.dostype	N/A	Yes	RW		Device Onboarding State
Is Device Operational	isop	Boolean	T F	Yes	R	RESET	Server shall set to FALSE
					R	RFOTM	Server shall set to FALSE
					R	RFPRO	Server shall set to FALSE
					R	RFNOP	Server shall set to TRUE
					R	SRESET	Server shall set to FALSE
Current Mode	cm	oic.sec.dpmttype	bitmask	Yes	R		Current Mode
Target Mode	tm	oic.sec.dpmttype	bitmask	Yes	RW		Target Mode
Operational Mode	om	oic.sec.pomtype	bitmask	Yes	R	RESET	Server shall set to manufacturer default.
					RW	RFOTM	Set by DOTS after successful OTM
					RW	RFPRO	Set by CMS, AMS, DOTS after successful authentication
					RW	RFNOP	Set by CMS, AMS, DOTS after successful authentication
					RW	SRESET	Set by DOTS.
Supported Mode	sm	oic.sec.pomtype	bitmask	Yes	R	All states	Supported provisioning services operation modes
Device UUID	deviceuuid	String	uuid	Yes	RW	All states	[DEPRECATED] A uuid that identifies the Device to which the status applies
Resource Owner ID	rowneruuid	String	uuid	Yes	R	RESET	Server shall set to the nil uuid value (e.g. "00000000-0000-0000-0000-000000000000")
					RW	RFOTM	The DOTS should configure the rowneruuid Property when a successful owner transfer session is established.
					R	RFPRO	n/a
					R	RFNOP	n/a
					RW	SRESET	The DOTS (referenced via devowneruuid Property of "/oic/sec/doxm" Resource) should verify and if needed, update the Resource owner Property when a mutually authenticated secure session is established. If the rowneruuid does not refer to a valid DOTS the Server shall transition to RESET.

Table 40 – Properties of the ".oic.sec.dostype" Property

Property Title	Property Name	Value Type	Value Rule	Mandatory	Access Mode	Device State	Description
Device Onboarding State	s	UINT16	enum (0=RESET, 1=RFOTM, 2=RFPRO, 3=RFNOP, 4=SRESET)	Y	R	RESET	The Device is in a hard reset state.
					RW	RFOTM	Set by DOTS after successful OTM to RFPRO.
					RW	RFPRO	Set by CMS, AMS, DOTS after successful authentication
					RW	RFNOP	Set by CMS, AMS, DOTS after successful authentication
					RW	SRESET	Set by CMS, AMS, DOTS after successful authentication
Pending state	p	Boolean	T F	Y	R	All States	FALSE (0) – "s" state changes are complete. Since Device is not able to respond when the value is TRUE, other values of this property are DEPRECATED.

3154 In all Device states:

- 3155 – The Device permits an authenticated and authorised Client to change the Device state of a
3156 Device by updating the "s" Property of the "dos" Property of the "/oic/sec/pstat" Resource to
3157 the desired value. The allowed Device state transitions are defined in Figure 22.
- 3158 – Prior to updating the "s" Property of the "dos" Property of the "/oic/sec/pstat" Resource, the
3159 Client configures the Device to meet entry conditions for the new Device state. The SVR
3160 definitions define the entity (Client or Server) expected to perform the specific SVR
3161 configuration change to meet the entry conditions. Once the Client has configured the aspects
3162 for which the Client is responsible, it can update the "s" Property of the "dos" Property of the
3163 "/oic/sec/pstat" Resource. The Server then makes any changes for which the Server is
3164 responsible, including updating required SVR values, and set the "s" Property of the "dos"
3165 Property of the "/oic/sec/pstat" Resource to the new value.

3166 When Device state is RESET:

- 3167 – All SVR content is removed and reset to manufacturer default values.
- 3168 – The default manufacturer Device state is RESET.
- 3169 – NCRs are reset to manufacturer default values.
- 3170 – NCRs shall not be accessible.
- 3171 – After successfully processing RESET the SRM transitions to RFOTM by setting the "s" Property
3172 of the "dos" Property of the "/oic/sec/pstat" Resource to 1 (RFOTM).

3173 When Device state is RFOTM:

- 3174 – NCRs shall not be accessible.
- 3175 – Before OTM is successful, the the "s" Property of the "dos" Property of the "/oic/sec/pstat"
3176 Resource is read-only by unauthenticated requestors
- 3177 – After the OTM is successful, the "s" Property of the "dos" Property of the "/oic/sec/pstat"
3178 Resource is read-write by authorized requestors.
- 3179 – The negotiated Device OC is used to create an authenticated session over which the DOTS
3180 directs the Device state to transition to RFPRO.

- 3181 – If an authenticated session cannot be established the ownership transfer session should be
3182 disconnected and SRM sets back the Device state to RESET.
- 3183 – Ownership transfer session, especially Random PIN OTM, should not exceed 60 seconds. If
3184 the SRM asserts the OTM failed, the ownership transfer session should be disconnected, and
3185 the Device should transition to RESET ("/pstat.dos.s"=0 (RESET)).
- 3186 – The DOTS UPDATES the "devowneruuid" Property in the "/oic/sec/doxm" Resource to a non-
3187 nil UUID value. The DOTS (or other authorized client) can update it multiple times while in
3188 RFOTM. It is not updatable while in other device states except when the Device state returns
3189 to RFOTM through RESET.
- 3190 – The DOTS can have additional provisioning tasks to perform while in RFOTM. When done, the
3191 DOTS UPDATES the "owned" Property in the "/oic/sec/doxm" Resource to "true".
- 3192 – After successful OTM, the DOTS triggers the transition to RFPRO and the "s" Property of the
3193 "dos" Property of the "/oic/sec/pstat" Resource is set to 2 (RFPRO).
- 3194 When Device state is RFPRO:
 - 3195 – The "s" Property of the "dos" Property of the "/oic/sec/pstat" Resource is read-only by
3196 unauthorized requestors and read-write by authorized requestors.
 - 3197 – NCRs shall not be accessible, except for Easy Setup Resources, if supported.
 - 3198 – An authorized Client may provision SVRs as needed for normal functioning in RFNOP.
 - 3199 – An authorized Client may perform consistency checks on SVRs to determine which shall be re-
3200 provisioned.
 - 3201 – Failure to successfully provision SVRs may trigger a state change to RESET. For example, if
3202 the Device has already transitioned from SRESET but consistency checks continue to fail.
 - 3203 – The authorized Client sets the "s" Property of the "dos" Property of the "/oic/sec/pstat" Resource
3204 to 3 (RFNOP).
- 3205 When Device state is RFNOP:
 - 3206 – The "s" Property of the "dos" Property of the "/oic/sec/pstat" Resource is read-only by
3207 unauthorized requestors and read-write by authorized requestors.
 - 3208 – NCRs, SVRs and core Resources are accessible following normal access processing.
 - 3209 – When additional provisioning is necessary, the Device may be transitioned to RFPRO by an
3210 authorized Client. Only the Device owner should transition to SRESET or RESET.
- 3211 When Device state is SRESET:
 - 3212 – NCRs shall not be accessible. The integrity of NCRs may be suspect but the SRM doesn't
3213 attempt to access or reference them.
 - 3214 – SVR integrity is not guaranteed, but access to some SVR Properties is necessary. These
3215 include "devowneruuid" Property of the "/oic/sec/doxm" Resource,
3216 "creds":[{...,"subjectuuid":<devowneruuid>,...}] Property of the "/oic/sec/cred" Resource and
3217 "pstat.dos.s" "/oic/sec/pstat" Resource.
 - 3218 – The certificates that identify and authorize the Device owner are sufficient to re-create
3219 minimalist "/oic/sec/cred" and "/oic/sec/doxm" Resources enabling Device owner control of
3220 SRESET. If the SRM can't establish these Resources, then it will transition to RESET.
 - 3221 – An authorized Client performs SVR consistency checks. The authorized Client can provision
3222 SVRs as needed to ensure they are available for continued provisioning in RFPRO or for normal
3223 functioning in RFNOP.
 - 3224 – The authorized Device owner can avoid entering RESET and RFOTM by UPDATING
3225 "pstat.dos.s" with RFPRO or RFNOP values.

- 3226 – ACLs on SVR are presumed to be invalid. Access authorization is granted according to Device
3227 owner privileges only.
- 3228 – The SRM asserts a Client-directed operational mode (e.g. "/pstat.om"=4).
- 3229 The provisioning mode type is a 16-bit mask enumerating the various Device provisioning modes.
3230 "{ProvisioningMode}" should be used in this document to refer to an instance of a provisioning
3231 mode without selecting any particular value.
- 3232 "oic.sec.dpmdtype" is defined in Table 41.

3233 **Table 41 – Definition of the "oic.sec.dpmdtype" Property**

Type Name	Type URN	Description
Device Provisioning Mode	oic.sec.dpmdtype	Device provisioning mode is a 16-bit bitmask describing various provisioning modes

3234 Table 42 and Table 43 define the values of "oic.sec.dpmdtype".

3235 **Table 42 – Value Definition of the "oic.sec.dpmdtype" Property (Low-Byte)**

Value	Device Mode	Description
bx0000,0001 (1)	Deprecated	
bx0000,0010 (2)	Deprecated	
bx0000,0100 (4)	Deprecated	
bx0000,1000 (8)	Deprecated	
bx0001,0000 (16)	Deprecated	
bx0010,0000 (32)	Deprecated	
bx0100,0000 (64)	Initiate Software Version Validation	Software version validation requested/pending (1) Software version validation complete (0) Requires software download to verify integrity of software package
bx1000,0000 (128)	Initiate Secure Software Update	Secure software update requested/pending (1) Secure software update complete (0)

3236 **Table 43 – Value Definition of the "oic.sec.dpmdtype" Property (High-Byte)**

Value	Device Mode	Description
bx0000,0001 (1)	Initiate Software Availability Check	Checks if new software is available on remote endpoint. Does not require to download software. Methods used are out of bound.
Bits 2-8	<Reserved>	Reserved for later use

3237 The provisioning operation mode type is an 8-bit mask enumerating the various provisioning
3238 operation modes.

3239 "oic.sec.pomtype" is defined in Table 44.

3240 **Table 44 – Definition of the "oic.sec.pomtype" Property**

Type Name	Type URN	Description
Device Provisioning OperationMode	oic.sec.pomtype	Device provisioning operation mode is a 8-bit bitmask describing various provisioning operation modes

3241 Table 45 defines the values of "oic.sec.pomtype".

3242

Table 45 – Value Definition of the "oic.sec.pomtype" Property

Value	Operation Mode	Description
bx0000,0001 (1)	Server-directed utilizing multiple provisioning services	Deprecated
bx0000,0010 (2)	Server-directed utilizing a single provisioning service	Deprecated
bx0000,0100 (4)	Client-directed provisioning	Device supports provisioning service control of this Device's provisioning operations. This bit is always TRUE.
bx0000,1000(8) – bx1000,0000(128)	<Reserved>	Reserved for later use
bx1111,11xx	<Reserved>	Reserved for later use

3243 **13.9 Certificate Signing Request Resource**

3244 The "/oic/sec/csr" Resource is used by a Device to provide its desired identity, public key to be
 3245 certified, and a proof of possession of the corresponding private key in the form of a IETF RFC
 3246 2986 PKCS#10 Certification Request. If the Device supports certificates (i.e. the "sct" Property of
 3247 "/oic/sec/doxm" Resource has a 1 in the 0x8 bit position), the Device shall have a "/oic/sec/csr"
 3248 Resource.

3249 "/oic/sec/csr" Resource is defined in Table 46.

3250

Table 46 – Definition of the "/oic/sec/csr" Resource

Fixed URI	Resource Type Title	Resource Type ID ("rt" value)	OCF Interfaces	Description	Related Functional Interaction
/oic/sec/csr	Certificate Signing Request	oic.r.csr	oic.if.baseline, oic.if.rw	The CSR Resource contains a Certificate Signing Request for the Device's public key.	Configuration

3251 Table 47 defines the Properties of "/oic/sec/csr".

3252

Table 47 – Properties of the "oic.r.csr" Resource

Property Title	Property Name	Value Type	Access Mode	Mandatory	Description
Certificate Signing Request	csr	String	R	Yes	Contains the signed CSR encoded according to the encoding Property
Encoding	encoding	String	R	Yes	A string specifying the encoding format of the data contained in the csr Property "oic.sec.encoding.pem" – Encoding for PEM-encoded certificate signing request

3253 The Device chooses which public key to use, and may optionally generate a new key pair for this
 3254 purpose.

3255 In the CSR, the Common Name component of the Subject Name shall contain a string of the format
 3256 "uuid:X" where X is the Device's requested UUID in the format defined by IETF RFC 4122. The
 3257 Common Name, and other components of the Subject Name, may contain other data. If the Device
 3258 chooses to include additional information in the Common Name component, it shall delimit it from
 3259 the UUID field by white space, a comma, or a semicolon.

3260 If the Device does not have a pre-provisioned key pair to use, but is capable and willing to generate
 3261 a new key pair, the Device may begin generation of a key pair as a result of a RETRIEVE of this
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3262 Resource. If the Device cannot immediately respond to the RETRIEVE request due to time required
3263 to generate a key pair, the Device shall return an "operation pending" error. This indicates to the
3264 Client that the Device is not yet ready to respond, but will be able at a later time. The Client should
3265 retry the request after a short delay.

3266 **13.10 Roles Resource**

3267 The "roles" Resource maintains roles that have been asserted with role certificates, as described
3268 in clause 10.4.2. Asserted roles have an associated public key, i.e., the public key in the role
3269 certificate. Servers shall only grant access to the roles information associated with the public key
3270 of the Client. The roles Resource should be viewed as an extension of the (D)TLS session state.
3271 See 10.4.2 for how role certificates are validated.

3272 The roles Resource shall be created by the Server upon establishment of a secure (D)TLS session
3273 with a Client, if is not already created. The roles Resource shall only expose a secured OCF
3274 Endpoint in the "/oic/res" response. A Server shall retain the roles Resource at least as long as the
3275 (D)TLS session exists. A Server shall retain each certificate in the roles Resource at least until the
3276 certificate expires or the (D)TLS session ends, whichever is sooner. The requirements of clause
3277 10.3 and 10.4.2 to validate a certificate's time validity at the point of use always apply. A Server
3278 should regularly inspect the contents of the roles Resource and purge contents based on a policy
3279 it determines based on its resource constraints. For example, expired certificates, and certificates
3280 from Clients that have not been heard from for some arbitrary period of time could be candidates
3281 for purging.

3282 The OCF namespace ("oic.role.*") is restricted to OCF-defined roles. "oic.role.owner" is an OCF-
3283 defined Role that is intended to provide Resource Owner privileges to multiple Clients in a scalable
3284 way. Servers shall grant access to perform all supported operations in the current Device state
3285 (see clause 0) on all supported SVRs regardless of ACL configuration the Clients asserting
3286 "oic.role.owner" Role. Servers shall reject assertion of any Role, which starts with "oic.role.", but
3287 is not one of the following Roles:

3288 – "oic.role.owner"

3289 The "roles" Resource is implicitly created by the Server upon establishment of a (D)TLS session.
3290 In more detail, the RETRIEVE, UPDATE and DELETE operations on the roles Resource shall
3291 behave as follows. Unlisted operations are implementation specific and not reliable.

- 3292 1) A RETRIEVE request shall return all previously asserted roles associated with the currently
3293 connected and authenticated Client's identity. RETRIEVE requests with a "credid" query
3294 parameter is not supported; all previously asserted roles associated with the currently
3295 connected and authenticated Client's identity are returned.
- 3296 2) An UPDATE request that includes the "roles" Property shall replace or add to the Properties
3297 included in the array as follows:
 - 3298 a) If either the "publicdata" or the "optionaldata" are different than the existing entries in the
3299 "roles" array, the entry shall be added to the "roles" array with a new, unique "credid" value.
 - 3300 b) If both the "publicdata" and the "optionaldata" match an existing entry in the "roles" array,
3301 the entry shall be considered to be the same. The Server shall reply with a 2.04 Changed
3302 response and a duplicate entry shall not be added to the array.
 - 3303 c) The "credid" Property is optional in an UPDATE request and if included, it may be ignored
3304 by the Server. The Server shall assign a unique "credid" value for every entry of the "roles"
3305 array.
- 3306 3) A DELETE request without a "credid" query parameter shall remove all entries from the
3307 "/oic/sec/roles" Resource array corresponding to the currently connected and authenticated
3308 Client's identity.

3309 4) A DELETE request with a "credid" query parameter shall remove only the entries of the
 3310 "/oic/sec/roles" Resource array corresponding to the currently connected and authenticated
 3311 Client's identity and where the corresponding "credid" matches the entry.

3312 NOTE The "/oic/sec/roles" Resource's use of the DELETE operation is not in accordance with the OCF Interfaces
 3313 defined in ISO/IEC 30118-1.

3314 See clause 0 for restrictions on the states in which this Resource may be modified.

3315 "/oic/sec/roles" Resource is defined in Table 48.

3316 **Table 48 – Definition of the "/oic/sec/roles" Resource**

Fixed URI	Resource Type Title	Resource Type ID ("rt" value)	OCF Interfaces	Description	Related Functional Interaction
/oic/sec/roles	Roles	oic.r.roles	oic.if.basel ine, oic.if.rw	Resource containing roles that have previously been asserted to this Server	Security

3317 Table 49 defines the Properties of "/oic/sec/roles".

3318 **Table 49 – Properties of the "/oic/sec/roles" Resource**

Property Title	Property Name	Value Type	Value Rule	Access Mode	Mandatory	Description
Roles	roles	oic.sec.cred	array	RW	Yes	List of roles previously asserted to this Server

3319 Because "/oic/sec/roles" shares the "oic.sec.cred" schema with "/oic/sec/cred", "subjectuuid" is a required Property.
 3320 However, "subjectuuid" is not used in a role certificate. Therefore, a Device may ignore the "subjectuuid" Property if the
 3321 Property is contained in an UPDATE request to the "/oic/sec/roles" Resource.

3322 13.11 Auditable Events List Resource

3323 13.11.1 Auditable Events List Resource General

3324 The "/oic/sec/ael" Resource maintains a list of logged Auditable Events. Every OCF Device logs
 3325 AEEs filtered according to the values of the "categoryfilter" and "priorityfilter" Properties of
 3326 "/oic/sec/ael" Resource. All Devices shall have a "/oic/sec/ael" Resource to maintain AEEs. The
 3327 new AEE shall be added to the "events" Property of "/oic/sec/ael" Resource as the last entry in the
 3328 array. A Device shall store all AEEs of the "/oic/sec/ael" Resource in non-volatile memory. A Device
 3329 shall be able to store at least 1 AEE.

3330 The "categoryfilter" Property determines what categories of AEEs are to be logged. The
 3331 "categoryfilter" Property is an integer value which is a composition of bitmasks. A Device shall log
 3332 all AEEs filtered by this value. If the "categoryfilter" is either set to 0xff or is not set, then the Device
 3333 shall log AEEs of all categories. Refer to Table 51 for more details.

3334 The "priorityfilter" Property determines the lowest priority of AEE to be logged. A smaller value
 3335 means higher priority. The AEEs whose "priority" Property values are equal to or smaller than this
 3336 value shall be logged. If the "priorityfilter" Property is either set to the highest priority or is not set,
 3337 then the Device shall log all AEEs. No matter what value is set to "priorityfilter", an AEE of CRIT
 3338 (== 0) "priority" shall always be logged. Refer to Table 51 for more details.

3339 When an AEE is added, the "usedspace" Property shall be updated to reflect the total storage used
 3340 by all logged events. When the reserved storage for AEEs is full, the oldest AEE shall be purged.

3341 A Device logs a new AEE as follows:

3342 5) If a new AEE is not filtered by "categoryfilter" and "priorityfilter", then it is dropped.

```
3343 /* c-like pseudo code */
3344 If ((categoryfilter & new_aee->category) && (priorityfilter >= new_aee->priority))
```

```

3345     {
3346         addAEE(new_aee);
3347     }
3348     else
3349     {
3350         free(new_aee);
3351     }

```

3352 6) If the value of "usedspace" Property is equal to, or the sum of the "usedspace" Property value
3353 and the size of the new AEE is bigger than the value of the "maxspace" Property of "/oic/sec/ael"
3354 Resource, then:

3355 a) Remove the oldest AEE continuously while the sum of the "usedspace" Property value and
3356 the size of the new AEE is bigger than the "maxspace" Property value.

```

3357 /* c-like pseudo code */
3358 Int addAEE(AEEtype *new_aee)
3359 {
3360
3361     While ((usespace + new_aee->size) > maxspace)
3362     {
3363         /* purgeAEE() returns the size of purged AEE */
3364         sizeOfPurgedAEE = purgeAEE();
3365         usespace -= sizeOfPurgedAEE;
3366     }
3367
3368     ...
3369     ...
3370 }

```

3371 7) Add the new AEE to the "events" array Property of the "/oic/sec/ael" Resource as the last entry
3372 in the array.

3373 8) Increase the value of the "usedspace" Property by the size of the new AEE.

3374 In order to provide a mechanism which allows management of the "events" array Property, the
3375 RETRIEVE and UPDATE operations on the "/oic/sec/ael" Resource shall behave as follows:

3376 9) A RETRIEVE operation shall return the full Resource representation.

3377 10) An UPDATE operation may set the "categoryfilter" and/or "priorityfilter" Properties.

3378 The "/oic/sec/ael" Resource is defined in Table 50.

Table 50 – Definition of the "/oic/sec/ael" Resource

Fixed URI	Resource Type Title	Resource Type ID ("rt" value)	OCF Interfaces	Description	Related Functional Interaction
/oic/sec/ael	Auditable Event List	oic.r.ael	oic.if.baseline, oic.if.rw	Resource for storing AEEs	Security

Table 51 defines the Properties of the "/oic/sec/ael" Resource.

Table 51 – Properties of the "/oic/sec/ael" Resource

Property Title	Property Name	Value Type	Value Rule	Mandatory	Device State	Access Mode	Description
AEE list	"events"	"array"		Yes	RESET	R	The Device clears

			Array of "oic.sec.aee" entries		RFOTM RFPRO RFNOP SRESET	R	This list stores AEEs whose "category" Property value is filtered by "categoryfilter" Property and "priority" Property value is equal or less than the value of "priorityfilter" Property.
current used storage size	"usedspace"	"integer"	>= 0 (default: 0)	Yes	RESET RFOTM RFPRO RFNOP SRESET	R	The Device sets to 0 Current used space for logged AEEs. The Device updates this Property whenever new AEEs are logged.
maximum allowed storage size for AEEs	"maxspace"	"integer"	> 0	Yes		R	This means the maximum allowable storage size for AEEs that can be stored in "events" list. The Manufacturer chooses this value.
unit for storage size	"unit"	"string"	enum ["Kbyte", "Byte"] (default: "Byte")	No		R	The unit for "usedspace" and "maxspace" Properties. The Manufacturer chooses this value.
Categories of AEE to be logged	"categoryfilter"	"integer"	bitmask (default: 0xff)	Yes	RESET RFOTM RFPRO RFNOP SRESET	R RW R RW	The Device sets to the manufacturer default value This value decides what categories of AEEs are to be logged. Meaning of each bit: <ul style="list-style-type: none"> • 0x01 (Access Control) • 0x02 (Onboarding) • 0x04 (Device) • 0x08 (Authentication) • 0x10 (SVR Modification) • 0x20 (Cloud) • 0x40 (Communication) • 0x80 (Reserved) e.g.) if "categoryfilter" == 0xff: log all events of all categories e.g.) if "categoryfilter" == 0x03: log all events of 'AC' (== 0x01) and 'OB' (==0x02) categories
Minimum priority of AEEs to be logged	"priorityfilter"	"integer"	enum [0, 1, 2, 3, 4] (default: 4)	Yes	RESET RFOTM RFPRO RFNOP SRESET	R RW R RW	Device sets to manufacturer default value The AEEs whose "priority" values are equal to or smaller than this value are logged. A smaller value means a higher priority. Meaning of each value: <ul style="list-style-type: none"> • 0 (CRIT) • 1 (ERR) • 2 (WARN) • 3 (INFO) • 4 (DEBUG) e.g.) if "priorityfilter" is set to DEBUG (==4) all AEEs will be logged

						e.g.) if "priorityfilter" is set to 1, CRIT (==0) and ERR (==1) SEEs will be logged
--	--	--	--	--	--	-------------------------------------------------------------------------------------

Table 52 defines the Properties of the "oic.sec.aee" type.

Table 52 – "oic.sec.aee" data type definition

Property Title	Property Name	Value Type	Value Rule	Access Mode	Mandatory	Device State	Description
Auditable Event Identifier	"aaid"	"string"	N/A	R	Yes	-	Identity of the logged event
Category of AEE	"category"	"integer"	enum [1, 2, 4, 8, 16, 32, 64, 128]	R	Yes	-	The category of this AEE: <ul style="list-style-type: none"> • 0x01 (Access Control) • 0x02 (Onboarding) • 0x04 (Device) • 0x08 (Authentication) • 0x10 (SVR Modification) • 0x20 (Cloud) • 0x40 (Communication) • 0x80 (Reserved)
Priority of AEE	"priority"	"integer"	enum [0, 1, 2, 3, 4]	R	Yes	-	The priority of this AEE: <ul style="list-style-type: none"> • 0 (CRIT) • 1 (ERR) • 2 (WARN) • 3 (INFO) • 4 (DEBUG)
Time stamp	"timestamp"	"string"	date-time (RFC3339 clause 5.6)	R	Yes	-	The time when the AEE occurred
Event message	"message"	"string"	N/A	R	Yes	-	The description of the logged AEE.
Auxiliary info	"auxiliaryinfo"	"array"	Array of strings	R	Yes	-	Supplementary information for the "message" Property e.g.) URI of specific Resource in ACE2

OCF-defined AEEs are listed in Table 54, and each such AEE has its own values for the "category" and "priority" Properties.

The "timestamp" Property follows a full-date and partial-time format of RFC3339. Every new AEE shall have a later timestamp than the latest previously logged AEE.

The "auxiliaryinfo" Property provides supplementary info which is not covered by the description in "message" Property. For example, the URI of specific Resource in ACE2 could be "auxiliaryinfo" for "Access Denied" AEE. Please see Table 54 "List of Auditable Events".

13.12 Security Virtual Resources (SVRs) and Access Policy

The SVRs expose the security-related Properties of the Device.

Granting access requests (RETRIEVE, UPDATE, DELETE, etc.) for these SVRs to unauthenticated (anonymous) Clients could create privacy or security concerns.

3396 For example, when the Device onboarding State is RFOTM, it is necessary to grant requests for
 3397 the "/oic/sec/doxm" Resource to anonymous requesters, so that the Device can be discovered and
 3398 onboarded by an OBT. Subsequently, it might be preferable to deny requests for the
 3399 "/oic/sec/doxm" Resource to anonymous requesters, to preserve privacy.

3400 **13.13 SVRs, Discoverability and OCF Endpoints**

3401 All implemented SVRs shall be "discoverable" (reference ISO/IEC 30118-1, Policy Parameter
 3402 clause 7.8.2.1.2).

3403 All implemented discoverable SVRs shall expose a Secure OCF Endpoint (e.g. CoAPS) (reference
 3404 ISO/IEC 30118-1, clause 10).

3405 The "/oic/sec/doxm" Resource shall expose an Unsecure OCF Endpoint (e.g. CoAP) in RFOTM
 3406 (reference ISO/IEC 30118-1, clause 10).

3407 **13.14 Additional Privacy Consideration for Core Resources**

3408 Unique immutable identifiers are a privacy consideration due to their potential for being used as a
 3409 tracking mechanism. These include the following Resources and Properties:

- 3410 – "/oic/d" Resource containing the "piid" Property.
- 3411 – "/oic/p" Resource containing the "pi" Property.

3412 These identifiers are unique values that are visible at various times throughout the Device lifecycle
 3413 by anonymous requestors. This implies any Client Device, including those with malicious intent,
 3414 are able to reliably obtain identifiers useful for building a log of activity correlated with a specific
 3415 Platform and Device.

3416 The "di" Property in the "/oic/d" Resource shall mirror that of the "deviceuuid" Property of the
 3417 "/oic/sec/doxm" Resource. The DOTS should provision an ACL policy that restricts access to the
 3418 "/oic/d" Resource such that only authenticated Clients are able to obtain the "di" Property of "/oic/d"
 3419 Resource. See clause 13.1 for deviceuuid Property lifecycle requirements.

3420 Servers should expose a temporary, non-repeated, "piid" Property of "/oic/d" Resource Value upon
 3421 entering RESET. Servers shall expose a persistent value via the "piid" Property of "/oic/d" Property
 3422 when the DOTS sets "devowneruuid" Property to a non-nil-UUID value. The DOTS should provision
 3423 an ACL policy on the "/oic/d" Resource such that only authenticated Clients are able to obtain the
 3424 "piid" Property of "/oic/d" Resource

3425 Servers should expose a temporary, non-repeated, "pi" Property value upon entering RESET.
 3426 Servers shall expose a persistent value via the "pi" Property of the "/oic/p" Resource when the
 3427 DOTS sets "devowneruuid" Property to a non-nil-UUID value. The DOTS should provision an ACL
 3428 policy on the "/oic/p" Resource such that only authenticated Clients are able to obtain the "pi"
 3429 Property.

3430 Table 53 depicts Core Resource Properties Access Modes given various Device States.

3431 **Table 53 – Core Resource Properties Access Modes given various Device States**

Resource Type	Property title	Property name	Value type	Access Mode		Behaviour
oic.wk.p	Platform ID	pi	oic.types-schema.uuid	All States	R	Server exposes a temporary random UUID when in RESET.

oic.wk.d	Permanent Immutable ID	piid	oic.types-schema.uuid	All States	R	Server exposes a temporary random UUID when in RESET.
oic.wk.d	Device Identifier	di	oic.types-schema.uuid	All states	R	/d di mirrors the value contained in "/doxm" "deviceuuid" in all device states.

13.15 Easy Setup Resource Device State

This clause only applies to a new Device that uses Easy Setup for ownership transfer as defined in OCF Wi-Fi Easy Setup. Easy Setup has no impact to new Devices that have a different way of connecting to the network i.e. DOTS and AMS don't use a Soft AP to connect to non-Easy Setup Devices.

Figure 29 shows an example of Soft AP and Easy Setup Resource in different Device states.

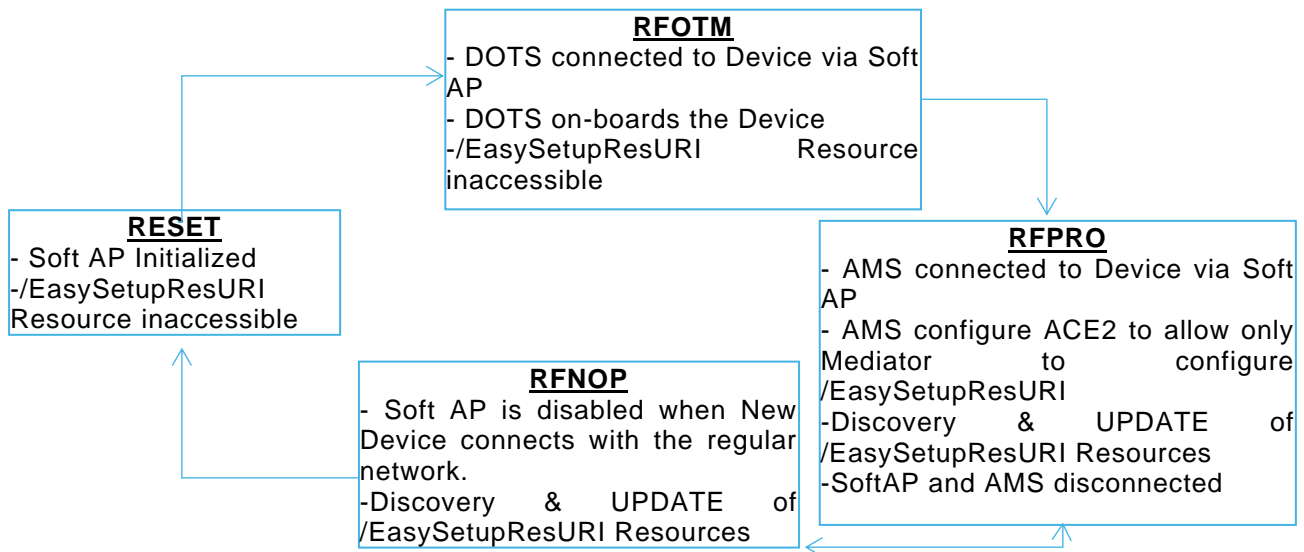


Figure 29 – Example of Soft AP and Easy Setup Resource in different Device states

Device enters RFOTM, Soft AP may be accessible in RFOTM and RFPRO.

While it is reasonable for an End User to expect that power cycling a new Device will turn on the Soft AP for Easy Setup during the initial setup, since that is potentially how it behaved on first boot, it is a security risk to make this the default behaviour of a device that remains unenrolled beyond a reasonable period after first boot.

Therefore, the Soft AP for Easy Setup has several requirements to improve security:

- Time availability of Easy Setup Soft AP should be minimised, and shall not exceed 30 minutes after Device factory reset, RESET or first power boot, or when an End User initiates the Soft AP for Easy Setup.
- If a new Device tried and failed to complete Easy Setup Enrolment immediately following the first boot, or after a factory reset, it may turn the Easy Setup Soft AP back on automatically for another 30 minutes upon being power cycled, provided that the power cycle occurs within 3 hours of first boot or the most recent factory reset. If the End User has initiated the Easy Setup Soft AP directly without a factory reset, it is not necessary to turn it back on if it was on immediately prior to power cycle, because the End User obviously knows how to initiate the process manually.

3456 – After 3 hours from first boot or factory reset without successfully enrolling the device, the Soft
3457 AP should not turn back on for Easy Setup until another factory reset occurs, or the End User
3458 initiates the Easy Setup Soft AP directly.

3459 – Easy Setup Soft AP may stay enabled during RFNOP, until the Mediator instructs the new
3460 Device to connect to the Enroller.

3461 – The Easy Setup Soft AP shall be disabled when the new Device successfully connects to the
3462 Enroller.

3463 – Once a new Device has successfully connected to the Enroller, it shall not turn the Easy Setup
3464 Soft AP back on for Easy Setup Enrolment again unless the Device is factory reset, or the End
3465 User initiates the Easy Setup Soft AP directly.

3466 – Just Works OTM shall not be enabled on Devices which support Easy Setup.

3467 – The Soft AP shall be secured (e.g. shall not expose an open AP).

3468 – The Soft AP shall support a passphrase for connection by the Mediator, and the passphrase
3469 shall be between and 8 and 64 ASCII printable characters. The passphrase may be printed on
3470 a label, sticker, packaging etc., and may be entered by the End User into the Mediator device.

3471 – The Soft AP should not use a common passphrase across multiple Devices. Instead, the
3472 passphrase may be sufficiently unique per device, to prevent guessing of the passphrase by an
3473 attacker with knowledge of the Device type, model, manufacturer, or any other information
3474 discoverable through Device's exposed interfaces.

3475 The Enrollee shall support WPA2 security (i.e. shall list WPA2 in the "swat" Property of the
3476 "/example/WiFiConfResURI" Resource), for potential selection by the Mediator in connecting the
3477 Enrollee to the Enroller. The Mediator should select the best security available on the Enroller, for
3478 use in connecting the Enrollee to the Enroller.

3479 The Enrollee may not expose any interfaces (e.g. web server, debug port, NCRs, etc.) over the
3480 Soft AP, other than SVRs, and Resources required for Wi-Fi Easy Setup.

3481 The "/example/EasySetupResURI" Resource should not be discoverable in RFOTM or SRESET.
3482 After ownership transfer process is completed with the DOTS, and the Device enters in RFPRO,
3483 the "/example/EasySetupResURI" may be Discoverable.

3484 The OTM CoAPS session may be used by Mediator for connection over Soft AP for ownership
3485 transfer and initial Easy Setup provisioning. SoftAP or regular network connection may be used by
3486 AMS for "/oic/sec/acl2" Resource provisioning in RFPRO. The CoAPS session authentication and
3487 encryption is already defined in the Security spec.

3488 In RFPRO, AMS is expected to configure ACL2 Resource on the Device with ACE2 for following
3489 Resources to be only configurable by the Mediator with permission to UPDATE or RETRIEVE
3490 access:

3491 – "/example/EasySetupResURI"
3492 – "/example/WifiConfResURI"
3493 – "/example/DevConfResURI"

3494 An ACE2 granting RETRIEVE or UPDATE access to the Easy Setup Resource

3495 {
3496 "subject": { "uuid": "<insert-UUID-of-Mediator>" },
3497 "resources": [
3498 { "href": "/example/EasySetupResURI" },
3499 { "href": "/example/WiFiConfResURI" },
3500 { "href": "/example/DevConfResURI" },
3501],

3502 "permission": 6 // RETRIEVE (2) or UPDATE and RETRIEVE(6)
 3503 }

3504 ACE2 may be re-configured after Easy Setup process. These ACE2s should be installed prior to
 3505 the Mediator performing any RETRIEVE/UPDATE operations on these Resources.

3506 In RFPRO or RFNOP, the Mediator should discover /EasySetupResURI Resources and UPDATE
 3507 these Resources. The Mediator may UPDATE /EasySetupResURI Resources in RFNOP Device
 3508 state.

3509 A Mediator shall be hosted on an OCF Device.

3510 13.16 List of Auditable Events

3511 Whenever a Device detects an occurrence of any of the Auditable Events in Table 54, then the
 3512 Device shall log an AEE using the corresponding "category", "priority" and "auxiliaryinfo" Properties
 3513 defined in Table 54. The "auxiliaryinfo" Property shall contain the entries in the "auxiliaryinfo"
 3514 column of Table 54 in the order specified in the table with each bullet contained in a separate array
 3515 entry. The "auxiliaryinfo" Property may contain additional entries for further information following
 3516 the entries for mandatory information. The "aaid" Property shall include the corresponding
 3517 Auditable Event Identifier from Table 54.

3518 **Table 54 – List of mandatory Auditable Events and corresponding Property values**

Auditable Event Identifier ("aaid")	Auditable Event Description	Example "message"	"category"	"priority"	"auxiliaryinfo"
AC-1	A Device received a request from an authenticated Client with valid URI path, valid interface and valid operation for that Resource, but for which access was denied.	"Access Denied"	0x01 (Access Control)	2 (WARN)	<ul style="list-style-type: none"> Client IP address & port in format [xxxx:…:xxxx]:xxxx Client UUID in UUID format (e.g. "00000000-0000-0000-0000-000000000000") Resource URI (e.g. "/oic/sec/ael") Requested CRUDN operation (e.g. "CREATE") Server security state (e.g. "RFNOP") Asserted roles by Client (e.g. "oic.role.owner"), or "No roles asserted" if there are none
AUTH-1	The Device encountered an error during a DTLS handshaking procedure due to a credential validation failure.	"DTLS handshake failed due to a credential validation failure"	0x08 (Authentication)	1 (ERR)	<ul style="list-style-type: none"> Client IP address & port in format [xxxx:…:xxxx]:xxxx
COMM-1	The Device received a CoAP request which contained unexpected /unsupported CoAP header parameters or unexpected/unsupported CoAP options.	"Unexpected CoAP Command"	0x40 (COMM)	2 (WARN)	<ul style="list-style-type: none"> Client IP address & port in format [xxxx:…:xxxx]:xxxx Hex-encoded CoAP header in format [xx:xx:xx:xx] Hex-encoded CoAP options except payload (empty if not present)

3519 Whenever a Device detects an occurrence of any of the Auditable Events in Table 55, then the
 3520 Device should log an AEE using the corresponding "category", "priority" and "auxiliaryinfo"
 3521 Properties defined in Table 55. The "auxiliaryinfo" Property shall contain the entries in the
 3522 "auxiliaryinfo" column of Table 55 in the order specified in the table with each bullet contained in a
 3523 separate array entry. The "auxiliaryinfo" Property may contain additional entries for further

3524 information following the entries for mandatory information. The "aeid" Property shall include the
3525 corresponding Auditable Event Identifier from Table 55.

3526 **Table 55 – List of recommended Auditable Events and corresponding Property values**

Auditable Event Identifier	Auditable Event Description	Example "message"	"category"	"priority"	"auxiliaryinfo"
SVR-1	The Device's attempted to use one of its credentials, and detected that the credential is expired	"My credential is expired"	0x10 (SVR Modification)	2 (WARN)	<ul style="list-style-type: none">• credid• Credential expiration value
SVR-2	The Device could not validate the role certificate being asserted	"Role assertion failed"	0x10 (SVR Modification)	2 (WARN)	<ul style="list-style-type: none">• Client IP address & port in format [xxxx:...:xxxx]:xxxx

3527

13.17 Security Domain Information Resource

The "/oic/sec/sdi" Resource contains the information that identifies the OCF Security Domain to which the Device belongs. OCF Security Domains are uniquely identifiable.

This Resource is optional to implement. When it is exposed by a Device, an OCF Onboarding Tool (OBT) is expected to provision a random UUID and a Security Domain Name for the OCF Security Domain. These two fields are provisioned to a Device during the onboarding process.

"oic.r.sdi" Resource Type is defined in Table 56.

Table 56 –Definition of the "oic.r.sdi" Resource Type

Fixed URI	Resource Type Title	Resource Type ID ("rt" value)	OCF Interfaces	Description	Related Functional Interaction
"/oic/sec/sdi"	Security Domain Information	"oic.r.sdi"	"oic.if.baseline" "oic.if.rw"	Resource containing Security Domain information	Configuration

Table 57 defines the Properties of "oic.r.sdi".

Table 57 – Properties of the "oic.r.sdi" Resource Type

Property Title	Property Name	Value Type	Value Rule	Mandatory	Access Mode	Device State	Description
Security Domain UUID	"uuid"	string	"uuid"	Yes	R	RESET	A UUID that identifies the Security Domain, set by DOTS during onboarding.
					RW	RFOTM	
					R	RFPRO	
					R	RFNOP	
					R	SRESET	
Security Domain Name	"name"	string	N/A	Yes	R	RESET	Human-friendly name for the Security Domain, set by DOTS during onboarding.
					RW	RFOTM	
					RW	RFPRO	
					R	RFNOP	
					RW	SRESET	
Privacy Flag	"priv"	boolean	N/A	Yes	R	RESET	Flag to indicate whether the Security Domain Information is copied to "/oic/res", and thus whether it is publicly visible or private.
					RW	RFOTM	
					RW	RFPRO	
					R	RFNOP	
					RW	SRESET	

The purpose of the "priv" Property is to control whether information about a Device's OCF Security Domain is exposed during multicast discoveries.

If the "priv" Property is set to "false", then the "/oic/res" Resource shall expose its "sduuid" and "sdname" Properties with values copied from the "uuid" and "name" Properties of the "/oic/sec/sdi" Resource, respectively.

If the "priv" Property is set to "true", then the "/oic/res" Resource shall not expose its "sduuid" and "sdname" Properties.

Security Hardening Guidelines/ Execution Environment Security

14.1 Preamble

This is an informative clause. Many TGs in OCF have security considerations for their protocols and environments. These security considerations are addressed through security mechanisms specified in the security documents for OCF. However, effectiveness of these mechanisms depends on security robustness of the underlying hardware and software Platform. This clause defines the components required for execution environment security.

14.2 Execution Environment Elements

14.2.1 Execution Environment Elements General

Execution environment within a computing Device has many components. To perform security functions in a robustness manner, each of these components has to be secured as a separate dimension. For instance, an execution environment performing AES cannot be considered secure if the input path entering keys into the execution engine is not secured, even though the partitions of the CPU, performing the AES encryption, operate in isolation from other processes. Different dimensions referred to as elements of the execution environment are listed below. To qualify as a secure execution environment (SEE), the corresponding SEE element must qualify as secure.

- (Secure) Storage
- (Secure) Execution engine
- (Trusted) Input/output paths
- (Secure) Time Source/clock
- (Random) number generator
- (Approved) cryptographic algorithms
- Hardware Tamper (protection)

NOTE Software security practices (such as those covered by Open Web Application Security Project) are outside scope of this document, as development of secure code is a practice to be followed by the open source development community. This document will however address the underlying Platform assistance required for executing software. Examples are secure boot and secure software upgrade.

Each of the elements above are described in the clauses 14.2.2, 14.2.3, 14.2.4, 14.2.5, 14.2.6, 14.2.7.

14.2.2 Secure Storage

14.2.2.1 Secure Storage General

Secure storage refers to the physical method of housing sensitive or confidential data ("Sensitive Data"). Such data could include but not be limited to symmetric or asymmetric private keys, certificate data, OCF Security Domain access credentials, or personal user information. Sensitive Data requires that its integrity be maintained, whereas Critical Sensitive Data requires that both its integrity and confidentiality be maintained.

It is strongly recommended that IoT Device makers provide reasonable protection for Sensitive Data so that it cannot be accessed by unauthorized Devices, groups or individuals for either malicious or benign purposes. In addition, since Sensitive Data is often used for authentication and encryption, it must maintain its integrity against intentional or accidental alteration.

A partial list of Sensitive Data is outlined in Table 58:

Table 58 – Examples of Sensitive Data

Data	Integrity protection	Confidentiality protection
Owner PSK (Symmetric Keys)	Yes	Yes
Service provisioning keys	Yes	Yes
Asymmetric Private Keys	Yes	Yes
Certificate Data and Signed Hashes	Yes	Not required
Public Keys	Yes	Not required
Access credentials (e.g. SSID, passwords, etc.)	Yes	Yes
ECDH/ECDH Dynamic Shared Key	Yes	Yes
Root CA Public Keys	Yes	Not required
Device and Platform IDs	Yes	Not required
Easy Setup Resources	Yes	Yes
Access Token	Yes	Yes

3587 Exact method of protection for secure storage is implementation specific, but typically combinations
 3588 of hardware and software methods are used.

3589 **14.2.2.2 Hardware Secure Storage**

3590 Hardware secure storage is recommended for use with critical Sensitive Data such as symmetric
 3591 and asymmetric private keys, access credentials, and personal private data. Hardware secure
 3592 storage most often involves semiconductor-based non-volatile memory ("NVRAM") and includes
 3593 countermeasures for protecting against unauthorized access to Critical Sensitive Data.

3594 Hardware-based secure storage not only stores Sensitive Data in NVRAM, but also provides
 3595 protection mechanisms to prevent the retrieval of Sensitive Data through physical and/or electronic
 3596 attacks. It is not necessary to prevent the attacks themselves, but an attempted attack should not
 3597 result in an unauthorized entity successfully retrieving Sensitive Data.

3598 Protection mechanisms should provide JIL Moderate protection against access to Sensitive Data
 3599 from attacks that include but are not limited to:

- 3600 1) Physical decapping of chip packages to optically read NVRAM contents
- 3601 2) Physical probing of decapped chip packages to electronically read NVRAM contents
- 3602 3) Probing of power lines or RF emissions to monitor voltage fluctuations to discern the bit patterns
 3603 of Critical Sensitive Data
- 3604 4) Use of malicious software or firmware to read memory contents at rest or in transit within a
 3605 microcontroller
- 3606 5) Injection of faults that induce improper Device operation or loss or alteration of Sensitive Data

3607 **14.2.2.3 Software Storage**

3608 It is generally NOT recommended to rely solely on software and unsecured memory to store
 3609 Sensitive Data even if it is encrypted. Critical Sensitive Data such as authentication and encryption
 3610 keys should be housed in hardware secure storage whenever possible.

3611 Sensitive Data stored in volatile and non-volatile memory shall be encrypted using acceptable
 3612 algorithms to prevent access by unauthorized parties through methods described in 14.2.2.2.

14.2.2.4 Additional Security Guidelines and Best Practices

Some general practices that can help ensure that Sensitive Data is not compromised by various forms of security attacks:

- 1) FIPS Random Number Generator ("RNG") – Insufficient randomness or entropy in the RNG used for authentication challenges can substantially degrade security strength. For this reason, it is recommended that a FIPS 800-90A-compliant RNG with a certified noise source be used for all authentication challenges.
- 2) Secure download and boot – To prevent the loading and execution of malicious software, where it is practical, it is recommended that Secure Download and Secure Boot methods that authenticate a binary's source as well as its contents be used.
- 3) Deprecated algorithms – Algorithms included but not limited to the list below are considered insecure and shall not be used for any security-related function:
 - a) SHA-1
 - b) MD5
 - c) RC4
 - d) RSA 1024
- 4) Encrypted transmission between blocks or components – Even if critical Sensitive Data is stored in Secure Storage, any use of that data that requires its transmission out of that Secure Storage should be encrypted to prevent eavesdropping by malicious software within an MCU/MPU.
- 5) It is recommended to avoid using wildcard in Subject Id ("*"), when setting up "/oic/sec/cred" Resource entries, since this opens up an identity spoofing opportunity.
- 6) Device vendor understands that it is the Device vendor's responsibility to ensure the Device meets security requirements for its intended uses. As an example, IoTivity is a reference implementation intended to be used as a basis for a product, but IoTivity has not undergone 3rd party security review, penetration testing, etc. Any Device based on IoTivity should undergo appropriate penetration testing and security review prior to sale or deployment.
- 7) Device vendor agrees to publish the expected support lifetime for the Device to OCF and to consumers. Changes should be made to a public and accessible website. Expectations should be clear as to what will be supported and for how long the Device vendor expects to support security updates to the software, operating system, drivers, networking, firmware and hardware of the device.
- 8) Device vendor has not implemented test or debug interfaces on the Device which are operable or which can be enabled which might present an attack vector on the Device which circumvents the interface-level security or access policies of the Device.
- 9) Device vendor understands that if an application running on the Device has access to cryptographic elements such as the private keys or Ownership Credential, then those elements have become vulnerable. If the Device vendor is implementing a Bridge, an OBT, or a Device with access to the Internet beyond the local network, the execution of critical functions should take place within a Trusted or Secure Execution Environment (TEE/SEE).
- 10) Any PINs or fixed passphrases used for onboarding, Wi-Fi Easy Setup, SoftAP management or access, or other security-critical function, should be sufficiently unique (do not duplicate passphrases. The creation of these passphrases or PINS should not be algorithmically deterministic nor should they use insufficient entropy in their creation.
- 11) Ensure that there are no remaining "VENDOR_TODO" items in the source code.
- 12) If the implementation of this document uses the "Just Works" onboarding method, understand that there is a man-in-the-middle vulnerability during the onboarding process where a malicious party could intercept messages between the device being onboarded and the OBT and could persist, acting as an intermediary with access to message traffic, during the lifetime of that

onboarded device. The recommended best practice would be to use an alternate ownership transfer method (OTM) instead of "Just Works".

- 13) It is recommended that at least one static and dynamic analysis tool¹ be applied to any proposed major production release of the software before its release, and any vulnerabilities resolved.

14.2.3 Secure execution engine

Execution engine is the part of computing Platform that processes security functions, such as cryptographic algorithms or security protocols (e.g. DTLS). Securing the execution engine requires the following

- Isolation of execution of sensitive processes from unauthorized parties/ processes. This includes isolation of CPU caches, and all of execution elements that needed to be considered as part of trusted (crypto) boundary.
- Isolation of data paths into and out of execution engine. For instance, both unencrypted but sensitive data prior to encryption or after decryption, or cryptographic keys used for cryptographic algorithms, such as decryption or signing. See clause 14.2.4 for more details.

14.2.4 Trusted input/output paths

Platform implementations should only expose information, network interfaces, ports and other functions that are necessary for the correct functioning of the Platform. It is also strongly recommended that Vendors configure a Platform to expose only a fixed set of explicitly documented open network ports and/or port ranges.

14.2.5 Secure clock

Many security functions depend on time-sensitive credentials. Examples are time stamped Kerberos tickets, OAuth tokens, X.509 certificates, OSCP response, software upgrades, etc. Lack of secure source of clock can mean an attacker can modify the system clock and fool the validation mechanism. Thus an SEE needs to provide a secure source of time that is protected from tampering. Trustworthiness from security robustness standpoint is not the same as accuracy. Protocols such as NTP can provide rather accurate time sources from the network, but are not immune to attacks. A secure time source on the other hand can be off by seconds or minutes depending on the time-sensitivity of the corresponding security mechanism. Secure time source can be external as long as it is signed by a trusted source and the signature validation in the local Device is a trusted process (e.g. backed by secure boot).

14.2.6 Approved algorithms

An important aspect of security of the entire ecosystem is the robustness of publicly vetted and peer-reviewed (e.g. NIST-approved) cryptographic algorithms. Security is not achieved by obscurity of the cryptographic algorithm. To ensure both interoperability and security, not only widely accepted cryptographic algorithms must be used, but also a list of approved cryptographic functions must be specified explicitly. As new algorithms are NIST approved or old algorithms are deprecated, the list of approved algorithms must be maintained by OCF. All other algorithms (even if they deemed stronger by some parties) must be considered non-approved.

The set of algorithms to be considered for approval are algorithms for

- Hash functions
- Signature algorithms
- Encryption algorithms
- Key exchange algorithms
- Pseudo Random functions (PRF) used for key derivation

¹ A general discussion of analysis tools can be found here: <https://www.ibm.com/developerworks/library/se-static/>

3707 This list will be included in this or a separate security robustness rules document and must be
3708 followed for all security specifications within OCF.

3709 **14.2.7 Hardware tamper protection**

3710 Various levels of hardware tamper protection exist. We borrow FIPS 140-2 terminology (not
3711 requirements) regarding tamper protection for cryptographic module

3712 – Production-grade (lowest level): this means components that include conformal sealing coating
3713 applied over the module's circuitry to protect against environmental or other physical damage.
3714 This does not however require zeroization of secret material during physical maintenance. This
3715 definition is borrowed from FIPS 140-2 security level 1.

3716 – Tamper evident/proof (mid-level), This means the Device shows evidence (through covers,
3717 enclosures, or seals) of an attempted physical tampering. This definition is borrowed from FIPS
3718 140-2 security level 2.

3719 – Tamper resistance (highest level), this means there is a response to physical tempering that
3720 typically includes zeroization of sensitive material on the module. This definition is borrowed
3721 from FIPS 140-2 security level 3.

3722 It is difficult of specify quantitative certification test cases for accreditation of these levels. Content
3723 protection regimes usually talk about different tools (widely available, specialized and professional
3724 tools) used to circumvent the hardware protections put in place by manufacturing. If needed, OCF
3725 can follow that model, if and when OCF engage in distributing sensitive key material (e.g. PKI) to
3726 its members.

3727 **14.3 Secure Boot**

3728 **14.3.1 Concept of software module authentication**

3729 In order to ensure that all components of a Device are operating properly and have not been
3730 tampered with, it is best to ensure that the Device is booted properly. There may be multiple stages
3731 of boot. The end result is an application running on top an operating system that takes advantage
3732 of memory, CPU and peripherals through drivers.

3733 The general concept is that each software module is invoked only after cryptographic integrity
3734 verification is complete. The integrity verification relies on the software module having been hashed
3735 (e.g. SHA_1, SHA_256) and then signed with a cryptographic signature algorithm with (e.g. RSA),
3736 with a key that only a signing authority has access to.

3737 Figure 30 depicts software module authentication.

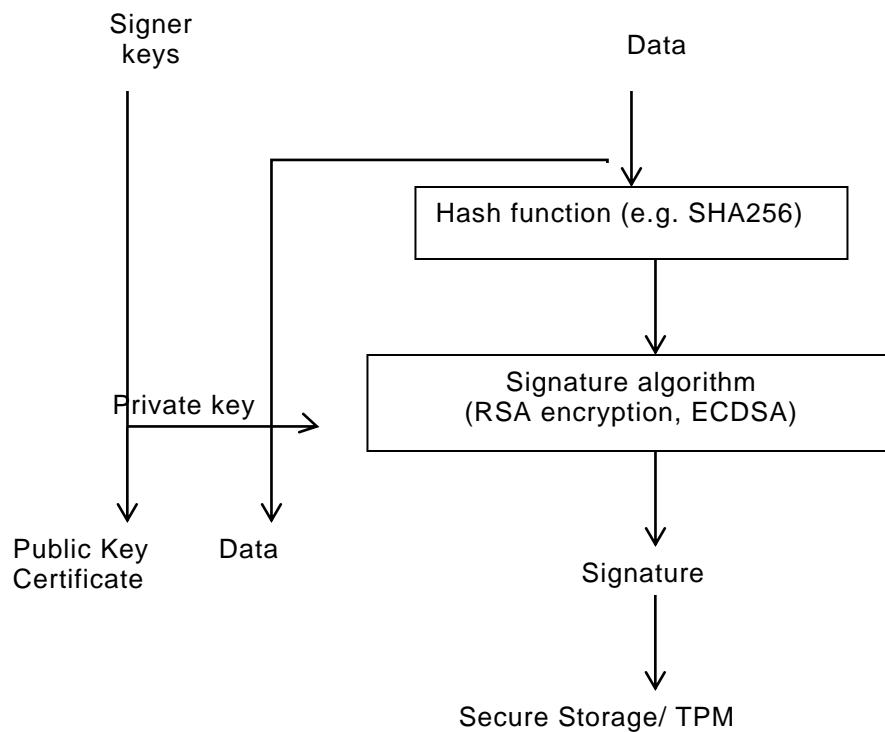


Figure 30 – Software Module Authentication

After the data is signed with the signer’s signing key (a private key), the verification key (the public key corresponding to the private signing key) is provided for later verification. For lower level software modules, such as bootloaders, the signatures and verification keys are inserted inside tamper proof memory, such as one-time programmable memory or TPM. For higher level software modules, such as application software, the signing is typically performed according to the PKCS#7 format IETF RFC 2315, where the signed data format includes both indications for signature algorithm, hash algorithm as well as the signature verification key (or certificate). Secure boot does not require use of PKCS#7 format.

Figure 31 depicts verification software module.

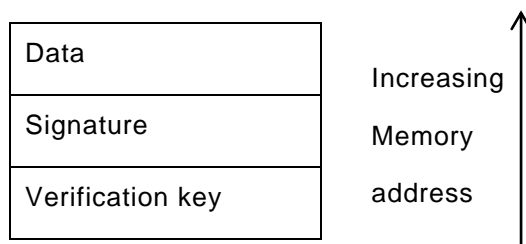


Figure 31 – Verification Software Module

As shown in Figure 32 the verification module first decrypts the signature with the verification key (public key of the signer). The verification module also calculates a hash of the data and then compares the decrypted signature (the original) with the hash of data (actual) and if the two values match, the software module is authentic.

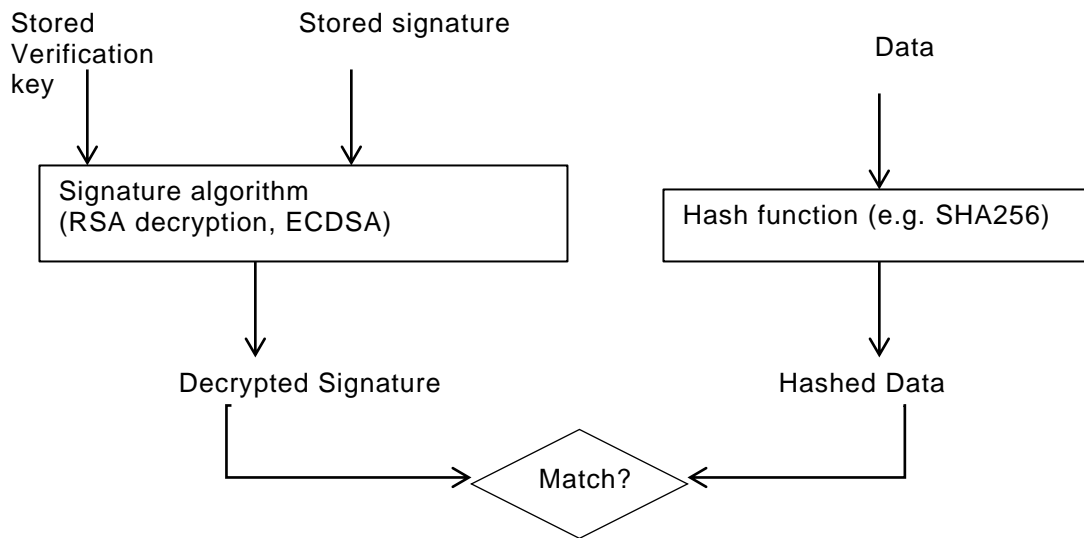


Figure 32 – Software Module Authenticity

14.3.2 Secure Boot process

Depending on the Device implementation, there may be several boot stages. Typically, in a PC/Linux type environment, the first step is to find and run the BIOS code (first-stage bootloader) to find out where the boot code is and then run the boot code (second-stage boot loader). The second stage bootloader is typically the process that loads the operating system (Kernel) and transfers the execution to the where the Kernel code is. Once the Kernel starts, it may load external Kernel modules and drivers.

When performing a secure boot, it is required that the integrity of each boot loader is verified before executing the boot loader stage. As mentioned, while the signature and verification key for the lowest level bootloader is typically stored in tamper-proof memory, the signature and verification key for higher levels should be embedded (but attached in an easily accessible manner) in the data structures software.

14.3.3 Robustness Requirements

14.3.3.1 Robustness General

To qualify as high robustness secure boot process, the signature and hash algorithms shall be one of the approved algorithms, the signature values and the keys used for verification shall be stored in secure storage and the algorithms shall run inside a secure execution environment and the keys shall be provided the SEE over trusted path.

14.3.3.2 Next steps

Develop a list of approved algorithms and data formats

14.4 Attestation

14.5 Software Update

14.5.1 Overview

The Device lifecycle does not end at the point when a Device is shipped from the manufacturer; the distribution, retailing, purchase, installation/onboarding, regular operation, maintenance and end-of-life stages for the Device remain outstanding. It is possible for the Device to require update during any of these stages, although the most likely times are during onboarding, regular operation

and maintenance. The manufacturer shall have a defined policy available to OCF Security Domain Owner (e.g. via a website link) covering handling of any device vulnerabilities, including the software update information (e.g. if and how such updates are provided). This policy shall also cover any post end-of-life or end-of-service vulnerabilities. The aspects of the software include, but are not limited to, firmware, operating system, networking stack, application code, drivers, etc.

14.5.2 Recognition of Current Differences

Different manufacturers approach software update utilizing a collection of tools and strategies: over-the-air or wired USB connections, full or partial replacement of existing software, signed and verified code, attestation of the delivery package, verification of the source of the code, package structures for the software, etc.

It is recommended that manufacturers review their processes and technologies for compliance with industry best-practices that a thorough security review of these takes place and that periodic review continue after the initial architecture has been established.

This document applies to software updates as recommended to be implemented by OCF Devices; it does not have any bearing on the above-mentioned alternative proprietary software update mechanisms. The described steps are being triggered by an OCF Client, the actual implementation of the steps and how the software package is downloaded and upgraded is vendor specific.

The triggers that can be invoked from OCF clients can:

- 1) Check if new software is available
- 2) Download and verify the integrity of the software package
- 3) Install the verified software package

The triggers are not sequenced; each trigger can be invoked individually.

The state of the transitions of software update is in Figure 33.

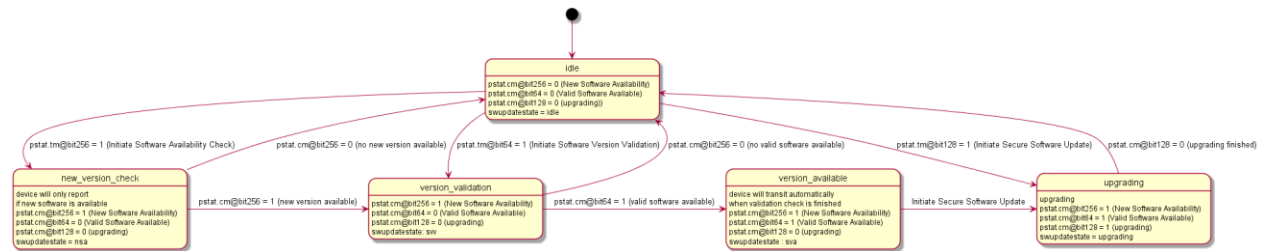


Figure 33 – State transitioning diagram for software download

Table 59 – Description of the software update bits

Bit	TM property	CM property
Bit 9	Initiate Software Availability Check	New Software Available
Bit 7	Initiate Software Version Validation	Valid Software Available
Bit 8	Initiate Secure Software Update	Upgrading

14.5.2.1 Checking availability of new software

Setting the Initiate Software Availability Check bit in the "/oic/sec/pstat.tm" Property (see Table 39 of clause 13.8) indicates a request to initiate the process to check if new software is available, e.g.

the process whereby the Device checks if a newer software version is available on the external endpoint. Once the Device has determined if a newer software version is available, it sets the Initiate Software Availability Check bit in the `"/oic/sec/pstat.cm"` Property to 1 (TRUE), indicating that new software is available or to 0 (FALSE) if no newer software version is available, See also Table 59 where the bits in property TM indicates that the action is initiated and the CM bits are indicating the result of the action. The Device receiving this trigger is not downloading and not validating the software to determine if new software is available. The version check is determined by the current software version and the software version on the external endpoint. The determination if a software package is newer is vendor defined.

14.5.3 Software Version Validation

Setting the Initiate Software Version Validation bit in the `"/oic/sec/pstat.tm"` Property (see Table 39 of 13.8) indicates a request to initiate the software version validation process, the process whereby the Device validates the software (including firmware, operating system, Device drivers, networking stack, etc.) against a trusted source to see if, at the conclusion of the check, the software update process will need to be triggered (see clause 14.5.4). When the Initiate Software Version Validation bit of `"/oic/sec/pstat.tm"` is set to 1 (TRUE) by a sufficiently privileged Client, the Device sets the `"/oic/sec/pstat.cm"` Initiate Software Version Validation bit to 0 and initiates a software version check. Once the Device has determined if a valid software is available, it sets the Initiate Software Version Validation bit in the `"/oic/sec/pstat.cm"` Property to 1 (TRUE) if an update is available or 0 (FALSE) if no update is available. To signal completion of the Software Version Validation process, the Device sets the Initiate Software Version Validation bit in the `"/oic/sec/pstat.tm"` Property back to 0 (FALSE). If the Initiate Software Version Validation bit of `"/oic/sec/pstat.tm"` is set to 0 (FALSE) by a Client, it has no effect on the validation process. The Software Version Validation process can download the software from the external endpoint to verify the integrity of the software package.

14.5.4 Software Update

The software of a Device shall be updatable.

Setting the Initiate Secure Software Update bit in the `"/oic/sec/pstat.tm"` Property (see Table 39 of clause 13.8) indicates a request to initiate the software update process. When the Initiate Secure Software Update bit of `"/oic/sec/pstat.tm"` is set to 1 (TRUE) by a sufficiently privileged Client, the Device sets the `"/oic/sec/pstat.cm"` Initiate Software Version Validation bit to 0 and initiates a software update process. Once the Device has completed the software update process, it sets the Initiate Secure Software Update bit in the `"/oic/sec/pstat.cm"` Property to 1 (TRUE) if/when the software was successfully updated or 0 (FALSE) if no update was performed. To signal completion of the Secure Software Update process, the Device sets the Initiate Secure Software Update bit in the `"/oic/sec/pstat.tm"` Property back to 0 (FALSE). If the Initiate Secure Software Update bit of `"/oic/sec/pstat.tm"` is set to 0 (FALSE) by a Client, it has no effect on the update process.

14.5.4.1 State of Device after software update

The state of all Resources implemented in the Device should be the same as after boot, meaning that the software update is not resetting user data and retaining a correct state.

User data of a Device is defined as:

- Retain the SVR states, e.g. the on boarded state, registered clients.
- Retain all created Resources
- Retain all stored data of a Resource
 - For example the preferences stored for the brewing Resource (`"/oic.r.brewing"`).

14.5.5 Recommended Usage

The Initiate Secure Software Update bit of `"/oic/sec/pstat.tm"` should only be set by a Client after the Initiate Software Version Validation check is complete.

3859 The process of updating Device software may involve state changes that affect the Device
3860 Operational State ("/oic/sec/pstat.dos"). Devices with an interest in the Device(s) being updated
3861 should monitor "/oic/sec/pstat.dos" and be prepared for pending software update(s) to affect Device
3862 state(s) prior to completion of the update.

3863 The Device itself may indicate that it is autonomously initiating a software version check/update or
3864 that a check/update is complete by setting the "pstat.tm" and "pstat.cm" Initiate Software Version
3865 Validation and Secure Software Update bits when starting or completing the version check or
3866 update process. As is the case with a Client-initiated update, Clients can be notified that an
3867 autonomous version check or software update is pending and/or complete by observing pstat
3868 Resource changes.

3869 The "oic.r.softwareupdate" Resource Type specifies additional features to control the software
3870 update process see core specification.

3871 **14.6 Non-OCF Endpoint interoperability**

3872 **14.7 Security Levels**

3873 Security Levels are a way to differentiate Devices based on their security criteria. This need for
3874 differentiation is based on the requirements from different verticals such as industrial and health
3875 care and may extend into smart home. This differentiation is distinct from Device classification
3876 (e.g. IETF RFC 7228)

3877 These categories of security differentiation may include, but is not limited to:

- 3878 1) Security Hardening
- 3879 2) Identity Attestation
- 3880 3) Certificate/Trust
- 3881 4) Onboarding Technique
- 3882 5) Regulatory Compliance
 - 3883 a) Data at rest
 - 3884 b) Data in transit
- 3885 6) Cipher Suites – Crypto Algorithms & Curves
- 3886 7) Key Length
- 3887 8) Secure Boot/Update

3888 In the future security levels can be used to define interoperability.

3889 The following applies to the OCF Security Specification 1.1:

3890 The current document does not define any other level beyond Security Level 0. All Devices will be
3891 designated as Level 0. Future versions may define additional levels.

3892 Additional comments:

- 3893 – The definition of a given security level will remain unchanged between versions of the document.
- 3894 – Devices that meet a given level may, or may not, be capable of upgrading to a higher level.
- 3895 – Devices may be evaluated and re-classified at a higher level if it meets the requirements of the
3896 higher level (e.g. if a Device is manufactured under the 1.1 version of the document, and a later
3897 document version defines a security level 1, the Device could be evaluated and classified as
3898 level 1 if it meets level 1 requirements).
- 3899 – The security levels may need to be visible to the End User.

14.8 Security Profiles

14.8.1 Security Profiles General

Security Profiles are a way to differentiate OCF Devices based on their security criteria. This need for differentiation is based on the requirements from different verticals such as industrial and health care and may extend into smart home. This differentiation is distinct from device classification (e.g. IETF RFC 7228)

These categories of security differentiation may include, but is not limited to:

- 1) Security Hardening and assurances criteria
- 2) Identity Attestation
- 3) Certificate/Trust
- 4) Onboarding Technique
- 5) Regulatory Compliance
 - a) Data at rest
 - b) Data in transit
- 6) Cipher Suites – Crypto Algorithms & Curves
- 7) Key Length
- 8) Secure Boot/Update

Each Security Profile definition must specify the version or versions of the OCF Security Specification(s) that form a baseline set of normative requirements. The profile definition may include security requirements that supersede baseline requirements (not to relax security requirements).

Security Profiles have the following properties:

- A given profile definition is not specific to the version of the document that defines it. For example, the profile may remain constant for subsequent OCF Security Specification versions.
- A specific OCF Device and platform combination may be used to satisfy the security profile.
- Profiles may have overlapping criteria; hence it may be possible to satisfy multiple profiles simultaneously.
- An OCF Device that satisfied a profile initially may be re-evaluated at a later time and found to satisfy a different profile (e.g. if a device is manufactured under the 1.1 version of the document, and a later document version defines a security profile Black, the device could be evaluated and classified as profile Black if it meets profile Black requirements).
- A machine-readable representation of compliance results specifically describing profiles satisfied may be used to facilitate OCF Device onboarding. (e.g. a manufacturer certificate or manifest may contain security profiles attributes).

14.8.2 Identification of Security Profiles (Normative)

14.8.2.1 Security Profiles in Prior Documents

OCF Devices conforming to versions of the OCF Security Specifications where Security Profiles Resource was not defined may be presumed to satisfy the "sp-baseline-v0" profile (defined in 14.8.3.3) or may be regarded as unspecified. If Security Profile is unspecified, the Client may use the OCF Security Specification version to characterize expected security behaviour.

14.8.2.2 Security Profile Resource Definition

The "/oic/sec/sp" Resource is used by the OCF Device to show which OCF Security Profiles the OCF Device is capable of supporting and which are authorized for use by the OCF Security Domain owner. Properties of the Resource identify which OCF Security Profile is currently operational. The

3944 ocfSecurityProfileOID value type shall represent OID values and may reference an entry in the form
3945 of strings (UTF-8).

3946 "/oic/sec/sp" Resource is defined in Table 60.

3947 **Table 60 – Definition of the "/oic/sec/sp" Resource**

Fixed URI	Resource Type Title	Resource Type ID ("rt" value)	OCF Interfaces	Description	Related Functional Interaction
/oic/sec/sp	Security Profile Resource Definition	oic.r.sp	oic.if.baselin e, oic.if.rw	Resource specifying supported and current security profile(s)	Discoverable

3948 Table 61 defines the Properties of "/oic/sec/sp" Resource.

3949 **Table 61 – Properties of the "/oic/sec/sp" Resource**

Property Title	Property Name	Value Type	Value Rule	Access Mode	Mandatory	Description
Supported Security Profiles	supportedprofiles	ocfSecurityProfileOID	array	RW	Yes	Array of supported Security Profiles (e.g. ["1.3.6.1.4.1.51414.0.0.2.0","1.3.6.1.4.1.51414.0.0.3.0"])
SecurityProfile	currentprofile	ocfSecurityProfileOID	N/A	RW	Yes	Currently active Security Profile (e.g. "1.3.6.1.4.1.51414.0.0.3.0")

3950 The following OIDs are defined to uniquely identify Security Profiles. Future Security Profiles or
3951 changes to existing Security Profiles may result in a new ocfSecurityProfileOID.

3952 id-OCF OBJECT IDENTIFIER ::= { iso(1) identified-organization(3) dod(6) internet(1)
3953 private(4) enterprise(1) OCF(51414) }

3954
3955 id-ocfSecurity OBJECT IDENTIFIER ::= { id-OCF 0 }

3956
3957 id-ocfSecurityProfile ::= { id-ocfSecurity 0 }

3958
3959 sp-unspecified ::= OBJECT IDENTIFIER { id-ocfSecurityProfile 0 }

3960 --The Security Profile is not specified

3961 sp-baseline ::= OBJECT IDENTIFIER { id-ocfSecurityProfile 1 }

3962 --This specifies the OCF Baseline Security Profile(s)

3963 sp-black ::= OBJECT IDENTIFIER { id-ocfSecurityProfile 2 }

3964 --This specifies the OCF Black Security Profile(s)

3965 sp-blue ::= OBJECT IDENTIFIER { id-ocfSecurityProfile 3 }

3966 --This specified the OCF Blue Security Profile(s)

3967 sp-purple ::= OBJECT IDENTIFIER { id-ocfSecurityProfile 4 }

3968 --This specifies the OCF Purple Security Profile(s)

3969

3970 --versioned Security Profiles

3971 sp-unspecified-v0 ::= ocfSecurityProfileOID (id-sp-unspecified 0)

3972 --v0 of unspecified security profile, "1.3.6.1.4.1.51414.0.0.0.0"

3973 sp-baseline-v0 ::= ocfSecurityProfileOID {id-sp-baseline 0}

3974 --v0 of baseline security profile, "1.3.6.1.4.1.51414.0.0.1.0"

3975 sp-black-v0 ::= ocfSecurityProfileOID {id-sp-black 0}

3976 --v0 of black security profile, "1.3.6.1.4.1.51414.0.0.2.0"

3977 sp-blue-v0 ::= ocfSecurityProfileOID {id-sp-blue 0}

3978 --v0 of blue security profile, "1.3.6.1.4.1.51414.0.0.3.0"

3979 sp-purple-v0 ::= ocfSecurityProfileOID {id-sp-purple 0}

3980 --v0 of purple security profile, "1.3.6.1.4.1.51414.0.0.4.0"

3981

3982 ocfSecurityProfileOID ::= UTF8String

3983

3984 **14.8.3 Security Profiles**

3985 **14.8.3.1 Security Profiles General**

3986 The Security Profiles Resource shall be pre-populated with manufacturer default values (Refer to
3987 the Security Profile clauses for additional details).

3988 The OCF Conformance criteria may require vendor attestation that establishes the expected
3989 environment in which the OCF Device is hosted (Refer to the Security Profile clauses for specific
3990 requirements).

3991 **14.8.3.2 Security Profile Unspecified (sp-unspecified-v0)**

3992 The Security Profile "sp-unspecified-v0" is reserved for future use.

3993 **14.8.3.3 Security Profile Baseline v0 (sp-baseline-v0)**

3994 The Security Profile "sp-baseline-v0" is defined for all OCF Security Specification versions where
3995 the "/oic/sec/sp" Resource is defined. All Devices shall include the "sp-baseline-v0" OID in the
3996 "supportedprofiles" Property of the "/oic/sec/sp" Resource.

3997 It indicates the OCF Device satisfies the normative security requirements for this document.

3998 When a device supports the baseline profile, the "supportedprofiles" Property shall contain sp-
3999 baseline-v0, represented by the OID string "1.3.6.1.4.1.51414.0.0.1.0", and may contain other
4000 profiles.

4001 When a manufacturer makes sp-baseline-v0 the default, by setting the "currentprofile" Property to
4002 "1.3.6.1.4.1.51414.0.0.1.0", the "supportedprofiles" Property shall contain sp-baseline-v0.

4003 **14.8.3.4 Security Profile Black (sp-black-v0)**

4004 **14.8.3.4.1 Black Profile General**

4005 The need for Security Profile Black v0 is to support devices and manufacturers who wish to certify
4006 their devices meeting this specific set of security criteria. A Device may satisfy the Black
4007 requirements as well as requirements of other profiles, the Black Security Profile is not necessarily
4008 mutually exclusive with other Security Profiles unless those requirements conflict with the explicit
4009 requirements of the Black Security Profile.

4010 **14.8.3.4.2 Devices Targeted for Security Profile Black v0**

4011 Security Profile Black devices could include any device a manufacturer wishes to certify at this
4012 profile, but healthcare devices and industrial devices with additional security requirements are the
4013 initial target. Additionally, manufacturers of devices at the edge of the network (or fog), or devices
4014 with exceptional profiles of trust bestowed upon them, may wish to certify at this profile; these types
4015 of devices may include, but are not limited to the following:

- 4016 – Bridges (Mapping devices between ecosystems handling virtual devices from different
4017 ecosystems)
- 4018 – Resource Directories (Devices trusted to manage OCF Security Domain Resources)
- 4019 – Remote Access (Devices which have external access but can also act within the OCF Security
4020 Domain)
- 4021 – Healthcare Devices (Devices with specific requirements for enhanced security and privacy)
- 4022 – Industrial Devices (Devices with advanced management, security and attestation requirements)

4023 **14.8.3.4.3 Requirements for Certification at Security Profile Black (Normative)**

4024 Every device with "currentprofile" Property of the "/oic/sec/sp" Resource designating a Security
4025 Profile of "sp-black-v0", as defined in clause 14.8.2, must support each of the following:

4026 – Onboarding via OCF Rooted Certificate Chain, including PKI chain validation

4027 – Support for AES 128 encryption for data at rest and in transit.

4028 – Hardening minimums: manufacturer assertion of secure credential storage

4029 – In – in enumerated item #10 “The “/oic/sec/cred” Resource should contain credential(s) if
 4030 required by the selected OTM” is changed to require the credential be stored: “The
 4031 “/oic/sec/cred” Resource shall contain credential(s).”

4032 – The OCF Device shall include an X.509v3 OCF Compliance Extension (clause 9.4.2.2.4) in its
 4033 certificate and the extension's 'securityProfile' field shall contain sp-black-v0 represented by
 4034 the ocfSecurityProfileOID string, "1.3.6.1.4.1.51414.0.0.2.0".

4035 When a device supports the black profile, the "supportedprofiles" Property shall contain sp-black-
 4036 v0, represented by the OID string "1.3.6.1.4.1.51414.0.0.2.0", and may contain other profiles.

4037 When a manufacturer makes sp-black-v0 the default, by setting the "currentprofile" Property to
 4038 "1.3.6.1.4.1.51414.0.0.2.0", the "supportedprofiles" Property shall contain sp-black-v0.

4039 The OCF Rooted Certificate Chain and PKI Is defined by and structured within a framework
 4040 described in the supporting documents:

4041 – Certificate Profile (See 9.4.2)

4042 – Certificate Policy (see Certificate Policy document:
 4043 <https://openconnectivity.org/specs/OCF%20Certificate%20Policy.pdf>)

4044 **14.8.3.5 Security Profile Blue v0 (sp-blue-v0)**

4045 **14.8.3.5.1 Blue Profile General**

4046 The Security Profile Blue is used when manufacturers issue platform certificates for platforms
 4047 containing manufacturer-embedded keys. Compatibility with interoperable trusted platforms is
 4048 anticipated using certificate extensions defined by the Trusted Computing Group (TCG). OCF
 4049 Security Domain owners evaluate manufacturer supplied certificates and attributed data to
 4050 determine an appropriate OCF Security Profile that is configured for OCF Devices at onboarding.
 4051 OCF Devices may satisfy multiple OCF Security Profiles. The OCF Security Domain owner may
 4052 configure deployments using the Security Profile as OCF Security Domain partitioning criteria.

4053 Certificates issued to Blue Profile Devices shall be issued by a CA conforming to the CA Vetting
 4054 Criteria defined by OCF.

4055 **14.8.3.5.2 Platforms and Devices for Security Profile Blue v0**

4056 The OCF Security Profile Blue anticipates an ecosystem where platform vendors may differ from
 4057 OCF Device vendor and where platform vendors may implement trusted platforms that may conform
 4058 to industry standards defining trusted platforms. The OCF Security Profile Blue specifies
 4059 mechanisms for linking platforms with OCF Device(s) and for referencing quality assurance criteria
 4060 produced by OCF conformance operations. The OCF Security Domain owner evaluates these data
 4061 when an OCF Device is onboarded into the OCF Security Domain. Based on this evaluation the
 4062 OCF Security Domain owner determines which Security Profile may be applied during OCF Device
 4063 operation. All OCF Device types may be considered for evaluation using the OCF Security Profile
 4064 Blue.

4065 **14.8.3.5.3 Requirements for Certification at Security Profile Blue v0**

4066 The OCF Device satisfies the Blue profile v0 (sp-blue-v0) when all of the security normative for this
 4067 document version are satisfied and the following additional criteria are satisfied.

4068 OCF Blue profile defines the following OCF Device quality assurances:

- 4069 – The OCF Conformance criteria shall require vendor attestation that the conformant OCF Device
4070 was hosted on one or more platforms that satisfies OCF Blue platform security assurances and
4071 platform security and privacy functionality requirements.
- 4072 – The OCF Device achieving OCF Blue Security Profile compliance will be registered by OCF and
4073 published by OCF in a machine readable format.
- 4074 – The OCF Blue Security Profile compliance registry may be digitally signed by an OCF owned
4075 signing key.
- 4076 – The OCF Device shall include an X.509v3 OCF Compliance Extension (clause 9.4.2.2.4) in its
4077 certificate and the extension's 'securityProfile' field shall contain sp-blue-v0 represented by the
4078 ocfSecurityProfileOID string, "1.3.6.1.4.1.51414.0.0.3.0".
- 4079 – The OCF Device shall include an X.509v3 OCF CPL Attributes Extension (clause 9.4.2.2.7) in
4080 its certificate.
- 4081 – The DOTS is expected to perform a lookup of the certification status of the OCF Device using
4082 the OCF CPL Attributes Extension values and verify that the sp-blue-v0 OID is listed in the
4083 extension's "securityprofiles" field.
- 4084 OCF Blue profile defines the following OCF Device security functionality:
 - 4085 – OCF Device(s) shall be hosted on a platform where a cryptographic and secure storage
4086 functions are hardened by the platform.
 - 4087 – OCF Device(s) hosted on a platform shall expose accompanying manufacturer credentials using
4088 the "/oic/sec/cred" Resource where the "credusage" Property contains the value
4089 "oic.sec.cred.mfgcert".
 - 4090 – OCF Device(s) that are hosted on a TCG-defined trusted platform should use an IEEE802.1AR
4091 IDevID and should verify the "TCG Endorsement Key Credential". All TCG-defined
4092 manufacturer credentials may be identified by the "oic.sec.cred.mfgcert" value of the
4093 "credusage" Property of the "/oic/sec/cred" Resource. They may be used in response to
4094 selection of the "oic.sec.doxm.mfgcert" owner transfer method.
 - 4095 – OCF Device(s) shall use AES128 equivalent minimum protection for transmitted data. (See
4096 NIST SP 800-57).
 - 4097 – OCF Device(s) shall use AES128 equivalent minimum protection for stored data. (See NIST SP
4098 800-57).
 - 4099 – OCF Device(s) should use AES256 equivalent minimum protection for stored data. (See NIST
4100 SP 800-57).
 - 4101 – OCF Device(s) should protect the "/oic/sec/cred" Resource using the platform provided secure
4102 storage.
 - 4103 – OCF Device(s) shall protect trust anchors (aka policy defining trusted CAs and pinned
4104 certificates) using platform provided secure storage.
 - 4105 – OCF Device(s) should check certificate revocation status for locally issued certificates.
 - 4106 – The DOTS is expected to check certificate revocation status for all certificates in manufacturer
4107 certificate path(s) if available. If a certificate is revoked, certificate validation fails and the
4108 connection is refused. The DOTS may disregard revocation status results if unavailable.
- 4109 OCF Blue profile defines the following platform security assurances:
 - 4110 – Platforms implementing cryptographic service provider (CSP) functionality and secure storage
4111 functionality should be evaluated with a minimum FIPS140-2 Level 2 or Common Criteria EAL
4112 Level 2.
 - 4113 – Platforms implementing trusted platform functionality should be evaluated with a minimum
4114 Common Criteria EAL Level 1.
- 4115 OCF Blue profile defines the following platform security and privacy functionality:

- 4116 – The Platform shall implement cryptographic service provider (CSP) functionality.
- 4117 – Platform CSP functionality shall include cryptographic algorithms, random number generation,
- 4118 secure time.
- 4119 – The Platform shall implement AES128 equivalent protection for transmitted data. (See NIST SP
- 4120 800-57).
- 4121 – The Platform shall implement AES128 and AES256 equivalent protection for stored data. (See
- 4122 NIST SP 800-57).
- 4123 – Platforms hosting OCF Device(s) should implement a platform identifier following IEEE802.1AR
- 4124 or Trusted Computing Group(TCG) specifications.
- 4125 – Platforms based on Trusted Computing Group (TCG) platform definition that host OCF Device(s)
- 4126 should supply TCG-defined manufacture certificates; also known as "TCG Endorsement Key
- 4127 Credential" (which complies with IETF RFC 5280) and "TCG Platform Credential" (which
- 4128 complies with IETF RFC 5755).
- 4129 When a device supports the blue profile, the "supportedprofiles" Property shall contain sp-blue-v0,
- 4130 represented by the OID string "1.3.6.1.4.1.51414.0.0.3.0", and may contain other profiles.
- 4131 When a manufacturer makes sp-blue-v0 the default, by setting the "currentprofile" Property to
- 4132 "1.3.6.1.4.1.51414.0.0.3.0", the "supportedprofiles" Property shall contain sp-blue-v0.
- 4133 During onboarding, while the device state is RFOTM, the DOTS may update the "currentprofile"
- 4134 Property to one of the other values found in the "supportedprofiles" Property.
- 4135 **14.8.3.6 Security Profile Purple v0 (sp-purple-v0)**
- 4136 Every device with the "/oic/sec/sp" Resource designating "sp-purple-v0", as defined in clause
- 4137 14.8.2 must support following minimum requirements
- 4138 – Hardening minimums: secure credential storage, software integrity validation, secure update.
- 4139 – If a Certificate is used, the OCF Device shall include an X.509v3 OCF Compliance Extension
- 4140 (clause 9.4.2.2.4) in its certificate and the extension's 'securityProfile' field shall contain sp-
- 4141 purple-v0 represented by the ocfSecurityProfileOID string, "1.3.6.1.4.1.51414.0.0.4.0"
- 4142 – The OCF Device shall include a X.509v3 OCF CPLAttributes Extension (clause 9.4.2.2.7) in its
- 4143 End-Entity Certificate when manufacturer certificate is used.
- 4144 Security Profile Purple has following optional security hardening requirements that the device can
- 4145 additionally support.
- 4146 – Hardening additions: secure boot, hardware backed secure storage
- 4147 – The OCF Device shall include a X.509v3 OCFSecurityClaims Extension (clause 9.4.2.2.6) in its
- 4148 End-Entity Certificate and it shall include corresponding OIDs to the hardening additions
- 4149 implemented and attested by the vendor. If there is no additional support for hardening
- 4150 requirements, X.509v3 OCFSecurityClaims Extension shall be omitted.
- 4151 For software integrity validation, OCF Device(s) shall provide the integrity validation mechanism
- 4152 for security critical executables such as cryptographic modules or secure service applications, and
- 4153 they should be validated before the execution. The key used for validating the integrity must be
- 4154 pinned at the least to the validating software module.
- 4155 For secure update, OCF Device(s) shall be able to update its firmware in a secure manner.
- 4156 For secure boot, OCF Device(s) shall implement the BIOS code (first-stage bootloader on ROM) to
- 4157 be executed by the processor on power-on, and secure boot parameters to be provisioned by
- 4158 tamper-proof memory. Also OCF Device(s) shall provide software module authentication for the
- 4159 security critical executables and stop the boot process if any integrity of them is compromised.

4160 For hardware backed secure storage, OCF Device(s) shall store sensitive data in non-volatile
4161 memory ("NVRAM") and prevent the retrieval of sensitive data through physical and/or electronic
4162 attacks.

4163 More details on security hardening guidelines for software integrity validation, secure boot, secure
4164 update, and hardware backed secure storage are described in 14.3, 14.5 and 14.2.2.2.

4165 Certificates issued to Purple Profile Devices shall be issued by a CA conforming to the CA Vetting
4166 Criteria defined by OCF.

4167 When a device supports the purple profile, the "supportedprofiles" Property shall contain sp-purple-
4168 v0, represented by the OID string "1.3.6.1.4.1.51414.0.0.4.0", and may contain other profiles.

4169 When a manufacturer makes sp-purple-v0 the default, by setting the "currentprofile" Property to
4170 "1.3.6.1.4.1.51414.0.0.4.0", the "supportedprofiles" Property shall contain sp-purple-v0.

4171 **Device Type Specific Requirements**

4172 **15.1 Bridging Security**

4173 **15.1.1 Universal Requirements for Bridging to another Ecosystem**

4174 The Bridge shall go through OCF ownership transfer as any other onboarder would.

4175 The software of a Bridge shall be field updatable. (This requirement need not be tested but can be
4176 certified via a vendor declaration.)

4177 Each VOD shall be onboarded by an OCF OBT. Each Virtual Bridged Device should be provisioned
4178 as appropriate in the Bridged Protocol. In other words, VODs and Virtual Bridged Devices are
4179 treated the same way as physical Devices. They are entities that have to be provisioned in their
4180 network.

4181 Each VOD shall implement the behaviour required by ISO/IEC 30118-1 and this document. Each
4182 VOD shall perform authentication, access control, and encryption according to the security settings
4183 it received from the OCF OBT. Each Virtual Bridged Device shall implement the security
4184 requirements of the Bridged Protocol.

4185 In addition, in order to be considered secure from an OCF perspective, the Bridge Platform shall
4186 use appropriate ecosystem-specific security options for communication between the Virtual Bridged
4187 Devices instantiated by the Bridge and Bridged Devices. This security shall include mutual
4188 authentication, and encryption and integrity protection of messages in the bridged ecosystem.

4189 A VOD may authenticate itself to the DOTS using the Manufacturer Certificate Based OTM (see
4190 clause 7.3.6) with the Manufacturer Certificate and corresponding private key of the Bridge which
4191 instantiated that VOD.

4192 A VOD may authenticate itself to the OCF Cloud using the Manufacturer Certificate and
4193 corresponding private key of the Bridge which instantiated that VOD.

4194 A Bridge and the VODs created by that Bridge shall operate as independent Devices, with the
4195 following exceptions:

- 4196 – If a Bridge creates a VOD while the Bridge is in an Unowned State, then the VOD shall be
4197 created in an Unowned State.
- 4198 – An Unowned VOD shall not accept DTLS connection attempts nor TLS connection attempts nor
4199 any other requests, including discovery requests, while the Bridge (that created that VOD) is
4200 Unowned.
- 4201 – At any time when a Bridge is transitioning from Owned to Unowned State, all Unowned VODs
4202 (created by that Bridge prior to the transition) shall drop any existing TLS and/or DTLS
4203 connections.
- 4204 – At any time when a Bridge is transitioning from Unowned to Owned State, the Bridge shall
4205 trigger all Unowned VODs (created by that Bridge prior to the transition) to become accessible
4206 in RFOTM, with internal state as if the VOD has just transitioned from RESET to RFOTM.
- 4207 – If a Bridge creates a VOD while the Bridge is in an Owned State, then the VOD shall become
4208 accessible in RFOTM, with internal state as if the VOD has just transitioned from RESET to
4209 RFOTM.

4210 Table 62 intends to clarify this behaviour.

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Table 62 – Dependencies of VOD Behaviour on Bridge state, as clarification of accompanying text

Bridge state	Additional dependencies on VOD behaviour	
	VOD is Unowned (either just created, or created previously)	VOD is Owned
From unboxing Bridge until just prior to the end of transition of Bridge from Unowned to Owned	No accepting DTLS connection attempts nor TLS connection attempts nor any other requests, including discovery requests	Not applicable
At end of transition from Unowned to Owned	VOD becomes accessible in RFOTM following Bridge's transition. Internal state as if just transitioned from RESET.	As per normal Device
Owned	As per normal Device	As per normal Device
At Start of transition from Owned to Unowned	Drop any established TLS/DTLS connections, even if already partway through Device ownership	As per normal Device
Start of transition from Owned to Unowned, until just prior to the end of transition from Unowned to Owned.	No accepting DTLS connection attempts nor TLS connection attempts nor any other requests, including discovery requests	As per normal Device

4213 The "vods" Property of the "oic.r.vodlist" Resource on a Bridge reflects the details of all currently
4214 Owned VODs which have been created by that Bridge since the most recent hardware reset (if any)
4215 of the Bridge Platform (which removes all the created VODs), regardless of whether the VODs have
4216 the same owner as the Bridge or not. The entries in the "vods" Property are added and removed
4217 according to the following criteria:

- 4218 – Whenever a VOD created by a Bridge transitions from being Unowned to being Owned, then
4219 an entry for that VOD shall be added to the "vods" Property of the "oic.r.vodlist" Resource of
4220 that Bridge.
- 4221 – Whenever a VOD created by a Bridge transitions from being Owned to being Unowned, then
4222 entry for that VOD shall be removed from the "vods" Property of the "oic.r.vodlist" Resource of
4223 that Bridge. If that Bridge is currently in Unowned state, then the "oic.r.vodlist" Resource is not
4224 accessible, and the entry for that VOD shall be removed from the "vods" Property before or
4225 during the transition of that Bridge to the Owned state.
- 4226 – All other modifications of the list are not allowed.

4227 A Bridge shall only expose a secure OCF Endpoint for the "oic.r.vodlist" Resource.

4228 **15.1.2 Additional Security Requirements specific to Bridged Protocols**

4229 **15.1.2.1 Additional Security Requirements specific to the AllJoyn Protocol**

4230 For AllJoyn translator, an authenticated and authorized Client shall be able to block the
4231 communication of all OCF Devices with all Bridged Devices that don't communicate securely with
4232 the Bridge, by using the Bridge Device's "oic.r.securemode" Resource specified in ISO/IEC 30118-
4233 3

4234 **15.1.2.2 Additional Security Requirements specific to the Bluetooth LE Protocol**

4235 A Bridge shall block the communication of all OCF Devices with all Bridged Devices that don't
4236 communicate securely with the Bridge.

4237 **15.1.2.3 Additional Security Requirements specific to the oneM2M Protocols**

4238 The Bridge shall implement oneM2M application access control as defined in the oneM2M Release
4239 3 Specifications.

4240 An Bridge shall block the communication of all OCF Devices with all Bridged Devices that don't
4241 communicate securely with the Bridge.

4242 **15.1.2.4 Additional Security Requirements specific to the U+ Protocol**
4243 A Bridge shall block the communication of all OCF Devices with all Bridged Devices that don't
4244 communicate securely with the Bridge.

4245 **15.1.2.5 Additional Security Requirements specific to the Z-Wave Protocol**
4246 A Bridge shall block the communication of all OCF Devices with all Bridged Devices that don't
4247 communicate securely with the Bridge.

4248 **15.1.2.6 Additional Security Requirements specific to the Zigbee Protocol**
4249 A Bridge shall block the communication of all OCF Devices with all Bridged Devices that don't
4250 communicate securely with the Bridge.

4251 **15.1.2.7 Additional Security Requirements specific to the EnOcean Radio Protocol**
4252 A Bridge shall block the communication of all OCF Devices with all Bridged Devices that don't
4253 communicate securely with the Bridge.

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Annex A (informative) Access Control Examples

Alternative in-transit protection mechanisms

16.1 Introduction to in-transit protection mechanisms

In addition to the DTLS protection mechanisms for device-to-device communication specified in clause 9.4.7 and clause 11.2, and TLS protection specified in OCF Cloud Security Specification, OCF supports the following in-transit protection mechanisms:

- End-to-End Security of Unicast Messages using OSCORE, specified in clause 16.2.
- Simple Secure Multicast, specified in clause 16.3

16.2 End-to-End Security of Unicast Messages using OSCORE

16.2.1 Introduction to End-to-End Security of Unicast Messages using OSCORE

End-to-End Security of Unicast Messages is accomplished by applying a layer of in-transit protection above the transport layer Security (provided by DTLS or TLS) and below the resource-access authorization layer, using Object Security for Constrained RESTful Environments (OSCORE) IETF RFC 8613.

Relative to an exchange of an OCF CRUDN Request message and OCF CRUDN Response message:

- The Device acting as a Client (that is, sending an OCF CRUDN Request message and receiving the corresponding OCF CRUDN Response message) acts as an OSCORE client. Within the scope of clause 16.2, all Clients are assumed to support OSCORE and perform OSCORE client processing.
- The Device acting as a Server (that is, receiving an OCF CRUDN Request message and sending one or more corresponding OCF CRUDN Response messages) acts as an OSCORE server. Within the scope of clause 16.2, all Servers are assumed to support OSCORE and perform OSCORE server processing.

Clause 16.2.4 specifies the supported mechanism for establishing an OSCORE Security Context between two Devices. For each Device, an authorized Client (e.g. OBT) provisions the OSCORE Security Context parameters to a credential entry of the "/oic/sec/cred" Resource. The "subjectuuiid" of that credential entry identifies the other Device that shares that OSCORE Security Context (similar to how a DTLS endpoint associates each DTLS PSK session with the Device UUID of the other DTLS endpoint).

16.2.2 OSCORE ID Namespace Prefix

Clause 16.2.4 specifies one mechanism for establishing an OSCORE Security Context between two Devices. Different mechanisms have different entities responsible for managing the selection of OSCORE Sender ID and OSCORE Recipient ID. There is value in preventing Devices having multiple OSCORE Security Contexts with identical Recipient IDs: this simplifies processing and avoids inefficiencies.

If a set of one or more coordinated entities (e.g. a group of OBTs) assigns a set of OSCORE Recipient IDs to OSCORE Security Contexts on a Device, then that set of entities is responsible for avoiding duplicate OSCORE Recipient IDs. However, two non-coordinated entities assigning OSCORE Recipient IDs might assign identical OSCORE Recipient IDs if there is no predefined agreement on assignment of OSCORE Recipient IDs.

For this reason, the first byte of the OSCORE Sender ID and OSCORE Recipient ID use a OSCORE Identifier Namespace Prefix. The Table Y is the authoritative definition of the assigned OSCORE Identifier Namespace Prefix values.

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Table 63 – OSCORE Identifier Namespace Prefix

Value	Interpretation	Applicable clauses
0x00	Reserved for future use	
0x01	Directly provisioned OSCORE Security Context	16.2.4
0x02	Simple Secure Multicast	16.3
0x03-0x0F	Reserved for future use	

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16.2.3 OSCORE protection and verification of unicast OCF CRUDN messages

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All OSCORE message processing requirements in clause 8 in IETF RFC 8613 apply.

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NOTE 1: Clause 8 in IETF RFC 8613 requires the Client keep the association of the request Token (see IETF RFC 7252) with the Security Context and Partial IV of the request, in order to be able to find the Security Context and compute the OSCORE Additional Authenticated Data when verifying the response.

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If a Client has an established OSCORE Security Context associated with a Server, then the following call flow applies whenever the Client sends unicast OCF CRUDN request targeting Resources hosted on the Server. The Client may send multiple OSCORE requests to multiple Servers

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- 1) The Client shall apply the OSCORE request protection processing to OCF CRUDN requests targeting Resources hosted on the Server as specified in clause 8.1 in IETF RFC 8613, using the OSCORE Security Context. See ISO/IEC 30118-1 for details on setting the Proxy-URI option.

The Client sends the OSCORE request message to the Server (optionally via OCF Proxies). The OSCORE request message shall be delivered over secure transports: Device-to-Device communication is secured as specified in clause 9.4.7; Device to Cloud communication is secured as specified in OCF Cloud Specification and OCF Cloud Security Specification; and Cloud-to-Cloud communication is secured as specified in OCF Cloud API for Cloud Services Specification.

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- 2) The Server receives a unicast OSCORE request message. The Server shall apply the OSCORE request verification and decryption processing in clause 8.2 of IETF RFC 8613 with the following clarifications:

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- a) At Step 2 in clause 8.2 of IETF RFC 8613

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- i) If either the decompression or the COSE message fails to decode, the Server shall respond with error response message (e.g. "Bad Option") including an Outer Max-Age option with value zero.

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- ii) The Server attempts to retrieve the OSCORE Security Contexts associated with the Recipient ID in the 'kid' parameter. If the Server fails to retrieve a OSCORE Security Context with OSCORE Recipient ID corresponding to the 'kid' parameter received, then the Server shall respond with an error response message (e.g. "Unauthorized") including an Outer Max-Age option with value zero.

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- b) At step 6 in clause 8.2 of IETF RFC 8613, if the decryption failed then the Server shall respond with an error response message (e.g. "Bad Request") including an Outer Max-Age option with value zero.

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- c) If a Server exposes one or more observable Resources, then the Server shall support receiving OSCORE request messages using the Observe option.

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- 3) The Server shall process the OCF CRUDN request message (encapsulated in the OSCORE request message) resulting in OCF CRUDN response message(s). The Server shall treat the value of "subjectuuid" in the credential entry which contains the OSCORE Security Context used to verify and decrypt the OSCORE request message in Step 2 as Client's Device UUID for access control processing. The Server shall treat the connection type as "auth-crypt" for access control processing.

4364 NOTE 2: Multiple OCF CRUDN response messages are only sent in scenarios where the OCF CRUDN Request message
4365 is an Observe Request message.

4366 4) The Server shall apply the OSCORE response protection processing of clause 8.3 of IETF RFC
4367 8613 to each OCF CRUDN response message, using the OSCORE Security Context used to
4368 successfully decrypt the OSCORE request (in Step 2 of the present clause).
4369 At Step 3 in clause 8.3 of IETF RFC 8613, the Server shall compute the AEAD nonce as
4370 described in clause 5.2 of IETF RFC 8613 by applying the following steps:

4371 a) Encode the Partial IV (OSCORE Sender Sequence Number in network byte order) and
4372 increment the OSCORE Sender Sequence Number by one.

4373 b) Compute the OSCORE AEAD nonce from the Sender ID, Common IV, and Partial IV.

4374 The Server shall support sending the OCF CRUDN response messages using the Observe
4375 option in OSCORE response messages. If an OCF CRUDN response message uses the
4376 Observe option, then the OSCORE response message shall include an Outer Max-Age option
4377 with value zero. The Server sends the OSCORE response message to the Client (optionally via
4378 OCF Proxies). As with the OSCORE request message, the OSCORE response message shall
4379 be delivered over secure transports - see Step 1 for details.

4380 The Server shall update the value of the "ssn" Property in the matching credential entry of the
4381 "/oic/sec/cred" Resource to reflect the next value of the OSCORE Sender Sequence Number
4382 to be sent to a corresponding Endpoint.

4383 NOTE 3: If a Client retrieves the "/oic/sec/cred" Resource over the OSCORE channel, the OSCORE Sender Sequence
4384 Number in the header of the OSCORE message is expected to match the "ssn" value within the Resource representation.

4385 5) The Client receives the OSCORE response message. The Client uses the Token (see IETF
4386 RFC 7252) in this response message to determine the corresponding OCF CRUDN request
4387 message, the OSCORE Security Context and Partial IV in Step 1 of the present clause; see
4388 Note 1. The Client shall apply OSCORE response protection processing of clause 8.3 of IETF
4389 RFC 8613 using this OSCORE Security Context and Partial IV. The Client should ignore a
4390 success response to an OSCORE-protected request if the response is not an OSCORE
4391 response message (indicated by the presence of the OSCORE option).

4392 **16.2.4 Direct provisioning of an OSCORE Security Context**

4393 This is a mechanism for establishing an OSCORE Security Context for communication between
4394 two Endpoints. All configurable parameters of the OSCORE Security Context are either:

- 4395 – fixed to the OSCORE-specified default value, or
- 4396 – directly provisioned by an authorized Client (e.g. OBT) to a credential entry of the
4397 "/oic/sec/cred" Resource of the two Endpoints.

4398 The following OSCORE Security Context parameters shall use the default values defined in clause
4399 3.2 of IETF RFC 8613 (this information is not configured by the OBT):

- 4400 – AEAD Algorithm,
- 4401 – HKDF,
- 4402 – Replay Window,
- 4403 – Master Salt,
- 4404 – ID Context.

4405 The following OSCORE Security Context parameters and associated Device UUID shall be
4406 provisioned to a credential entry of "/oic/sec/cred" of the Device:

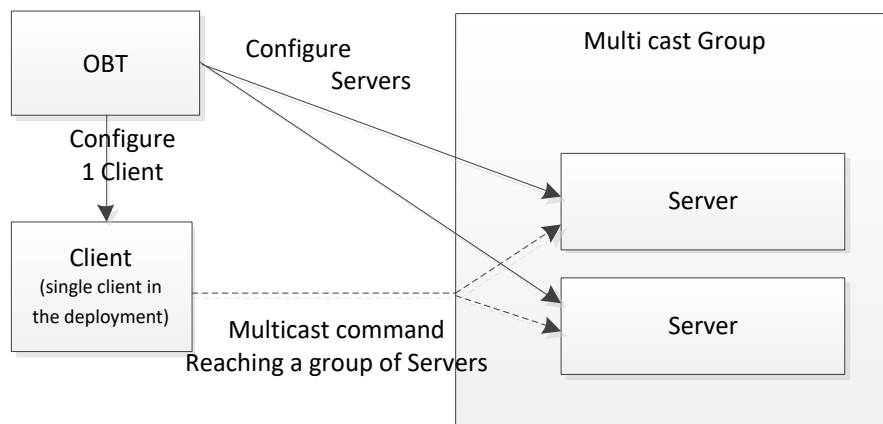
- 4407 – The "subjectuuid" shall be set to the deviceUUID of the other Endpoint to be associated with
4408 the OSCORE Security Context.
- 4409 – The "credtype" shall be set to the value specified for a directly provisioned OSCORE Security
4410 Context in Table 22, clause 13.3.1.

- 4411 – The "privatedata" Property of the credential entry shall be set to the 256-bit secret generated
 4412 by the provisioning client (e.g. OBT). This value shall be used as the OSCORE Master Secret.
 4413 Two Endpoints provisioned using this mechanism can communicate securely only if provisioned
 4414 with identical values for the OSCORE Master Secret.
- 4415 – The OSCORE Configuration parameters ("oscore") Property shall be present, and shall include
 4416 the following Properties:
- 4417 – The OSCORE Sender ID of the OSCORE Security Context is in the "senderid" Property.
 4418 That value shall be set to the hexadecimal representation of a 56-bit value selected by the
 4419 provisioning Client (e.g. OBT). When using the mechanism described in the present clause,
 4420 the first byte of this value is expected to have the value assigned in Table 63 for a directly
 4421 provisioned OSCORE Security Context.
 - 4422 – The OSCORE Recipient ID of the OSCORE Security Context is in the "recipientid" Property.
 4423 That value shall be set to the hexadecimal representation of a 56-bit value selected by the
 4424 provisioning Client (e.g. OBT). The first byte of this value is expected to have the value
 4425 assigned in Table 63 for a directly provisioned OSCORE Security Context.
- 4426 NOTE: The values for the OSCORE Sender ID and OSCORE Recipient ID of the OSCORE Security Context for one
 4427 Device are provisioned as the values for the OSCORE Recipient ID and OSCORE Sender ID of the OSCORE Security
 4428 Context for the other Device respectively.
- 4429 On Device powering down, for each such credential entry, the Device shall write the value of
 4430 corresponding OSCORE Sender Sequence Number as "ssn" Property to non-volatile memory. In
 4431 event of a crash, devices should apply Appendix B.1.1 of IETF RFC 8613.

4432 16.3 Simple Secure Multicast

4433 16.3.1 Introduction to Simple Secure Multicast

4434 The communication model is that one (1) Client communicates to a group of Servers with a single
 4435 UPDATE request, as shown in Figure 34. Each Server receives the UPDATE request at
 4436 approximately the same time and can execute the UPDATE request at approximately the same
 4437 time. As example of this kind of communication is sending an "on" command to a group of lights,
 4438 all lights that are member of that group turn on at approximately the same time. Sending UPDATE
 4439 requests to a group of devices can be achieved on IP by means of sending messages to a
 4440 predefined URL on a multicast address.



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 4442 **Figure 34 – Simple Multicast requests**

4443 Security of SSM is accomplished by applying an application layer of in-transit protection and below
4444 the resource-access authorization layer, using OSCORE IETF RFC 8613.

4445 Relative to an exchange of an UPDATE non-confirmable message:

- 4446 – The Device acting as a Client (that is, sending an UPDATE request message) acts as an
4447 OSCORE client. Within the scope of clause 16.3 the single Client is assumed to support
4448 OSCORE and perform OSCORE client processing.
- 4449 – The Device acting as a Server (that is, receiving an UPDATE request message) acts as an
4450 OSCORE server. Within the scope of clause 16.3, all Servers are assumed to support OSCORE
4451 and perform OSCORE server processing.

4452 Clause 16.3.2 details the assumptions and prerequisites for correct functioning of SSM. Clause
4453 16.3.3 describes the process for encapsulating an UPDATE request message into an SSM Request
4454 at the Client of an SSM Group, and subsequent extraction of an UPDATE request message from
4455 an SSM Request at the Server of an SSM Group. Clause 16.3.4 specifies how a Client generates
4456 an OSCORE Common Context and OSCORE Sender Context from an SSM Client Context and
4457 specifies how a Server generates an OSCORE Common Context and OSCORE Recipient Context
4458 from an SSM Server Context.

4459 **16.3.2 Assumptions and Prerequisites for Simple Secure Multicast**

4460 As shown in the following example, any Server of the SSM Group can generate an SSM Request
4461 which other Servers in the SSM Group will interpret as being securely sent by the Client of the
4462 SSM Group, for the purposes of privilege escalation. The security of SSM relies on the assumption
4463 that no Server in the SSM Group attempts to generate an SSM Request using the credentials for
4464 the SSM Group. SSM should only be used in scenarios where the Security Domain Owner is
4465 confident that this is a valid assumption.

4466 SSM Requests are delivered to SSM-capable Servers via the All OCF Nodes multicast address
4467 defined in ISO/IEC 30118-1. As specified in ISO/IEC 30118-1, all Servers subscribe to this multicast
4468 address to facilitate discovery of "oic/res", and consequently all Servers can receive SSM Requests
4469 delivered in this manner. A Server that supports the reception of SSM Requests for one or more
4470 Resources that it hosts shall populate the All OCF nodes multicast address in the "eps" Parameter
4471 of the Resource Links of those Resources in the "oic/res" discovery response.

4472 The configured Client is aware of Multicast enabled Servers by means of detecting the multicast
4473 enabled resources in the Device discovery "oic/res" responses. The Client also knows how to
4474 create the multicast request to that resource, by means of the Introspection Device Data hosted on
4475 the Device. Therefore, the Client is able to send an UPDATE request to the multicast enabled
4476 Resources.

4477 The Client of an SSM Group cannot form SSM Requests for the SSM Group until the Client is
4478 provisioned with the SSM Client Context for the SSM Group. Likewise, each Server in an SSM
4479 Group cannot process SSM Requests for the SSM Group until the Server is provisioned with the
4480 SSM Server Context for the SSM Group. The SSM Client Context and SSM Server Context are
4481 provisioned by an OBT as specified in OCF Onboarding Tool Specification. Clause 16.3.4 specifies
4482 how the OSCORE Sender Context at a Client is derived from an SSM Client Context, and how the
4483 OSCORE Recipient Context at a Server is derived from an SSM Server Context.

4484 The UPDATE request encapsulated in an SSM Request includes a local URI path for a target
4485 Resource. A Server in the SSM Group for whom the request is intended, will process the request
4486 using the Resource at this local URI path, if such a Resource exists and the Resource matches the
4487 Resource Type and OCF Interface in the request. The SSM feature is designed with the
4488 assumption that the local URI path, Resource Type and supported OCF Interfaces on the intended
4489 Servers are consistent; but the SSM feature does not specify how such consistency is achieved.

4490 The UPDATE request message itself is expected to contain information in such way that the Server
4491 can determine if the received UPDATE request message is intended for the Server, but the
4492 specification of this information is not part of the SSM feature.

4493 **16.3.3 OSCORE protection and verification of Simple Secure Multicast Requests**

4494 All OSCORE message processing requirements in clauses 8.1 and 8.2 in IETF RFC 8613 apply.

4495 If a Client has an established SSM Client Context associated with an SSM Group, then the following
4496 call flow applies whenever the Client sends a multicast non-confirmable UPDATE request targeting
4497 multicast enabled Resources hosted on one or more Servers of the SSM Group.

4498 1) The Client shall apply the OSCORE request protection processing to the UPDATE request as
4499 specified in clause 8.1 in IETF RFC 8613, using the OSCORE Security Context derived from
4500 the SSM Client Context as specified in clause 16.3.4. See ISO/IEC 30118-1 for details on
4501 setting the Proxy-URI option.

4502 The Client shall send the resulting OSCORE request message to the predefined All OCF Nodes
4503 multicast address. Dependent on the deployment scenario the different scopes as defined in
4504 clause 12.2.9 of ISO/IEC 30118-1 can be used.

4505 2) All Servers subscribed to the predefined multicast address receive a copy of the OSCORE
4506 request message. Each Server supporting SSM which receives the OSCORE request message
4507 shall apply the OSCORE request verification and decryption processing in clause 8.2 of IETF
4508 RFC 8613 with the following clarifications:

4509 a) At Step 2 in clause 8.2 of IETF RFC 8613

4510 i) If either the decompression or the COSE message fails to decode, the Server shall
4511 ignore the message and shall not respond.

4512 ii) The Server attempts to retrieve the SSM Server Contexts with "recipientID" matching
4513 the 'kid' parameter. If the Server fails to retrieve an SSM Server Context with
4514 "recipientID" matching the 'kid' parameter received, then the Server shall ignore the
4515 message and shall not respond.

4516 b) At step 6 in clause 8.2 of IETF RFC 8613, if the decryption failed then the Server shall
4517 ignore the message and shall not respond.

4518 3) If any of the following criteria are met, then the CRUDN request message shall be silently
4519 discarded, and a response shall not be sent:

4520 – The operation of the CRUDN request is not the non-confirmable UPDATE operation on a
4521 multicast address.

4522 – The UPDATE request message is not intended for the Server – see clause 16.3.2 for further
4523 details.

4524 – There is no Resource hosted on the Server at the local URI path in the UPDATE request
4525 message.

4526 4) The Server shall process the UPDATE request message (encapsulated in the OSCORE request
4527 message). The Server shall treat the value of "subjectuuiid" in the credential entry which
4528 contains the OSCORE Security Context used to verify and decrypt the OSCORE request
4529 message in Step 2 as Client's Device UUID for access control processing. The Server shall
4530 treat the connection type as "auth-crypt" for access control processing. The Server shall not
4531 send a response.

4532 The mechanism outlined is for sending a message in a send and forget mode, i.e. sending a
4533 message to a group of Servers, where each Server does not acknowledge the receipt. Since
4534 multicast requests are typically unreliable (e.g. non-confirmable messages) the best practice is to
4535 send the same UPDATE request more than once in a short time frame. This is sufficient since the
4536 multicast communication has in most cases a unicast variant for the same UPDATE request.

4537 Notification (see clause 11.3 of ISO/IEC 30118-1) may be used to verify if the actual UPDATE
4538 request has been executed. If a subset of the group of Servers did not receive the UPDATE request,
4539 unicast (confirmable) messages can be used to complete the desired overall state of the system.

4540 **16.3.4 Creating OSCORE Security Context for Simple Secure Multicast**

4541 The present clause specifies how

- 4542 – a Client of an SSM Group creates a OSCORE Security Context from a SSM Client Context
4543 provisioned to a credential entry of the Client.
- 4544 – a Server of an SSM Group creates a OSCORE Security Context from a SSM Server Context
4545 provisioned to a credential entry of the Server.

4546 All configurable parameters of the OSCORE Security Context are either:

- 4547 – fixed to the OSCORE-specified default value, or
- 4548 – directly provisioned by an OBT to a credential entry of the "/oic/sec/cred" Resource.

4549 The following parameters of the OSCORE Security Context used for encryption by the Client of an
4550 SSM Group shall be set to the default values defined in clause 3.2 of IETF RFC 8613 (this
4551 information is not configured by the OBT):

- 4552 – AEAD Algorithm,
- 4553 – HKDF,
- 4554 – Master Salt,
- 4555 – ID Context.

4556 The following parameters of the OSCORE Security Context parameters used for encryption by the
4557 Client of an SSM Group are derived from the SSM Client Context provisioned to a credential entry
4558 of "/oic/sec/cred" of the Client:

- 4559 – The "subjectuuid" may be any schema compliant value. This Property serves no purpose when
4560 used in an SSM Client Context.
- 4561 – The credential entry is identified as an SSM Client Context when the "credtype" matches the
4562 value specified for a SSM Client Context in Table 22, clause 13.3.1.
- 4563 – The "privatedata" Property contains a 256-bit value which shall be used as the OSCORE Master
4564 Secret.
- 4565 – The OSCORE Configuration parameters ("oscore") Property is present, and includes the
4566 following Properties:
 - 4567 – The "senderid" Property shall be used as the OSCORE Sender ID of the OSCORE Security
4568 Context. The "recipientid" Property value shall be interpreted as the hexadecimal
4569 representation of a 56-bit value. The first byte of this value is expected to have the value
4570 assigned in Table Y for Simple Secure Multicast.
 - 4571 – The "desc" Property is not used in security processing. This Property is described in clause
4572 9.3.9.

4573 On the Device shutting down, for each such credential entry, the Device shall write the value of
4574 corresponding OSCORE Sender Sequence Number as "ssn" Property to non-volatile memory. In
4575 event of a crash, devices should apply Appendix B.1.1 of IETF RFC 8613.

4576 The following parameters of the OSCORE Security Context used by a Server of an SSM Group for
4577 verification and decryption shall be set to the default values defined in clause 3.2 of IETF RFC
4578 8613 (this information is not configured by the OBT):

- 4579 – AEAD Algorithm,
- 4580 – HKDF,

- 4581 – Replay Window,
- 4582 – Master Salt,
- 4583 – ID Context.

4584 The following parameters of the OSCORE Security Context parameters used by a Server of an
4585 SSM Group for verification and decryption are derived from the SSM Server Context provisioned
4586 to a credential entry of "/oic/sec/cred" of the Server:

- 4587 – The "subjectuuid" is used for access control processing as described in Step 4 of clause 16.3.3.
- 4588 – The credential entry is identified as an SSM Server Context when the "credtype" matches to
4589 the value specified for an SSM Server Context in Table 22, clause 13.3.1.
- 4590 – The "privatedata" Property of the credential entry contains a 256-bit value which shall be used
4591 as the OSCORE Master Secret.
- 4592 – The OSCORE Configuration parameters ("oscore") Property is present, and includes the
4593 following Properties:
- 4594 – The "recipientid" Property shall be used as the OSCORE Recipient ID of the OSCORE Security
4595 Context. The "recipientid" Property value shall be interpreted as the hexadecimal representation
4596 of a 56-bit value. The first byte of this value is expected to have the value assigned in Table Y
4597 for Simple Secure Multicast.
- 4598 – The "desc" Property is not used in security processing. This Property is described in clause
4599 9.3.9.

4600 A.1 Example OCF ACL Resource

4601 Figure A-1 shows how an "/oic/sec/acl2" Resource could be configured to enforce an example
4602 access policy on the Server.

```
4603 {
4604     "aclist2": [
4605         {
4606             // Subject with ID ...01 should access two named Resources with access mode "CRUDN" (Create, Retrieve, Update,
4607             Delete and Notify)
4608             "subject": {"uuid": "XXXX-...-XX01"},
4609             "resources": [
4610                 {"href": "/oic/sh/light/1"},
4611                 {"href": "/oic/sh/temp/0"}
4612             ],
4613             "permission": 31, // 31 dec = 0b0001 1111 which maps to ---N DURC
4614             "validity": [
4615                 // The period starting at 18:00:00 UTC, on January 1, 2015 and
4616                 // ending at 07:00:00 UTC on January 2, 2015
4617                 "period": ["20150101T180000Z/20150102T070000Z"],
4618                 // Repeats the {period} every week until the last day of Jan. 2015.
4619                 "recurrence": ["RRULE:FREQ=WEEKLY;UNTIL=20150131T070000Z"]
4620             ],
4621             "aceid": 1
4622         }
4623     ],
4624     // An ACL provisioning and management service should be identified as
4625     // the resource owner
```



```
4626     "owneruuid": "0685B960-736F-46F7-BEC0-9E6CBD61ADC1"  
4627 }  
4628
```

Figure A-1 – Example "/oic/sec/acl2" Resource

Annex B
(Informative)
Execution Environment Security Profiles

Given that IoT verticals and Devices will not be of uniform capabilities, a one-size-fits all security robustness requirements meeting all IOT applications and services will not serve the needs of OCF, and security profiles of varying degree of robustness (trustworthiness), cost and complexity have to be defined. To address a large ecosystem of vendors, the profiles can only be defined as requirements and the exact solutions meeting those requirements are specific to the vendors' open or proprietary implementations, and thus in most part outside scope of this document.

To align with the rest of OCF documents, where Device classifications follow IETF RFC 7228 (Terminology for constrained node networks) methodology, we limit the number of security profiles to a maximum of 3 (see Table B.1). However, our understanding is OCF capabilities criteria for each of 3 classes will be more fit to the current IoT chip market than that of IETF.

Given the extremely low level of resources at class 0, our expectation is that class 0 Devices are either capable of no security functionality or easily breakable security that depend on environmental (e.g. availability of human) factors to perform security functions. This means the class 0 will not be equipped with an SEE.

Table B.1 – OCF Security Profile

Platform class	SEE	Robustness level
0	No	N/A
1	Yes	Low
2	Yes	High

NOTE This analysis acknowledges that these Platform classifications do not take into consideration of possibility of security co-processor or other hardware security capability that augments classification criteria (namely CPU speed, memory, storage).

Annex C (normative) Resource Type definitions

C.1 List of Resource Type definitions

Table C.1 contains the list of defined security Resources in this document.

Table C.1 – Alphabetized list of security Resources

Friendly Name (informative)	Resource Type (rt)	Clause
Access Control List 2	oic.r.acl2	C.2
Auditable Event List	oic.r.ael	C.9
Certificate Signing Request	oic.r.csr	C.4
Credential	oic.r.cred	C.3
Device owner transfer method	oic.r.doxm	C.5
Device Provisioning Status	oic.r.pstat	C.6
Roles	oic.r.roles	C.7
Security Profile	oic.r.sp	C.8
Security Domain Information	oic.r.sdi	C.10

C.2 Access Control List-2

C.2.1 Introduction

This Resource specifies the local access control list.

When used without query parameters, all the ACE entries are returned.

When used with a query parameter, only the ACEs matching the specified parameter are returned.

C.2.2 Well-known URI

/oic/sec/acl2

C.2.3 Resource type

The Resource Type is defined as: "oic.r.acl2".

C.2.4 OpenAPI 2.0 definition

```
{
  "swagger": "2.0",
  "info": {
    "title": "Access Control List-2",
    "version": "2019-01-11",
    "license": {
      "name": "OCF Data Model License",
      "url":
"https://github.com/openconnectivityfoundation/core/blob/e28a9e0a92e17042ba3e83661e4c0fbce8bdc4ba/LI
CENSE.md",
      "x-copyright": "copyright 2016-2017, 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": {
```

```

4687     "/oic/sec/acl2" : {
4688         "get": {
4689             "description": "This Resource specifies the local access control list.\nWhen used without
4690 query parameters, all the ACE entries are returned.\nWhen used with a query parameter, only the ACEs
4691 matching the specified\nparameter are returned.\n",
4692             "parameters": [
4693                 {"$ref": "#/parameters/interface"},
4694                 {"$ref": "#/parameters/ace-filtered"}
4695             ],
4696             "responses": {
4697                 "200": {
4698                     "description": "",
4699                     "x-example":
4700                     {
4701                         "rt" : ["oic.r.acl2"],
4702                         "aclist2": [
4703                             {
4704                                 "aceid": 1,
4705                                 "subject": {
4706                                     "authority": "484b8a51-cb23-46c0-a5f1-b4aebef50ebe",
4707                                     "role": "SOME_STRING"
4708                                 },
4709                                 "resources": [
4710                                     {
4711                                         "href": "/light"
4712                                     },
4713                                     {
4714                                         "href": "/door"
4715                                     }
4716                                 ],
4717                                 "permission": 24
4718                             },
4719                             {
4720                                 "aceid": 2,
4721                                 "subject": {
4722                                     "uuid": "e61c3e6b-9c54-4b81-8ce5-f9039c1d04d9"
4723                                 },
4724                                 "resources": [
4725                                     {
4726                                         "href": "/light"
4727                                     },
4728                                     {
4729                                         "href": "/door"
4730                                     }
4731                                 ],
4732                                 "permission": 24
4733                             },
4734                             {
4735                                 "aceid": 3,
4736                                 "subject": {"conntype": "anon-clear"},
4737                                 "resources": [
4738                                     {
4739                                         "href": "/light"
4740                                     },
4741                                     {
4742                                         "href": "/door"
4743                                     }
4744                                 ],
4745                                 "permission": 16,
4746                                 "validity": [
4747                                     {
4748                                         "period": "20160101T180000Z/20170102T070000Z",
4749                                         "recurrence": [ "DSTART:XXXXX",
4750 "RRULE:FREQ=DAILY;UNTIL=20180131T140000Z;BYMONTH=1" ]
4751                                     },
4752                                     {
4753                                         "period": "20160101T180000Z/PT5H30M",
4754                                         "recurrence": [ "RRULE:FREQ=DAILY;UNTIL=20180131T140000Z;BYMONTH=1" ]
4755                                     }
4756                                 ]
4757                             }
4758                         ]
4759                     }
4760             }
4761         }
4762     },

```

```

4759         "rowneruuid": "de305d54-75b4-431b-adb2-eb6b9e546014"
4760     },
4761     "schema": { "$ref": "#/definitions/Acl2" }
4762 },
4763 "400": {
4764     "description": "The request is invalid."
4765 }
4766 },
4767 },
4768 "post": {
4769     "description": "Updates the ACL Resource with the provided ACEs.\n\nACEs provided in the
4770 update with aceids not currently in the ACL\nResource are added.\n\nACEs provided in the update with
4771 aceid(s) already in the ACL completely\nreplace the ACE(s) in the ACL Resource.\n\nACEs provided in
4772 the update without aceid properties are added and\nassigned unique aceids in the ACL Resource.\n",
4773     "parameters": [
4774         { "$ref": "#/parameters/interface" },
4775         { "$ref": "#/parameters/ace-filtered" },
4776     ],
4777     {
4778         "name": "body",
4779         "in": "body",
4780         "required": true,
4781         "schema": { "$ref": "#/definitions/Acl2-Update" },
4782         "x-example":
4783         {
4784             "aclist2": [
4785                 {
4786                     "aceid": 1,
4787                     "subject": {
4788                         "authority": "484b8a51-cb23-46c0-a5f1-b4aebef50ebe",
4789                         "role": "SOME_STRING"
4790                     },
4791                     "resources": [
4792                         {
4793                             "href": "/light"
4794                         },
4795                         {
4796                             "href": "/door"
4797                         }
4798                     ],
4799                     "permission": 24
4800                 },
4801                 {
4802                     "aceid": 3,
4803                     "subject": {
4804                         "uuid": "e61c3e6b-9c54-4b81-8ce5-f9039c1d04d9"
4805                     },
4806                     "resources": [
4807                         {
4808                             "href": "/light"
4809                         },
4810                         {
4811                             "href": "/door"
4812                         }
4813                     ],
4814                     "permission": 24
4815                 }
4816             ],
4817             "rowneruuid": "e61c3e6b-9c54-4b81-8ce5-f9039c1d04d9"
4818         }
4819     },
4820     "responses": {
4821         "400": {
4822             "description": "The request is invalid."
4823         },
4824         "201": {
4825             "description": "The ACL entry is created."
4826         },
4827         "204": {
4828             "description": "The ACL entry is updated."
4829         }
4830     }
4831 }

```

```

4831     },
4832     "delete": {
4833         "description": "Deletes ACL entries.\nWhen DELETE is used without query parameters, all the
4834         ACE entries are deleted.\nWhen DELETE is used with a query parameter, only the ACEs matching
4835         the\nspecified parameter are deleted.\n",
4836         "parameters": [
4837             {"$ref": "#/parameters/interface"},
4838             {"$ref": "#/parameters/ace-filtered"}
4839         ],
4840         "responses": {
4841             "200": {
4842                 "description": "The matching ACEs or the entire ACL Resource has been successfully
4843         deleted."
4844             },
4845             "400": {
4846                 "description": "The request is invalid."
4847             }
4848         }
4849     }
4850 },
4851 },
4852 "parameters": {
4853     "interface": {
4854         "in": "query",
4855         "name": "if",
4856         "type": "string",
4857         "enum": [ "oic.if.rw", "oic.if.baseline" ]
4858     },
4859     "ace-filtered": {
4860         "in": "query",
4861         "name": "aceid",
4862         "required": false,
4863         "type": "integer",
4864         "description": "Only applies to the ACE with the specified aceid.",
4865         "x-example": 2112
4866     }
4867 },
4868 "definitions": {
4869     "Acl2": {
4870         "properties": {
4871             "owneruuiid": {
4872                 "description": "The value identifies the unique Resource owner\nFormat pattern according
4873         to IETF RFC 4122.",
4874                 "pattern": "^[a-fA-F0-9]{8}-[a-fA-F0-9]{4}-[a-fA-F0-9]{4}-[a-fA-F0-9]{4}-[a-fA-F0-
4875         9]{12}$",
4876                 "type": "string"
4877             },
4878             "rt": {
4879                 "description": "Resource Type of the Resource.",
4880                 "items": {
4881                     "maxLength": 64,
4882                     "type": "string",
4883                     "enum": [ "oic.r.acl2" ]
4884                 },
4885                 "minItems": 1,
4886                 "readOnly": true,
4887                 "type": "array"
4888             },
4889             "aclist2": {
4890                 "description": "Access Control Entries in the ACL Resource.",
4891                 "items": {
4892                     "properties": {
4893                         "aceid": {
4894                             "description": "An identifier for the ACE that is unique within the ACL. In cases
4895         where it isn't supplied in an update, the Server will add the ACE and assign it a unique value.",
4896                             "minimum": 1,
4897                             "type": "integer"
4898                         },
4899                         "permission": {
4900                             "description": "Bitmask encoding of CRUDN permission\nThe encoded bitmask indicating
4901         permissions.",
4902                             "x-detail-desc": [

```

```

4903         "0 - No permissions",
4904         "1 - Create permission is granted",
4905         "2 - Read, observe, discover permission is granted",
4906         "4 - Write, update permission is granted",
4907         "8 - Delete permission is granted",
4908         "16 - Notify permission is granted"
4909     ],
4910     "maximum": 31,
4911     "minimum": 0,
4912     "type": "integer"
4913 },
4914 "resources": {
4915     "description": "References the application's Resources to which a security policy
4916 applies.",
4917     "items": {
4918         "description": "Each Resource must have at least one of these properties set.",
4919         "properties": {
4920             "href": {
4921                 "description": "When present, the ACE only applies when the href matches\nThis
4922 is the target URI, it can be specified as a Relative Reference or fully-qualified URI.",
4923                 "format": "uri",
4924                 "maxLength": 256,
4925                 "type": "string"
4926             },
4927             "wc": {
4928                 "description": "A wildcard matching policy.",
4929                 "pattern": "^[~+]*$",
4930                 "type": "string"
4931             }
4932         },
4933         "type": "object"
4934     },
4935     "type": "array"
4936 },
4937 "subject": {
4938     "anyOf": [
4939         {
4940             "description": "This is the Device identifier.",
4941             "properties": {
4942                 "uuid": {
4943                     "description": "A UUID Device ID\nFormat pattern according to IETF RFC
4944 4122.",
4945                     "pattern": "^[a-fA-F0-9]{8}-[a-fA-F0-9]{4}-[a-fA-F0-9]{4}-[a-fA-F0-9]{4}-[a-
4946 fA-F0-9]{12}$",
4947                     "type": "string"
4948                 }
4949             },
4950             "required": [
4951                 "uuid"
4952             ],
4953             "type": "object"
4954         },
4955         {
4956             "description": "Security role specified as an <Authority> & <Rolename>. A NULL
4957 <Authority> refers to the local entity or Device.",
4958             "properties": {
4959                 "authority": {
4960                     "description": "The Authority component of the entity being identified. A
4961 NULL <Authority> refers to the local entity or Device.",
4962                     "type": "string"
4963                 },
4964                 "role": {
4965                     "description": "The ID of the role being identified.",
4966                     "type": "string"
4967                 }
4968             },
4969             "required": [
4970                 "role"
4971             ],
4972             "type": "object"
4973         }
4974     ]

```

```

4975         "properties": {
4976             "conntype": {
4977                 "description": "This property allows an ACE to be matched based on the
4978 connection or message type.",
4979                 "x-detail-desc": [
4980                     "auth-crypt - ACE applies if the Client is authenticated and the data
4981 channel or message is encrypted and integrity protected",
4982                     "anon-clear - ACE applies if the Client is not authenticated and the data
4983 channel or message is not encrypted but may be integrity protected"
4984                 ],
4985                 "enum": [
4986                     "auth-crypt",
4987                     "anon-clear"
4988                 ],
4989                 "type": "string"
4990             }
4991         },
4992         "required": [
4993             "conntype"
4994         ],
4995         "type": "object"
4996     }
4997 ]
4998 },
4999 "validity": {
5000     "description": "validity is an array of time-pattern objects.",
5001     "items": {
5002         "description": "The time-pattern contains a period and recurrence expressed in
5003 RFC5545 syntax.",
5004         "properties": {
5005             "period": {
5006                 "description": "String represents a period using the RFC5545 Period.",
5007                 "type": "string"
5008             },
5009             "recurrence": {
5010                 "description": "String array represents a recurrence rule using the RFC5545
5011 Recurrence.",
5012                 "items": {
5013                     "type": "string"
5014                 },
5015                 "type": "array"
5016             }
5017         },
5018         "required": [
5019             "period"
5020         ],
5021         "type": "object"
5022     },
5023     "type": "array"
5024 }
5025 },
5026 "required": [
5027     "aceid",
5028     "resources",
5029     "permission",
5030     "subject"
5031 ],
5032 "type": "object"
5033 },
5034 "type": "array"
5035 },
5036 "n": {
5037     "$ref":
5038 "https://openconnectivityfoundation.github.io/core/schemas/oic.common.properties.core-
5039 schema.json#/definitions/n"
5040 },
5041 "id": {
5042     "$ref":
5043 "https://openconnectivityfoundation.github.io/core/schemas/oic.common.properties.core-
5044 schema.json#/definitions/id"
5045 },
5046 "if" : {

```



```

5047         "description": "The interface set supported by this Resource.",
5048         "items": {
5049             "enum": [ "oic.if.rw", "oic.if.baseline" ],
5050             "type": "string"
5051         },
5052         "minItems": 1,
5053         "readOnly": true,
5054         "type": "array"
5055     }
5056 },
5057 "type" : "object",
5058 "required": ["acl2", "owneruid"]
5059 },
5060 "Acl2-Update" : {
5061     "properties": {
5062         "owneruid" : {
5063             "description": "The value identifies the unique Resource owner\n Format pattern according
5064 to IETF RFC 4122.",
5065             "pattern": "^[a-fA-F0-9]{8}-[a-fA-F0-9]{4}-[a-fA-F0-9]{4}-[a-fA-F0-9]{4}-[a-fA-F0-
5066 9]{12}$",
5067             "type": "string"
5068         },
5069         "acl2" : {
5070             "description": "Access Control Entries in the ACL Resource.",
5071             "items": {
5072                 "properties": {
5073                     "aceid": {
5074                         "description": "An identifier for the ACE that is unique within the ACL. In cases
5075 where it isn't supplied in an update, the Server will add the ACE and assign it a unique value.",
5076                         "minimum": 1,
5077                         "type": "integer"
5078                     },
5079                     "permission": {
5080                         "description": "Bitmask encoding of CRUDN permission\nThe encoded bitmask indicating
5081 permissions.",
5082                         "x-detail-desc": [
5083                             "0 - No permissions",
5084                             "1 - Create permission is granted",
5085                             "2 - Read, observe, discover permission is granted",
5086                             "4 - Write, update permission is granted",
5087                             "8 - Delete permission is granted",
5088                             "16 - Notify permission is granted"
5089                         ],
5090                         "maximum": 31,
5091                         "minimum": 0,
5092                         "type": "integer"
5093                     },
5094                     "resources": {
5095                         "description": "References the application's Resources to which a security policy
5096 applies.",
5097                         "items": {
5098                             "description": "Each Resource must have at least one of these properties set.",
5099                             "properties": {
5100                                 "href": {
5101                                     "description": "When present, the ACE only applies when the href matches\nThis
5102 is the target URI, it can be specified as a Relative Reference or fully-qualified URI.",
5103                                     "format": "uri",
5104                                     "maxLength": 256,
5105                                     "type": "string"
5106                                 },
5107                                 "wc": {
5108                                     "description": "A wildcard matching policy.",
5109                                     "x-detail-desc": [
5110                                         "+ - Matches all discoverable Resources",
5111                                         "- - Matches all non-discoverable Resources",
5112                                         "* - Matches all Resources"
5113                                     ],
5114                                     "enum": [
5115                                         "+",
5116                                         "-",
5117                                         "*"
5118                                     ]

```

```

5119         "type": "string"
5120     },
5121 },
5122     "type": "object"
5123 },
5124     "type": "array"
5125 },
5126 "subject": {
5127     "anyOf": [
5128         {
5129             "description": "This is the Device identifier.",
5130             "properties": {
5131                 "uuid": {
5132                     "description": "A UUID Device ID\n Format pattern according to IETF RFC
5133 4122.",
5134                     "pattern": "^[a-fA-F0-9]{8}-[a-fA-F0-9]{4}-[a-fA-F0-9]{4}-[a-fA-F0-9]{4}-[a-
5135 fA-F0-9]{12}$",
5136                     "type": "string"
5137                 }
5138             },
5139             "required": [
5140                 "uuid"
5141             ],
5142             "type": "object"
5143         },
5144         {
5145             "description": "Security role specified as an <Authority> & <Rolename>. A NULL
5146 <Authority> refers to the local entity or Device.",
5147             "properties": {
5148                 "authority": {
5149                     "description": "The Authority component of the entity being identified. A
5150 NULL <Authority> refers to the local entity or Device.",
5151                     "type": "string"
5152                 },
5153                 "role": {
5154                     "description": "The ID of the role being identified.",
5155                     "type": "string"
5156                 }
5157             },
5158             "required": [
5159                 "role"
5160             ],
5161             "type": "object"
5162         },
5163         {
5164             "properties": {
5165                 "conntype": {
5166                     "description": "This property allows an ACE to be matched based on the
5167 connection or message type.",
5168                     "x-detail-desc": [
5169                         "auth-crypt - ACE applies if the Client is authenticated and the data
5170 channel or message is encrypted and integrity protected",
5171                         "anon-clear - ACE applies if the Client is not authenticated and the data
5172 channel or message is not encrypted but may be integrity protected"
5173                     ],
5174                     "enum": [
5175                         "auth-crypt",
5176                         "anon-clear"
5177                     ],
5178                     "type": "string"
5179                 }
5180             },
5181             "required": [
5182                 "conntype"
5183             ],
5184             "type": "object"
5185         }
5186     ]
5187 },
5188 "validity": {
5189     "description": "validity is an array of time-pattern objects.",
5190     "items": {

```

```

5191         "description": "The time-pattern contains a period and recurrence expressed in
5192 RFC5545 syntax.",
5193         "properties": {
5194             "period": {
5195                 "description": "String represents a period using the RFC5545 Period.",
5196                 "type": "string"
5197             },
5198             "recurrence": {
5199                 "description": "String array represents a recurrence rule using the RFC5545
5200 Recurrence.",
5201                 "items": {
5202                     "type": "string"
5203                 },
5204                 "type": "array"
5205             }
5206         },
5207         "required": [
5208             "period"
5209         ],
5210         "type": "object"
5211     },
5212     "type": "array"
5213 }
5214 },
5215 "required": [
5216     "resources",
5217     "permission",
5218     "subject"
5219 ],
5220 "type": "object"
5221 },
5222 "type": "array"
5223 }
5224 },
5225 "type" : "object"
5226 }
5227 }
5228 }
5229

```

5230 C.2.5 Property definition

5231 Table C-1 defines the Properties that are part of the "oic.r.acl2" Resource Type.

5232 **Table C-1 – The Property definitions of the Resource with type "rt" = "oic.r.acl2".**

Property name	Value type	Mandatory	Access mode	Description
rowneruuid	string	Yes	Read Write	The value identifies the unique Resource owner Format pattern according to IETF RFC 4122.
rt	array: see schema	No	Read Only	Resource Type of the Resource.
aclist2	array: see schema	Yes	Read Write	Access Control Entries in the ACL Resource.
n	multiple types: see schema	No	Read Write	
id	multiple types: see schema	No	Read Write	
if	array: see schema	No	Read Only	The interface set supported by this Resource.

rowneruuid	string	No	Read Write	The value identifies the unique Resource owner Format pattern according to IETF RFC 4122.
aclist2	array: see schema	No	Read Write	Access Control Entries in the ACL Resource.

C.2.6 CRUDN behaviour

Table C-2 defines the CRUDN operations that are supported on the "oic.r.acl2" Resource Type.

Table C-2 – The CRUDN operations of the Resource with type "rt" = "oic.r.acl2".

Create	Read	Update	Delete	Notify
	get	post	delete	observe

C.3 Credential

C.3.1 Introduction

This Resource specifies credentials a Device may use to establish secure communication.

Retrieves the credential data.

When used without query parameters, all the credential entries are returned.

When used with a query parameter, only the credentials matching the specified parameter are returned.

Note that write-only credential data will not be returned.

C.3.2 Well-known URI

/oic/sec/cred

C.3.3 Resource type

The Resource Type is defined as: "oic.r.cred".

C.3.4 OpenAPI 2.0 definition

```
{
  "swagger": "2.0",
  "info": {
    "title": "Credential",
    "version": "2020-10-19",
    "license": {
      "name": "OCF Data Model License",
      "url":
"https://github.com/openconnectivityfoundation/core/blob/e28a9e0a92e17042ba3e83661e4c0fbce8bdc4ba/LI
CENSE.md",
      "x-copyright": "copyright 2016-2017, 2019, 2020 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/sec/cred": {
      "get": {
        "description": "This Resource specifies credentials a Device may use to establish secure
communication.\nRetrieves the credential data.\nWhen used without query parameters, all the
credential entries are returned.\nWhen used with a query parameter, only the credentials matching
```

```

5275 the specified\nparameter are returned.\n\nNote that write-only credential data will not be
5276 returned.\n",
5277     "parameters": [
5278         {"$ref": "#/parameters/interface"},
5279         {"$ref": "#/parameters/cred-filtered-credid"},
5280         {"$ref": "#/parameters/cred-filtered-subjectuuid"}
5281     ],
5282     "responses": {
5283         "200": {
5284             "description": "",
5285             "x-example": {
5286                 "rt": ["oic.r.cred"],
5287                 "creds": [
5288                     {
5289                         "credid": 55,
5290                         "subjectuuid": "e61c3e6b-9c54-4b81-8ce5-f9039c1d04d9",
5291                         "roleid": {
5292                             "authority": "484b8a51-cb23-46c0-a5f1-b4aebef50ebe",
5293                             "role": "SOME_STRING"
5294                         },
5295                         "credtype": 32,
5296                         "publicdata": {
5297                             "encoding": "oic.sec.encoding.pem",
5298                             "data": "PEM-ENCODED-VALUE"
5299                         },
5300                         "privatedata": {
5301                             "encoding": "oic.sec.encoding.raw",
5302                             "data": "RAW-ENCODED-VALUE",
5303                             "handle": 4
5304                         },
5305                         "optionaldata": {
5306                             "revstat": false,
5307                             "encoding": "oic.sec.encoding.pem",
5308                             "data": "PEM-ENCODED-VALUE"
5309                         },
5310                         "period": "20160101T180000Z/20170102T070000Z",
5311                         "crms": [ "oic.sec.crm.pk10" ]
5312                     },
5313                     {
5314                         "credid": 56,
5315                         "subjectuuid": "e61c3e6b-9c54-4b81-8ce5-f9039c1d04d9",
5316                         "roleid": {
5317                             "authority": "484b8a51-cb23-46c0-a5f1-b4aebef50ebe",
5318                             "role": "SOME_STRING"
5319                         },
5320                         "credtype": 1,
5321                         "publicdata": {
5322                             "encoding": "oic.sec.encoding.pem",
5323                             "data": "PEM-ENCODED-VALUE"
5324                         },
5325                         "privatedata": {
5326                             "encoding": "oic.sec.encoding.base64",
5327                             "data": "BASE-64-ENCODED-VALUE",
5328                             "handle": 4
5329                         },
5330                         "optionaldata": {
5331                             "revstat": false,
5332                             "encoding": "oic.sec.encoding.pem",
5333                             "data": "PEM-ENCODED-VALUE"
5334                         },
5335                         "period": "20160101T180000Z/20170102T070000Z",
5336                         "crms": [ "oic.sec.crm.pk10" ]
5337                     }
5338                 ],
5339                 "owneruuid": "e61c3e6b-9c54-4b81-8ce5-f9039c1d04d9"
5340             },
5341             "schema": { "$ref": "#/definitions/Cred" }
5342         },
5343         "400": {
5344             "description": "The request is invalid."
5345         }
5346     }

```

```

5347     }
5348   },
5349   "post": {
5350     "description": "Updates the credential Resource with the provided
5351 credentials.\n\nCredentials provided in the update with credid(s) not currently in the\ncredential
5352 Resource are added.\n\nCredentials provided in the update with credid(s) already in the\ncredential
5353 Resource completely replace the creds in the credential\nResource.\n\nCredentials provided in the
5354 update without credid(s) properties are\nadded and assigned unique credid(s) in the credential
5355 Resource.\n",
5356     "parameters": [
5357       { "$ref": "#/parameters/interface" },
5358       {
5359         "name": "body",
5360         "in": "body",
5361         "required": true,
5362         "schema": { "$ref": "#/definitions/Cred-Update" },
5363         "x-example":
5364           {
5365             "creds": [
5366               {
5367                 "credid": 55,
5368                 "subjectuuid": "e61c3e6b-9c54-4b81-8ce5-f9039c1d04d9",
5369                 "roleid": {
5370                   "authority": "484b8a51-cb23-46c0-a5f1-b4aebef50ebe",
5371                   "role": "SOME_STRING"
5372                 },
5373                 "credtype": 32,
5374                 "publicdata": {
5375                   "encoding": "oic.sec.encoding.pem",
5376                   "data": "PEM-ENCODED-VALUE"
5377                 },
5378                 "privatedata": {
5379                   "encoding": "oic.sec.encoding.raw",
5380                   "data": "RAW-ENCODED-VALUE",
5381                   "handle": 4
5382                 },
5383                 "optionaldata": {
5384                   "revstat": false,
5385                   "encoding": "oic.sec.encoding.pem",
5386                   "data": "PEM-ENCODED-VALUE"
5387                 },
5388                 "period": "20160101T180000Z/20170102T070000Z",
5389                 "crms": [ "oic.sec.crm.pk10" ]
5390               },
5391               {
5392                 "credid": 56,
5393                 "subjectuuid": "e61c3e6b-9c54-4b81-8ce5-f9039c1d04d9",
5394                 "roleid": {
5395                   "authority": "484b8a51-cb23-46c0-a5f1-b4aebef50ebe",
5396                   "role": "SOME_STRING"
5397                 },
5398                 "credtype": 1,
5399                 "publicdata": {
5400                   "encoding": "oic.sec.encoding.pem",
5401                   "data": "PEM-ENCODED-VALUE"
5402                 },
5403                 "privatedata": {
5404                   "encoding": "oic.sec.encoding.base64",
5405                   "data": "BASE-64-ENCODED-VALUE",
5406                   "handle": 4
5407                 },
5408                 "optionaldata": {
5409                   "revstat": false,
5410                   "encoding": "oic.sec.encoding.pem",
5411                   "data": "PEM-ENCODED-VALUE"
5412                 },
5413                 "period": "20160101T180000Z/20170102T070000Z",
5414                 "crms": [ "oic.sec.crm.pk10" ]
5415               }
5416             ],
5417             "rowneruuid": "e61c3e6b-9c54-4b81-8ce5-f9039c1d04d9"
5418           }
5419     ]
5420   }

```

```

5419     }
5420   ],
5421   "responses": {
5422     "400": {
5423       "description": "The request is invalid."
5424     },
5425     "201": {
5426       "description": "The credential entry is created."
5427     },
5428     "204": {
5429       "description": "The credential entry is updated."
5430     }
5431   }
5432 },
5433 "delete": {
5434   "description": "Deletes credential entries.\nWhen DELETE is used without query parameters,
5435 all the cred entries are deleted.\nWhen DELETE is used with a query parameter, only the entries
5436 matching\nthe query parameter are deleted.\n",
5437   "parameters": [
5438     {"$ref": "#/parameters/interface"},
5439     {"$ref": "#/parameters/cred-filtered-credid"},
5440     {"$ref": "#/parameters/cred-filtered-subjectuuid"}
5441   ],
5442   "responses": {
5443     "400": {
5444       "description": "The request is invalid."
5445     },
5446     "204": {
5447       "description": "The specific credential(s) or the the entire credential Resource has
5448 been successfully deleted."
5449     }
5450   }
5451 }
5452 },
5453 },
5454 "parameters": {
5455   "interface" : {
5456     "in" : "query",
5457     "name" : "if",
5458     "type" : "string",
5459     "enum" : [ "oic.if.rw", "oic.if.baseline" ]
5460   },
5461   "cred-filtered-credid": {
5462     "in": "query",
5463     "name": "credid",
5464     "required": false,
5465     "type": "integer",
5466     "description": "Only applies to the credential with the specified credid.",
5467     "x-example": 2112
5468   },
5469   "cred-filtered-subjectuuid": {
5470     "in": "query",
5471     "name": "subjectuuid",
5472     "required": false,
5473     "type": "string",
5474     "description": "Only applies to credentials with the specified subject UUID.",
5475     "x-example": "e61c3e6b-9c54-4b81-8ce5-f9039c1d04d9"
5476   }
5477 },
5478 "definitions": {
5479   "Cred": {
5480     "properties": {
5481       "rowneruuid": {
5482         "description": "Format pattern according to IETF RFC 4122.",
5483         "pattern": "^[a-fA-F0-9]{8}-[a-fA-F0-9]{4}-[a-fA-F0-9]{4}-[a-fA-F0-9]{4}-[a-fA-F0-9]{12}$",
5484         "type": "string"
5485       },
5486       "rt": {
5487         "description": "Resource Type of the Resource.",
5488         "items": {
5489           "maxLength": 64,

```

```

5491         "type": "string",
5492         "enum": ["oic.r.cred"]
5493     },
5494     "minItems": 1,
5495     "readOnly": true,
5496     "type": "array",
5497     "uniqueItems": true
5498 },
5499 "n": {
5500     "$ref":
5501 "https://openconnectivityfoundation.github.io/core/schemas/oic.common.properties.core-
5502 schema.json#/definitions/n"
5503 },
5504 "id": {
5505     "$ref":
5506 "https://openconnectivityfoundation.github.io/core/schemas/oic.common.properties.core-
5507 schema.json#/definitions/id"
5508 },
5509 "creds": {
5510     "description": "List of credentials available at this Resource.",
5511     "items": {
5512         "properties": {
5513             "credid": {
5514                 "description": "Local reference to a credential Resource.",
5515                 "type": "integer"
5516             },
5517             "credtype": {
5518                 "description": "Representation of this credential's type\nCredential Types - Cred
5519 type encoded as a bitmask.0 - Empty credential used for testing\n1 - Symmetric pair-wise key\n2 -
5520 Symmetric group key\n4 - Asymmetric signing key\n8 - Asymmetric signing key with certificate\n16 -
5521 PIN or password\n32 - Asymmetric encryption key. \n 128 - SSM Client\n256 - SSM Server",
5522                 "maximum": 256,
5523                 "minimum": 0,
5524                 "type": "integer"
5525             },
5526             "credusage": {
5527                 "description": "A string that provides hints about how/where the cred is used\nThe
5528 type of credusage.oic.sec.cred.trustca - Trust certificateoic.sec.cred.cert -
5529 Certificateoic.sec.cred.rolecert - Role Certificateoic.sec.cred.mfgtrustca - Manufacturer
5530 Certificate Trust Anchoroic.sec.cred.mfgcert - Manufacturer Certificate.",
5531                 "enum": [
5532                     "oic.sec.cred.trustca",
5533                     "oic.sec.cred.cert",
5534                     "oic.sec.cred.rolecert",
5535                     "oic.sec.cred.mfgtrustca",
5536                     "oic.sec.cred.mfgcert"
5537                 ],
5538                 "type": "string"
5539             },
5540             "crms": {
5541                 "description": "The refresh methods that may be used to update this credential.",
5542                 "items": {
5543                     "description": "Each enum represents a method by which the credentials are
5544 refreshed.oic.sec.crm.pro - Credentials refreshed by a provisioning serviceoic.sec.crm.rdp -
5545 Credentials refreshed by a key agreement protocol and random PINoic.sec.crm.psk - Credentials
5546 refreshed by a key agreement protocoloic.sec.crm.skdc - Credentials refreshed by a key distribution
5547 serviceoic.sec.crm.pk10 - Credentials refreshed by a PKCS#10 request to a CA.",
5548                     "enum": [
5549                         "oic.sec.crm.pro",
5550                         "oic.sec.crm.psk",
5551                         "oic.sec.crm.rdp",
5552                         "oic.sec.crm.skdc",
5553                         "oic.sec.crm.pk10"
5554                     ],
5555                     "type": "string"
5556                 },
5557                 "type": "array",
5558                 "uniqueItems": true
5559             },
5560             "optionaldata": {
5561                 "description": "Credential Type dependent. Credential revocation status
5562 information\n1, 2, 4, 32, 64: revocation status information\n8: Revocation information",

```



```

5563         "properties": {
5564             "data": {
5565                 "description": "The encoded structure.",
5566                 "type": "string"
5567             },
5568             "encoding": {
5569                 "description": "A string specifying the encoding format of the data contained in
5570 the optdata.",
5571                 "x-detail-desc": [
5572                     "oic.sec.encoding.pem - Encoding for PEM encoded certificate or chain."
5573                 ],
5574                 "enum": [
5575                     "oic.sec.encoding.pem"
5576                 ],
5577                 "type": "string"
5578             },
5579             "revstat": {
5580                 "description": "Revocation status flag - true = revoked.",
5581                 "type": "boolean"
5582             }
5583         },
5584         "required": [
5585             "revstat"
5586         ],
5587         "type": "object"
5588     },
5589     "period": {
5590         "description": "String with RFC5545 Period.",
5591         "type": "string"
5592     },
5593     "privatedata": {
5594         "description": "Private credential information\nnCredencial Resource non-public
5595 contents.",
5596         "properties": {
5597             "data": {
5598                 "description": "The encoded value.",
5599                 "maxLength": 3072,
5600                 "type": "string"
5601             },
5602             "encoding": {
5603                 "description": "A string specifying the encoding format of the data contained in
5604 the privdata.",
5605                 "x-detail-desc": [
5606                     "oic.sec.encoding.pem - Encoding for PEM encoded private key.",
5607                     "oic.sec.encoding.base64 - Encoding for Base64 encoded PSK.",
5608                     "oic.sec.encoding.handle - Data is contained in a storage sub-system
5609 referenced using a handle.",
5610                     "oic.sec.encoding.raw - Raw hex encoded data."
5611                 ],
5612                 "enum": [
5613                     "oic.sec.encoding.pem",
5614                     "oic.sec.encoding.base64",
5615                     "oic.sec.encoding.handle",
5616                     "oic.sec.encoding.raw"
5617                 ],
5618                 "type": "string"
5619             },
5620             "handle": {
5621                 "description": "Handle to a key storage Resource.",
5622                 "type": "integer"
5623             }
5624         },
5625         "required": [
5626             "encoding"
5627         ],
5628         "type": "object"
5629     },
5630     "publicdata": {
5631         "description": "Credential Type dependent. Public credential information\n1:2:
5632 ticket, public SKDC values\n4, 32: Public key value\n8: A chain of one or more certificate",
5633         "properties": {
5634             "data": {

```

```

5635         "description": "The encoded value.",
5636         "maxLength": 3072,
5637         "type": "string"
5638     },
5639     "encoding": {
5640         "description": "A string specifying the encoding format of the data contained in
the pubdata.",
5641         "x-detail-desc": [
5642             "oic.sec.encoding.pem - Encoding for PEM encoded certificate or chain."
5643         ],
5644         "enum": [
5645             "oic.sec.encoding.pem"
5646         ],
5647         "type": "string"
5648     },
5649     },
5650 },
5651 "type": "object"
5652 },
5653 "oscore": {
5654     "description": "Contains parameters for use with credentials intended for use with
5655 OSCORE. See type definition for \"oic.sec.oscoretype\"",
5656     "properties": {
5657         "senderid": {
5658             "description": "OSCORE Sender ID for this OSCORE Security Context",
5659             "type": "string"
5660         },
5661         "recipientid": {
5662             "description": "OSCORE Recipient ID for this OSCORE Security Context",
5663             "type": "string"
5664         },
5665         "ssn": {
5666             "description": "OSCORE Sender Sequence Number SSN1 being stored in nonvolatile
5667 memory to handle the loss of mutable security context parameters",
5668             "type": "integer",
5669             "readOnly": true
5670         },
5671         "desc": {
5672             "description": "Human readable description of the usage of this OSCORE Security
5673 Context",
5674             "type": "string"
5675         }
5676     },
5677     "type": "object"
5678 },
5679 "roleid": {
5680     "description": "The role this credential possesses\nSecurity role specified as an
5681 <Authority> & <Rolename>. A NULL <Authority> refers to the local entity or Device.",
5682     "properties": {
5683         "authority": {
5684             "description": "The Authority component of the entity being identified. A NULL
5685 <Authority> refers to the local entity or Device.",
5686             "type": "string"
5687         },
5688         "role": {
5689             "description": "The ID of the role being identified.",
5690             "type": "string"
5691         }
5692     },
5693     "required": [
5694         "role"
5695     ],
5696     "type": "object"
5697 },
5698 "subjectuuid": {
5699     "anyOf": [
5700         {
5701             "description": "The id of the Device, which the cred entry applies to or \"*\
5702 for wildcard identity.",
5703             "pattern": "^[\\*$]",
5704             "type": "string"
5705         },
5706     ]

```

```

5707         "description": "Format pattern according to IETF RFC 4122.",
5708         "pattern": "^[a-fA-F0-9]{8}-[a-fA-F0-9]{4}-[a-fA-F0-9]{4}-[a-fA-F0-9]{4}-[a-fA-
5709 F0-9]{12}$",
5710         "type": "string"
5711     }
5712 ]
5713 }
5714 },
5715 "type": "object"
5716 },
5717 "type": "array"
5718 },
5719 "if": {
5720     "description": "The interface set supported by this Resource.",
5721     "items": {
5722         "enum": [ "oic.if.rw", "oic.if.baseline" ],
5723         "type": "string"
5724     },
5725     "minItems": 2,
5726     "readOnly": true,
5727     "type": "array"
5728 }
5729 },
5730 "type": "object",
5731 "required": ["creds", "rowneruuid"]
5732 },
5733 "Cred-Update": {
5734     "properties": {
5735         "rowneruuid": {
5736             "description": "Format pattern according to IETF RFC 4122.",
5737             "pattern": "^[a-fA-F0-9]{8}-[a-fA-F0-9]{4}-[a-fA-F0-9]{4}-[a-fA-F0-
5738 9]{12}$",
5739             "type": "string"
5740         },
5741         "creds": {
5742             "description": "List of credentials available at this Resource.",
5743             "items": {
5744                 "properties": {
5745                     "credid": {
5746                         "description": "Local reference to a credential Resource.",
5747                         "type": "integer"
5748                     },
5749                     "credtype": {
5750                         "description": "Representation of this credential's type\nCredential Types - Cred
5751 type encoded as a bitmask.0 - Empty credential used for testing\n1 - Symmetric pair-wise key\n2 -
5752 Symmetric group key\n4 - Asymmetric signing key\n8 - Asymmetric signing key with certificate\n16 -
5753 PIN or password\n32 - Asymmetric encryption key. \n 128 - SSM Client\n256 - SSM Server",
5754                         "maximum": 256,
5755                         "minimum": 0,
5756                         "type": "integer"
5757                     },
5758                     "credusage": {
5759                         "description": "A string that provides hints about how/where the cred is used\nThe
5760 type of credusage.oic.sec.cred.trustca - Trust certificateoic.sec.cred.cert -
5761 Certificateoic.sec.cred.rolecert - Role Certificateoic.sec.cred.mfgtrustca - Manufacturer
5762 Certificate Trust Anchoroic.sec.cred.mfgcert - Manufacturer Certificate.",
5763                         "enum": [
5764                             "oic.sec.cred.trustca",
5765                             "oic.sec.cred.cert",
5766                             "oic.sec.cred.rolecert",
5767                             "oic.sec.cred.mfgtrustca",
5768                             "oic.sec.cred.mfgcert"
5769                         ],
5770                         "type": "string"
5771                     },
5772                     "crms": {
5773                         "description": "The refresh methods that may be used to update this credential.",
5774                         "items": {
5775                             "description": "Each enum represents a method by which the credentials are
5776 refreshed.oic.sec.crm.pro - Credentials refreshed by a provisioning serviceoic.sec.crm.rdp -
5777 Credentials refreshed by a key agreement protocol and random PINoic.sec.crm.psk - Credentials
5778 refreshed by a key agreement protocoloic.sec.crm.skdc - Credentials refreshed by a key distribution

```

```

5779 serviceoic.sec.crm.pk10 - Credentials refreshed by a PKCS#10 request to a CA.",
5780     "enum": [
5781         "oic.sec.crm.pro",
5782         "oic.sec.crm.psk",
5783         "oic.sec.crm.rdp",
5784         "oic.sec.crm.skdc",
5785         "oic.sec.crm.pk10"
5786     ],
5787     "type": "string"
5788 },
5789 "type": "array"
5790 },
5791 "optionaldata": {
5792     "description": "Credential Type dependent. Credential revocation status
5793 information\n1, 2, 4, 32, 64: revocation status information\n8: Revocation information",
5794     "properties": {
5795         "data": {
5796             "description": "The encoded structure.",
5797             "type": "string"
5798         },
5799         "encoding": {
5800             "description": "A string specifying the encoding format of the data contained in
5801 the optdata.",
5802             "x-detail-desc": [
5803                 "oic.sec.encoding.pem - Encoding for PEM encoded certificate or chain."
5804             ],
5805             "enum": [
5806                 "oic.sec.encoding.pem"
5807             ],
5808             "type": "string"
5809         },
5810         "revstat": {
5811             "description": "Revocation status flag - true = revoked.",
5812             "type": "boolean"
5813         }
5814     },
5815     "required": [
5816         "revstat"
5817     ],
5818     "type": "object"
5819 },
5820 "period": {
5821     "description": "String with RFC5545 Period.",
5822     "type": "string"
5823 },
5824 "privatedata": {
5825     "description": "Private credential information\nCredential Resource non-public
5826 contents.",
5827     "properties": {
5828         "data": {
5829             "description": "The encoded value.",
5830             "maxLength": 3072,
5831             "type": "string"
5832         },
5833         "encoding": {
5834             "description": "A string specifying the encoding format of the data contained in
5835 the privdata.",
5836             "x-detail-desc": [
5837                 "oic.sec.encoding.pem - Encoding for PEM encoded private key.",
5838                 "oic.sec.encoding.base64 - Encoding for Base64 encoded PSK.",
5839                 "oic.sec.encoding.handle - Data is contained in a storage sub-system
5840 referenced using a handle.",
5841                 "oic.sec.encoding.raw - Raw hex encoded data."
5842             ],
5843             "enum": [
5844                 "oic.sec.encoding.pem",
5845                 "oic.sec.encoding.base64",
5846                 "oic.sec.encoding.handle",
5847                 "oic.sec.encoding.raw"
5848             ],
5849             "type": "string"
5850         }
5851     },

```

```

5851         "handle": {
5852             "description": "Handle to a key storage Resource.",
5853             "type": "integer"
5854         },
5855     },
5856     "required": [
5857         "encoding"
5858     ],
5859     "type": "object"
5860 },
5861 "publicdata": {
5862     "description": "Credential Type dependent. Public credential information\n1:2:
5863 ticket, public SKDC values\n4, 32: Public key value\n8: A chain of one or more certificate",
5864     "properties": {
5865         "data": {
5866             "description": "The encoded value.",
5867             "maxLength": 3072,
5868             "type": "string"
5869         },
5870         "encoding": {
5871             "description": "A string specifying the encoding format of the data contained in
5872 the pubdata.",
5873             "x-detail-desc": [
5874                 "oic.sec.encoding.pem - Encoding for PEM encoded certificate or chain."
5875             ],
5876             "enum": [
5877                 "oic.sec.encoding.pem"
5878             ],
5879             "type": "string"
5880         }
5881     },
5882     "type": "object"
5883 },
5884 "oscore": {
5885     "description": "Contains parameters for use with credentials intended for use with
5886 OSCORE. See type definition for \"oic.sec.oscoretype\"",
5887     "properties": {
5888         "senderid": {
5889             "description": "OSCORE Sender ID for this OSCORE Security Context",
5890             "type": "string"
5891         },
5892         "recipientid": {
5893             "description": "OSCORE Recipient ID for this OSCORE Security Context",
5894             "type": "string"
5895         },
5896         "desc": {
5897             "description": "Human readable description of the usage of this OSCORE Security
5898 Context",
5899             "type": "string"
5900         }
5901     },
5902     "type": "object"
5903 },
5904 "roleid": {
5905     "description": "The role this credential possesses\nSecurity role specified as an
5906 <Authority> & <Rolename>. A NULL <Authority> refers to the local entity or Device.",
5907     "properties": {
5908         "authority": {
5909             "description": "The Authority component of the entity being identified. A NULL
5910 <Authority> refers to the local entity or Device.",
5911             "type": "string"
5912         },
5913         "role": {
5914             "description": "The ID of the role being identified.",
5915             "type": "string"
5916         }
5917     },
5918     "required": [
5919         "role"
5920     ],
5921     "type": "object"
5922 },

```

```

5923         "subjectuuid": {
5924             "anyOf": [
5925                 {
5926                     "description": "The id of the Device, which the cred entry applies to or \"*\
5927 for wildcard identity.",
5928                     "pattern": "^\\*$",
5929                     "type": "string"
5930                 },
5931                 {
5932                     "description": "Format pattern according to IETF RFC 4122.",
5933                     "pattern": "^[a-fA-F0-9]{8}-[a-fA-F0-9]{4}-[a-fA-F0-9]{4}-[a-fA-F0-9]{4}-[a-fA-
5934 F0-9]{12}$",
5935                     "type": "string"
5936                 }
5937             ]
5938         },
5939     },
5940     "type": "object"
5941 },
5942 "type": "array"
5943 },
5944 "if": {
5945     "description": "The interface set supported by this Resource.",
5946     "items": {
5947         "enum": [ "oic.if.rw", "oic.if.baseline" ],
5948         "type": "string"
5949     },
5950     "minItems": 1,
5951     "readOnly": true,
5952     "type": "array"
5953 },
5954 },
5955 "type": "object"
5956 }
5957 }
5958 }
5959

```

C.3.5 Property definition

Table C-3 defines the Properties that are part of the "oic.r.cred" Resource Type.

Table C-3 – The Property definitions of the Resource with type "rt" = "oic.r.cred".

Property name	Value type	Mandatory	Access mode	Description
rowneruuid	string	Yes	Read Write	Format pattern according to IETF RFC 4122.
rt	array: see schema	No	Read Only	Resource Type of the Resource.
n	multiple types: see schema	No	Read Write	
id	multiple types: see schema	No	Read Write	
creds	array: see schema	Yes	Read Write	List of credentials available at this Resource.
if	array: see schema	No	Read Only	The interface set supported by this Resource.
rowneruuid	string	No	Read Write	Format pattern according to IETF RFC 4122.

creds	array: see schema	No	Read Write	List of credentials available at this Resource.
if	array: see schema	No	Read Only	The interface set supported by this Resource.

C.3.6 CRUDN behaviour

Table C-4 defines the CRUDN operations that are supported on the "oic.r.cred" Resource Type.

Table C-4 – The CRUDN operations of the Resource with type "rt" = "oic.r.cred".

Create	Read	Update	Delete	Notify
	get	post	delete	observe

C.4 Certificate Signing Request

C.4.1 Introduction

This Resource specifies a Certificate Signing Request.

C.4.2 Well-known URI

/oic/sec/csr

C.4.3 Resource type

The Resource Type is defined as: "oic.r.csr".

C.4.4 OpenAPI 2.0 definition

```
{
  "swagger": "2.0",
  "info": {
    "title": "Certificate Signing Request",
    "version": "2015-08-19",
    "license": {
      "name": "OCF Data Model License",
      "url":
"https://github.com/openconnectivityfoundation/core/blob/e28a9e0a92e17042ba3e83661e4c0fbce8bdc4ba/LI
CENSE.md",
      "x-copyright": "copyright 2016-2017, 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/sec/csr" : {
      "get": {
        "description": "This Resource specifies a Certificate Signing Request.\n",
        "parameters": [
          {"$ref": "#/parameters/interface"}
        ],
        "responses": {
          "200": {
            "description": "",
            "x-example":
{
  "rt": ["oic.r.csr"],
  "encoding" : "oic.sec.encoding.pem",
  "csr": "PEMENCODEDCSR"
},
            "schema": { "$ref": "#/definitions/Csr" }
          }
        }
      }
    }
  }
}
```

```

6010         },
6011         "404": {
6012             "description": "The Device does not support certificates and generating CSRs."
6013         },
6014         "503": {
6015             "description": "The Device is not yet ready to return a response. Try again later."
6016         }
6017     }
6018 }
6019 },
6020 },
6021 "parameters": {
6022     "interface" : {
6023         "in" : "query",
6024         "name" : "if",
6025         "type" : "string",
6026         "enum" : [ "oic.if.rw", "oic.if.baseline" ]
6027     }
6028 },
6029 "definitions": {
6030     "Csr" : {
6031         "properties": {
6032             "rt" : {
6033                 "description": "Resource Type of the Resource.",
6034                 "items": {
6035                     "maxLength": 64,
6036                     "type": "string",
6037                     "enum": ["oic.r.csr"]
6038                 },
6039                 "minItems": 1,
6040                 "readOnly": true,
6041                 "type": "array"
6042             },
6043             "encoding": {
6044                 "description": "A string specifying the encoding format of the data contained in CSR.",
6045                 "x-detail-desc": [
6046                     "oic.sec.encoding.pem - Encoding for PEM encoded CSR."
6047                 ],
6048                 "enum": [
6049                     "oic.sec.encoding.pem"
6050                 ],
6051                 "readOnly": true,
6052                 "type": "string"
6053             },
6054             "n": {
6055                 "$ref":
6056                 "https://openconnectivityfoundation.github.io/core/schemas/oic.common.properties.core-
6057                 schema.json#/definitions/n"
6058             },
6059             "id": {
6060                 "$ref":
6061                 "https://openconnectivityfoundation.github.io/core/schemas/oic.common.properties.core-
6062                 schema.json#/definitions/id"
6063             },
6064             "csr": {
6065                 "description": "Signed CSR in ASN.1 in the encoding specified by the encoding property.",
6066                 "maxLength": 3072,
6067                 "readOnly": true,
6068                 "type": "string"
6069             },
6070             "if": {
6071                 "description": "The interface set supported by this Resource.",
6072                 "items": {
6073                     "enum": [ "oic.if.rw", "oic.if.baseline" ],
6074                     "type": "string"
6075                 },
6076                 "minItems": 1,
6077                 "readOnly": true,
6078                 "type": "array"
6079             }
6080         },
6081         "type" : "object",

```



```

6082         "required": ["csr", "encoding"]
6083     }
6084 }
6085 }
6086

```

6087 C.4.5 Property definition

6088 Table C-5 defines the Properties that are part of the "oic.r.csr" Resource Type.

6089 **Table C-5 – The Property definitions of the Resource with type "rt" = "oic.r.csr".**

Property name	Value type	Mandatory	Access mode	Description
rt	array: see schema	No	Read Only	Resource Type of the Resource.
encoding	string	Yes	Read Only	A string specifying the encoding format of the data contained in CSR.
n	multiple types: see schema	No	Read Write	
id	multiple types: see schema	No	Read Write	
csr	string	Yes	Read Only	Signed CSR in ASN.1 in the encoding specified by the encoding property.
if	array: see schema	No	Read Only	The interface set supported by this Resource.

6090 C.4.6 CRUDN behaviour

6091 Table C-6 defines the CRUDN operations that are supported on the "oic.r.csr" Resource Type.

6092 **Table C-6 – The CRUDN operations of the Resource with type "rt" = "oic.r.csr".**

Create	Read	Update	Delete	Notify
	get			observe

6093 C.5 Device Owner Transfer Method

6094 C.5.1 Introduction

6095 This Resource specifies properties needed to establish a Device owner.

6096

6097 C.5.2 Well-known URI

6098 /oic/sec/doxm

6099 C.5.3 Resource type

6100 The Resource Type is defined as: "oic.r.doxm".

6101 C.5.4 OpenAPI 2.0 definition

```

6102 {
6103     "swagger": "2.0",
6104     "info": {
6105         "title": "Device Owner Transfer Method",
6106         "version": "2020-10-19",
6107         "license": {

```

```

6108         "name": "OCF Data Model License",
6109         "url":
6110 "https://github.com/openconnectivityfoundation/core/blob/e28a9e0a92e17042ba3e83661e4c0fbce8bdc4ba/LI
6111 CENSE.md",
6112         "x-copyright": "copyright 2016-2017, 2019, 2020 Open Connectivity Foundation, Inc. All rights
6113 reserved.",
6114     },
6115     "termsOfService": "https://openconnectivityfoundation.github.io/core/DISCLAIMER.md"
6116 },
6117 "schemes": ["http"],
6118 "consumes": ["application/json"],
6119 "produces": ["application/json"],
6120 "paths": {
6121     "/oic/sec/doxm" : {
6122         "get": {
6123             "description": "This Resource specifies properties needed to establish a Device owner.\n",
6124             "parameters": [
6125                 {"$ref": "#/parameters/interface"},
6126                 {"$ref": "#/parameters/owned"}
6127             ],
6128             "responses": {
6129                 "200": {
6130                     "description": "",
6131                     "x-example": {
6132                         "rt": ["oic.r.doxm"],
6133                         "oxms": [ 0, 2, 3 ],
6134                         "oxmsel": 0,
6135                         "sct": 16,
6136                         "owned": true,
6137                         "deviceuuid": "de305d54-75b4-431b-adb2-eb6b9e546014",
6138                         "devowneruuid": "e61c3e6b-9c54-4b81-8ce5-f9039c1d04d9",
6139                         "rowneruuid": "e61c3e6b-9c54-4b81-8ce5-f9039c1d04d9"
6140                     },
6141                     "schema": { "$ref": "#/definitions/Doxm" }
6142                 },
6143                 "400": {
6144                     "description": "The request is invalid."
6145                 }
6146             }
6147         },
6148         "post": {
6149             "description": "Updates the DOXM Resource data.\n",
6150             "parameters": [
6151                 {"$ref": "#/parameters/interface"},
6152                 {
6153                     "name": "body",
6154                     "in": "body",
6155                     "required": true,
6156                     "schema": { "$ref": "#/definitions/Doxm-Update" },
6157                     "x-example":
6158                     {
6159                         "oxmsel": 0,
6160                         "owned": true,
6161                         "deviceuuid": "de305d54-75b4-431b-adb2-eb6b9e546014",
6162                         "devowneruuid": "e61c3e6b-9c54-4b81-8ce5-f9039c1d04d9",
6163                         "rowneruuid": "e61c3e6b-9c54-4b81-8ce5-f9039c1d04d9"
6164                     }
6165                 }
6166             ],
6167             "responses": {
6168                 "400": {
6169                     "description": "The request is invalid."
6170                 },
6171                 "204": {
6172                     "description": "The DOXM entry is updated."
6173                 }
6174             }
6175         }
6176     }
6177 },
6178 "parameters": {
6179     "interface" : {

```

```

6180         "in" : "query",
6181         "name" : "if",
6182         "type" : "string",
6183         "enum" : [ "oic.if.rw", "oic.if.baseline" ]
6184     },
6185     "owned": {
6186         "in": "query",
6187         "name": "owned",
6188         "type": "boolean"
6189     }
6190 },
6191 "definitions": {
6192     "Doxm" : {
6193         "properties": {
6194             "rowneruuid": {
6195                 "description": "Format pattern according to IETF RFC 4122.",
6196                 "pattern": "^[a-fA-F0-9]{8}-[a-fA-F0-9]{4}-[a-fA-F0-9]{4}-[a-fA-F0-9]{4}-[a-fA-F0-
6197 9]{12}$",
6198                 "type": "string"
6199             },
6200             "oxms": {
6201                 "description": "List of supported owner transfer methods.",
6202                 "items": {
6203                     "description": "The Device owner transfer methods that may be selected at Device on-
6204 boarding. Each value indicates a specific Owner Transfer method0 - Numeric OTM identifier for the
6205 Just-Works method (oic.sec.doxm.jw)1 - Numeric OTM identifier for the random PIN method
6206 (oic.sec.doxm.rdp)2 - Numeric OTM identifier for the manufacturer certificate method
6207 (oic.sec.doxm.mfgcert)3 - Numeric OTM identifier for the decap method (oic.sec.doxm.dcap)
6208 (deprecated).",
6209                     "type": "integer"
6210                 },
6211                 "readOnly": true,
6212                 "type": "array"
6213             },
6214             "devowneruuid": {
6215                 "description": "Format pattern according to IETF RFC 4122.",
6216                 "pattern": "^[a-fA-F0-9]{8}-[a-fA-F0-9]{4}-[a-fA-F0-9]{4}-[a-fA-F0-9]{4}-[a-fA-F0-
6217 9]{12}$",
6218                 "type": "string"
6219             },
6220             "deviceuuid": {
6221                 "description": "The uuid formatted identity of the Device\nFormat pattern according to
6222 IETF RFC 4122.",
6223                 "pattern": "^[a-fA-F0-9]{8}-[a-fA-F0-9]{4}-[a-fA-F0-9]{4}-[a-fA-F0-9]{4}-[a-fA-F0-
6224 9]{12}$",
6225                 "type": "string"
6226             },
6227             "owned": {
6228                 "description": "Ownership status flag.",
6229                 "type": "boolean"
6230             },
6231             "n": {
6232                 "$ref":
6233 "https://openconnectivityfoundation.github.io/core/schemas/oic.common.properties.core-
6234 schema.json#/definitions/n"
6235             },
6236             "id": {
6237                 "$ref":
6238 "https://openconnectivityfoundation.github.io/core/schemas/oic.common.properties.core-
6239 schema.json#/definitions/id"
6240             },
6241             "oxmsel": {
6242                 "description": "The selected owner transfer method used during on-boarding\nThe Device
6243 owner transfer methods that may be selected at Device on-boarding. Each value indicates a specific
6244 Owner Transfer method0 - Numeric OTM identifier for the Just-Works method (oic.sec.doxm.jw)1 -
6245 Numeric OTM identifier for the random PIN method (oic.sec.doxm.rdp)2 - Numeric OTM identifier for
6246 the manufacturer certificate method (oic.sec.doxm.mfgcert)3 - Numeric OTM identifier for the decap
6247 method (oic.sec.doxm.dcap) (deprecated).",
6248                 "type": "integer"
6249             },
6250             "sct": {
6251                 "description": "Bitmask encoding of supported credential types\nCredential Types -

```

```

6252 Cred type encoded as a bitmask.0 - Empty credential used for testing1 - Symmetric pair-wise key2 -
6253 Symmetric group key4 - Asymmetric signing key8 - Asymmetric signing key with certificate16 - PIN or
6254 password32 - Asymmetric encryption key.",
6255     "maximum": 511,
6256     "minimum": 0,
6257     "type": "integer",
6258     "readOnly": true
6259 },
6260 "rt": {
6261     "description": "Resource Type of the Resource.",
6262     "items": {
6263         "maxLength": 64,
6264         "type": "string",
6265         "enum": ["oic.r.doxm"]
6266     },
6267     "minItems": 1,
6268     "readOnly": true,
6269     "type": "array"
6270 },
6271 "if": {
6272     "description": "The OCF Interface set supported by this Resource.",
6273     "items": {
6274         "enum": [ "oic.if.rw", "oic.if.baseline" ],
6275         "type": "string"
6276     },
6277     "minItems": 2,
6278     "readOnly": true,
6279     "type": "array"
6280 },
6281 },
6282 "type" : "object",
6283 "required": ["oxms", "oxmsel", "sct", "owned", "deviceuuid", "devowneruuid", "rowneruuid"]
6284 },
6285 "Doxm-Update" : {
6286     "properties": {
6287         "rowneruuid": {
6288             "description": "Format pattern according to IETF RFC 4122.",
6289             "pattern": "^[a-fA-F0-9]{8}-[a-fA-F0-9]{4}-[a-fA-F0-9]{4}-[a-fA-F0-9]{4}-[a-fA-F0-
6290 9]{12}$",
6291             "type": "string"
6292         },
6293         "devowneruuid": {
6294             "description": "Format pattern according to IETF RFC 4122.",
6295             "pattern": "^[a-fA-F0-9]{8}-[a-fA-F0-9]{4}-[a-fA-F0-9]{4}-[a-fA-F0-9]{4}-[a-fA-F0-
6296 9]{12}$",
6297             "type": "string"
6298         },
6299         "deviceuuid": {
6300             "description": "The uuid formatted identity of the Device\nFormat pattern according to
6301 IETF RFC 4122.",
6302             "pattern": "^[a-fA-F0-9]{8}-[a-fA-F0-9]{4}-[a-fA-F0-9]{4}-[a-fA-F0-9]{4}-[a-fA-F0-
6303 9]{12}$",
6304             "type": "string"
6305         },
6306         "owned": {
6307             "description": "Ownership status flag.",
6308             "type": "boolean"
6309         },
6310         "oxmsel": {
6311             "description": "The selected owner transfer method used during on-boarding\nThe Device
6312 owner transfer methods that may be selected at Device on-boarding. Each value indicates a specific
6313 Owner Transfer method0 - Numeric OTM identifier for the Just-Works method (oic.sec.doxm.jw)1 -
6314 Numeric OTM identifier for the random PIN method (oic.sec.doxm.rdp)2 - Numeric OTM identifier for
6315 the manufacturer certificate method (oic.sec.doxm.mfgcert)3 - Numeric OTM identifier for the decap
6316 method (oic.sec.doxm.dcap) (deprecated).",
6317             "type": "integer"
6318         }
6319     },
6320     "type" : "object"
6321 }
6322 }

```

6323 }
6324

6325 C.5.5 Property definition

6326 Table C-7 defines the Properties that are part of the "oic.r.doxm" Resource Type.

6327 **Table C-7 – The Property definitions of the Resource with type "rt" = "oic.r.doxm".**

Property name	Value type	Mandatory	Access mode	Description
rowneruuid	string	Yes	Read Write	Format pattern according to IETF RFC 4122.
oxms	array: see schema	Yes	Read Only	List of supported owner transfer methods.
devowneruuid	string	Yes	Read Write	Format pattern according to IETF RFC 4122.
deviceuuid	string	Yes	Read Write	The uuid formatted identity of the Device Format pattern according to IETF RFC 4122.
owned	boolean	Yes	Read Write	Ownership status flag.
n	multiple types: see schema	No	Read Write	
id	multiple types: see schema	No	Read Write	
oxmsel	integer	Yes	Read Write	The selected owner transfer method used during on-boarding The Device owner transfer methods that may be selected at Device on-boarding. Each value indicates a specific Owner Transfer method 0 - Numeric OTM identifier for the Just-Works method (oic.sec.doxm.jw) 1 - Numeric OTM identifier for the random PIN method (oic.sec.doxm.rdp) 2 - Numeric OTM identifier for the manufacturer certificate method (oic.sec.doxm.mfgcert) 3 - Numeric OTM identifier for the decap method (oic.sec.doxm.dcap) (deprecated).
sct	integer	Yes	Read Only	Bitmask encoding of supported credential types Credential Types - Cred type encoded as a bitmask 0 - Empty credential used for testing 1 - Symmetric pair-wise key 2 - Symmetric group key 4 -

				Asymmetric signing key8 - Asymmetric signing key with certificate16 - PIN or password32 - Asymmetric encryption key.
rt	array: see schema	No	Read Only	Resource Type of the Resource.
if	array: see schema	No	Read Only	The OCF Interface set supported by this Resource.
rowneruuid	string		Read Write	Format pattern according to IETF RFC 4122.
devowneruuid	string		Read Write	Format pattern according to IETF RFC 4122.
deviceuuid	string		Read Write	The uuid formatted identity of the Device Format pattern according to IETF RFC 4122.
owned	boolean		Read Write	Ownership status flag.
oxmsel	integer		Read Write	The selected owner transfer method used during on-boarding The Device owner transfer methods that may be selected at Device on-boarding. Each value indicates a specific Owner Transfer method 0 - Numeric OTM identifier for the Just-Works method (oic.sec.doxm.jw) 1 - Numeric OTM identifier for the random PIN method (oic.sec.doxm.rdp) 2 - Numeric OTM identifier for the manufacturer certificate method (oic.sec.doxm.mfgcert) 3 - Numeric OTM identifier for the decap method (oic.sec.doxm.dcap) (deprecated).

C.5.6 CRUDN behaviour

Table C-8 defines the CRUDN operations that are supported on the "oic.r.doxm" Resource Type.

Table C-8 – The CRUDN operations of the Resource with type "rt" = "oic.r.doxm".

Create	Read	Update	Delete	Notify
	get	post		observe

C.6 Device Provisioning Status

C.6.1 Introduction

This Resource specifies Device provisioning status.

C.6.2 Well-known URI

/oic/sec/pstat

C.6.3 Resource type

The Resource Type is defined as: "oic.r.pstat".

C.6.4 OpenAPI 2.0 definition

```
{
  "swagger": "2.0",
  "info": {
    "title": "Device Provisioning Status",
    "version": "2019-10-01",
    "license": {
      "name": "OCF Data Model License",
      "url":
        "https://github.com/openconnectivityfoundation/core/blob/e28a9e0a92e17042ba3e83661e4c0fbce8bdc4ba/LI
        CENSE.md",
      "x-copyright": "copyright 2016-2017, 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/sec/pstat" : {
      "get": {
        "description": "This Resource specifies Device provisioning status.\n",
        "parameters": [
          {"$ref": "#/parameters/interface"}
        ],
        "responses": {
          "200": {
            "description": "",
            "x-example":
              {
                "rt": ["oic.r.pstat"],
                "dos": {"s": 3, "p": true},
                "isop": true,
                "cm": 8,
                "tm": 60,
                "om": 2,
                "sm": 7,
                "rowneruuid": "de305d54-75b4-431b-adb2-eb6b9e546014"
              },
            "schema": { "$ref": "#/definitions/Pstat" }
          },
          "400": {
            "description": "The request is invalid."
          }
        }
      },
      "post": {
        "description": "Sets or updates Device provisioning status data.\n",
        "parameters": [
          {"$ref": "#/parameters/interface"},
          {
            "name": "body",
            "in": "body",
            "required": true,

```

```

6394         "schema": { "$ref": "#/definitions/Pstat-Update" },
6395         "x-example":
6396             {
6397                 "dos": {"s": 3},
6398                 "tm": 60,
6399                 "om": 2,
6400                 "rowneruuid": "de305d54-75b4-431b-adb2-eb6b9e546014"
6401             }
6402     },
6403 ],
6404     "responses": {
6405         "400": {
6406             "description": "The request is invalid."
6407         },
6408         "204": {
6409             "description": "The PSTAT entry is updated."
6410         }
6411     }
6412 },
6413 },
6414 },
6415     "parameters": {
6416         "interface" : {
6417             "in" : "query",
6418             "name" : "if",
6419             "type" : "string",
6420             "enum" : [ "oic.if.rw", "oic.if.baseline" ]
6421         }
6422     },
6423     "definitions": {
6424         "Pstat" : {
6425             "properties": {
6426                 "rowneruuid": {
6427                     "description": "The UUID formatted identity of the Resource owner\nFormat pattern
6428 according to IETF RFC 4122.",
6429                     "pattern": "^[a-fA-F0-9]{8}-[a-fA-F0-9]{4}-[a-fA-F0-9]{4}-[a-fA-F0-9]{4}-[a-fA-F0-
6430 9]{12}$",
6431                     "type": "string"
6432                 },
6433                 "rt": {
6434                     "description": "Resource Type of the Resource.",
6435                     "items": {
6436                         "maxLength": 64,
6437                         "type": "string",
6438                         "enum": ["oic.r.pstat"]
6439                     },
6440                     "minItems": 1,
6441                     "readOnly": true,
6442                     "type": "array"
6443                 },
6444                 "om": {
6445                     "description": "Current operational mode\nDevice provisioning operation may be server
6446 directed or client (aka provisioning service) directed. The value is a bitmask encoded as integer
6447 and indicates the provisioning operation modes1 - Server-directed utilizing multiple provisioning
6448 services2 - Server-directed utilizing a single provisioning service4 - Client-directed provisioning8
6449 - Unused16 - Unused32 - Unused64 - Unused128 - Unused.",
6450                     "maximum": 7,
6451                     "minimum": 1,
6452                     "type": "integer"
6453                 },
6454                 "cm": {
6455                     "description": "Current Device provisioning mode\nDevice provisioning mode maintains a
6456 bitmask of the possible provisioning states of a Device. The value can be either 8 or 16 character
6457 in length. If its only 8 characters it represents the lower byte value1 - Manufacturer reset state2
6458 - Device pairing and owner transfer state4 - Unused8 - Provisioning of credential management
6459 services16 - Provisioning of access management services32 - Provisioning of local ACLs64 - Initiate
6460 Software Version Validation128 - Initiate Secure Software Update.",
6461                     "maximum": 255,
6462                     "minimum": 0,
6463                     "type": "integer",
6464                     "readOnly": true
6465                 }
6466             }
6467     }
6468 },

```



```

6466         "n": {
6467             "$ref":
6468             "https://openconnectivityfoundation.github.io/core/schemas/oic.common.properties.core-
6469             schema.json#/definitions/n"
6470         },
6471         "id": {
6472             "$ref":
6473             "https://openconnectivityfoundation.github.io/core/schemas/oic.common.properties.core-
6474             schema.json#/definitions/id"
6475         },
6476         "isop": {
6477             "description": "true indicates Device is operational.",
6478             "readOnly": true,
6479             "type": "boolean"
6480         },
6481         "tm": {
6482             "description": "Target Device provisioning mode\nDevice provisioning mode maintains a
6483             bitmask of the possible provisioning states of a Device. The value can be either 8 or 16 character
6484             in length. If its only 8 characters it represents the lower byte value1 - Manufacturer reset state2
6485             - Device pairing and owner transfer state4 - Unused8 - Provisioning of credential management
6486             services16 - Provisioning of access management services32 - Provisioning of local ACLs64 - Initiate
6487             Software Version Validation128 - Initiate Secure Software Update.",
6488             "maximum": 255,
6489             "minimum": 0,
6490             "type": "integer"
6491         },
6492         "sm": {
6493             "description": "Supported operational modes\nDevice provisioning operation may be server
6494             directed or client (aka provisioning service) directed. The value is a bitmask encoded as integer
6495             and indicates the provisioning operation modes1 - Server-directed utilizing multiple provisioning
6496             services2 - Server-directed utilizing a single provisioning service4 - Client-directed provisioning8
6497             - Unused16 - Unused32 - Unused64 - Unused128 - Unused.",
6498             "maximum": 7,
6499             "minimum": 1,
6500             "type": "integer",
6501             "readOnly": true
6502         },
6503         "dos": {
6504             "description": "Device on-boarding state\nDevice operation state machine.",
6505             "properties": {
6506                 "p": {
6507                     "default": true,
6508                     "description": "'p' is TRUE when the 's' state is pending until all necessary changes
6509                     to Device Resources are complete.",
6510                     "readOnly": true,
6511                     "type": "boolean"
6512                 },
6513                 "s": {
6514                     "description": "The current or pending operational state.",
6515                     "x-detail-desc": [
6516                         "0 - RESET - Device reset state.",
6517                         "1 - RFOTM - Ready for Device owner transfer method state.",
6518                         "2 - RFPRO - Ready for Device provisioning state.",
6519                         "3 - RFNOP - Ready for Device normal operation state.",
6520                         "4 - SRESET - The Device is in a soft reset state."
6521                     ],
6522                     "maximum": 4,
6523                     "minimum": 0,
6524                     "type": "integer"
6525                 }
6526             },
6527             "required": [
6528                 "s"
6529             ],
6530             "type": "object"
6531         },
6532         "if" : {
6533             "description": "The interface set supported by this Resource.",
6534             "items": {
6535                 "enum": [ "oic.if.rw", "oic.if.baseline" ],
6536                 "type": "string"
6537             }

```

```

6538         "minItems": 1,
6539         "readOnly": true,
6540         "type": "array"
6541     },
6542 },
6543 "type" : "object",
6544 "required": ["dos", "isop", "cm", "tm", "om", "sm", "rowneruuid"]
6545 },
6546 "Pstat-Update" : {
6547     "properties": {
6548         "rowneruuid": {
6549             "description": "The UUID formatted identity of the Resource owner\nFormat pattern
6550 according to IETF RFC 4122.",
6551             "pattern": "^[a-fA-F0-9]{8}-[a-fA-F0-9]{4}-[a-fA-F0-9]{4}-[a-fA-F0-9]{4}-[a-fA-F0-
6552 9]{12}$",
6553             "type": "string"
6554         },
6555         "om": {
6556             "description": "Current operational mode\nDevice provisioning operation may be server
6557 directed or client (aka provisioning service) directed. The value is a bitmask encoded as integer
6558 and indicates the provisioning operation modes1 - Server-directed utilizing multiple provisioning
6559 services2 - Server-directed utilizing a single provisioning service4 - Client-directed provisioning8
6560 - Unused16 - Unused32 - Unused64 - Unused128 - Unused.",
6561             "maximum": 7,
6562             "minimum": 1,
6563             "type": "integer"
6564         },
6565         "tm": {
6566             "description": "Target Device provisioning mode\nDevice provisioning mode maintains a
6567 bitmask of the possible provisioning states of a Device. The value can be either 8 or 16 character
6568 in length. If its only 8 characters it represents the lower byte value1 - Manufacturer reset state2
6569 - Device pairing and owner transfer state4 - Unused8 - Provisioning of credential management
6570 services16 - Provisioning of access management services32 - Provisioning of local ACLs64 - Initiate
6571 Software Version Validation128 - Initiate Secure Software Update.",
6572             "maximum": 255,
6573             "minimum": 0,
6574             "type": "integer"
6575         },
6576         "dos": {
6577             "description": "Device on-boarding state\nDevice operation state machine.",
6578             "properties": {
6579                 "p": {
6580                     "default": true,
6581                     "description": "'p' is TRUE when the 's' state is pending until all necessary changes
6582 to Device Resources are complete.",
6583                     "readOnly": true,
6584                     "type": "boolean"
6585                 },
6586                 "s": {
6587                     "description": "The current or pending operational state.",
6588                     "x-detail-desc": [
6589                         "0 - RESET - Device reset state.",
6590                         "1 - RFOTM - Ready for Device owner transfer method state.",
6591                         "2 - RFPRO - Ready for Device provisioning state.",
6592                         "3 - RFNOP - Ready for Device normal operation state.",
6593                         "4 - SRESET - The Device is in a soft reset state."
6594                     ],
6595                     "maximum": 4,
6596                     "minimum": 0,
6597                     "type": "integer"
6598                 }
6599             },
6600             "required": [
6601                 "s"
6602             ],
6603             "type": "object"
6604         }
6605     },
6606     "type" : "object"
6607 }
6608 }

```

6609 }
6610

6611 C.6.5 Property definition

6612 Table C-9 defines the Properties that are part of the "oic.r.pstat" Resource Type.

6613 **Table C-9 – The Property definitions of the Resource with type "rt" = "oic.r.pstat".**

Property name	Value type	Mandatory	Access mode	Description
rowneruuid	string	Yes	Read Write	The UUID formatted identity of the Resource owner Format pattern according to IETF RFC 4122.
rt	array: see schema	No	Read Only	Resource Type of the Resource.
om	integer	Yes	Read Write	Current operational mode Device provisioning operation may be server directed or client (aka provisioning service) directed. The value is a bitmask encoded as integer and indicates the provisioning operation modes1 - Server-directed utilizing multiple provisioning services2 - Server-directed utilizing a single provisioning service4 - Client-directed provisioning8 - Unused16 - Unused32 - Unused64 - Unused128 - Unused.
cm	integer	Yes	Read Only	Current Device provisioning mode Device provisioning mode maintains a bitmask of the possible provisioning states of a Device. The value can be either 8 or 16 character in length. If its only 8 characters it represents the lower byte value1 - Manufacturer reset state2 - Device pairing and owner transfer state4 - Unused8 - Provisioning of credential management services16 -

				Provisioning of access management services32 - Provisioning of local ACLs64 - Initiate Software Version Validation128 - Initiate Secure Software Update.
n	multiple types: see schema	No	Read Write	
id	multiple types: see schema	No	Read Write	
isop	boolean	Yes	Read Only	true indicates Device is operational.
tm	integer	Yes	Read Write	Target Device provisioning mode Device provisioning mode maintains a bitmask of the possible provisioning states of a Device. The value can be either 8 or 16 character in length. If its only 8 characters it represents the lower byte value1 - Manufacturer reset state2 - Device pairing and owner transfer state4 - Unused8 - Provisioning of credential management services16 - Provisioning of access management services32 - Provisioning of local ACLs64 - Initiate Software Version Validation128 - Initiate Secure Software Update.
sm	integer	Yes	Read Only	Supported operational modes Device provisioning operation may be server directed or client (aka provisioning service) directed. The value is a bitmask encoded as integer and indicates the provisioning operation modes1 - Server-directed utilizing multiple provisioning services2 - Server-directed utilizing a single provisioning service4 - Client-directed

				provisioning8 - Unused16 - Unused32 - Unused64 - Unused128 - Unused.
dos	object: see schema	Yes	Read Write	Device on-boarding state Device operation state machine.
if	array: see schema	No	Read Only	The interface set supported by this Resource.
rowneruuid	string	No	Read Write	The UUID formatted identity of the Resource owner Format pattern according to IETF RFC 4122.
om	integer	No	Read Write	Current operational mode Device provisioning operation may be server directed or client (aka provisioning service) directed. The value is a bitmask encoded as integer and indicates the provisioning operation modes1 - Server-directed utilizing multiple provisioning services2 - Server- directed utilizing a single provisioning service4 - Client- directed provisioning8 - Unused16 - Unused32 - Unused64 - Unused128 - Unused.
tm	integer	No	Read Write	Target Device provisioning mode Device provisioning mode maintains a bitmask of the possible provisioning states of a Device. The value can be either 8 or 16 character in length. If its only 8 characters it represents the lower byte value1 - Manufacturer reset state2 - Device pairing and owner transfer state4 - Unused8 - Provisioning of credential management

				services16 - Provisioning of access management services32 - Provisioning of local ACLs64 - Initiate Software Version Validation128 - Initiate Secure Software Update.
dos	object: see schema	No	Read Write	Device on-boarding state Device operation state machine.

C.6.6 CRUDN behaviour

Table C-10 defines the CRUDN operations that are supported on the "oic.r.pstat" Resource Type.

Table C-10 – The CRUDN operations of the Resource with type "rt" = "oic.r.pstat".

Create	Read	Update	Delete	Notify
	get	post		observe

C.7 Asserted Roles

C.7.1 Introduction

This Resource specifies roles that have been asserted.

C.7.2 Well-known URI

/oic/sec/roles

C.7.3 Resource type

The Resource Type is defined as: "oic.r.roles".

C.7.4 OpenAPI 2.0 definition

```
{
  "swagger": "2.0",
  "info": {
    "title": "Asserted Roles",
    "version": "2017-03-23",
    "license": {
      "name": "OCF Data Model License",
      "url":
"https://github.com/openconnectivityfoundation/core/blob/e28a9e0a92e17042ba3e83661e4c0fbce8bdc4ba/LI
CENSE.md",
      "x-copyright": "copyright 2016-2017, 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/sec/roles" : {
      "get": {
        "description": "This Resource specifies roles that have been asserted.\n",
        "parameters": [
          {"$ref": "#/parameters/interface"}
        ],
        "responses": {
          "200": {
```

```

6653     "description" : "",
6654     "x-example":
6655     {
6656         "roles" :[
6657             {
6658                 "credid":1,
6659                 "credtype":8,
6660                 "subjectuuid":"00000000-0000-0000-0000-000000000000",
6661                 "publicdata":
6662                 {
6663                     "encoding":"oic.sec.encoding.pem",
6664                     "data":"PEMENCODEDROLECERT"
6665                 },
6666                 "optionaldata":
6667                 {
6668                     "revstat": false,
6669                     "encoding":"oic.sec.encoding.pem",
6670                     "data":"PEMENCODEDISSUERCERT"
6671                 }
6672             },
6673             {
6674                 "credid":2,
6675                 "credtype":8,
6676                 "subjectuuid":"00000000-0000-0000-0000-000000000000",
6677                 "publicdata":
6678                 {
6679                     "encoding":"oic.sec.encoding.pem",
6680                     "data":"PEMENCODEDROLECERT"
6681                 },
6682                 "optionaldata":
6683                 {
6684                     "revstat": false,
6685                     "encoding":"oic.sec.encoding.pem",
6686                     "data":"PEMENCODEDISSUERCERT"
6687                 }
6688             }
6689         ],
6690         "rt":["oic.r.roles"],
6691         "if":["oic.if.rw"]
6692     },
6693     "schema": { "$ref": "#/definitions/Roles" }
6694 },
6695 "400": {
6696     "description" : "The request is invalid."
6697 }
6698 }
6699 },
6700 },
6701 "post": {
6702     "description": "Update the roles Resource, i.e., assert new roles to this server.\n\nNew
6703 role certificates that match an existing certificate (i.e., publicdata\nand optionaldata are the
6704 same) are not added to the Resource (and 204 is\nreturned).\n\nThe provided credid values are
6705 ignored, the Resource assigns its own.\n",
6706     "parameters": [
6707         { "$ref": "#/parameters/interface" },
6708         {
6709             "name": "body",
6710             "in": "body",
6711             "required": true,
6712             "schema": { "$ref": "#/definitions/Roles-update" },
6713             "x-example":
6714             {
6715                 "roles" :[
6716                     {
6717                         "credid":1,
6718                         "credtype":8,
6719                         "subjectuuid":"00000000-0000-0000-0000-000000000000",
6720                         "publicdata":
6721                         {
6722                             "encoding":"oic.sec.encoding.pem",
6723                             "data":"PEMENCODEDROLECERT"
6724                         },

```

```

6725         "optionaldata":
6726         {
6727             "revstat": false,
6728             "encoding": "oic.sec.encoding.pem",
6729             "data": "PEMENCODEDISSUERCERT"
6730         }
6731     },
6732     {
6733         "credid": 2,
6734         "credtype": 8,
6735         "subjectuuiid": "00000000-0000-0000-0000-000000000000",
6736         "publicdata":
6737         {
6738             "encoding": "oic.sec.encoding.pem",
6739             "data": "PEMENCODEDROLECERT"
6740         },
6741         "optionaldata":
6742         {
6743             "revstat": false,
6744             "encoding": "oic.sec.encoding.pem",
6745             "data": "PEMENCODEDISSUERCERT"
6746         }
6747     }
6748 ]
6749 }
6750 ],
6751 "responses": {
6752     "400": {
6753         "description": "The request is invalid."
6754     },
6755     "204": {
6756         "description": "The roles entry is updated."
6757     }
6758 },
6759 },
6760 "delete": {
6761     "description": "Deletes roles Resource entries.\nWhen DELETE is used without query
6762 parameters, all the roles entries are deleted.\nWhen DELETE is used with a query parameter, only the
6763 entries matching\nthe query parameter are deleted.\n",
6764     "parameters": [
6765         {"$ref": "#/parameters/interface"},
6766         {"$ref": "#/parameters/roles-filtered"}
6767     ],
6768     "responses": {
6769         "200": {
6770             "description": "The specified or all roles Resource entries have been successfully
6771 deleted."
6772         },
6773         "400": {
6774             "description": "The request is invalid."
6775         }
6776     }
6777 },
6778 },
6779 },
6780 "parameters": {
6781     "interface" : {
6782         "in" : "query",
6783         "name" : "if",
6784         "type" : "string",
6785         "enum" : [ "oic.if.rw", "oic.if.baseline" ]
6786     },
6787     "roles-filtered" : {
6788         "in" : "query",
6789         "name" : "credid",
6790         "required" : false,
6791         "type" : "integer",
6792         "description" : "Only applies to the credential with the specified credid.",
6793         "x-example" : 2112
6794     }
6795 },
6796 },

```



```

6797 "definitions": {
6798   "Roles" : {
6799     "properties": {
6800       "rt": {
6801         "description": "Resource Type of the Resource.",
6802         "items": {
6803           "maxLength": 64,
6804           "type": "string",
6805           "enum": ["oic.r.roles"]
6806         },
6807         "minItems": 1,
6808         "readOnly": true,
6809         "type": "array"
6810       },
6811       "n": {
6812         "$ref":
6813 "https://openconnectivityfoundation.github.io/core/schemas/oic.common.properties.core-
6814 schema.json#/definitions/n"
6815       },
6816       "id": {
6817         "$ref":
6818 "https://openconnectivityfoundation.github.io/core/schemas/oic.common.properties.core-
6819 schema.json#/definitions/id"
6820       },
6821       "roles": {
6822         "description": "List of role certificates.",
6823         "items": {
6824           "properties": {
6825             "credid": {
6826               "description": "Local reference to a credential Resource.",
6827               "type": "integer"
6828             },
6829             "credtype": {
6830               "description": "Representation of this credential's type\nCredential Types - Cred
6831 type encoded as a bitmask.0 - Empty credential used for testing1 - Symmetric pair-wise key2 -
6832 Symmetric group key4 - Asymmetric signing key8 - Asymmetric signing key with certificate16 - PIN or
6833 password32 - Asymmetric encryption key.",
6834               "maximum": 63,
6835               "minimum": 0,
6836               "type": "integer"
6837             },
6838             "credusage": {
6839               "description": "A string that provides hints about how/where the cred is used\nThe
6840 type of credusage.oic.sec.cred.trustca - Trust certificateoic.sec.cred.cert -
6841 Certificateoic.sec.cred.rolecert - Role Certificateoic.sec.cred.mfgtrustca - Manufacturer
6842 Certificate Trust Anchoroic.sec.cred.mfgcert - Manufacturer Certificate.",
6843               "enum": [
6844                 "oic.sec.cred.trustca",
6845                 "oic.sec.cred.cert",
6846                 "oic.sec.cred.rolecert",
6847                 "oic.sec.cred.mfgtrustca",
6848                 "oic.sec.cred.mfgcert"
6849               ],
6850               "type": "string"
6851             },
6852             "crms": {
6853               "description": "The refresh methods that may be used to update this credential.",
6854               "items": {
6855                 "description": "Each enum represents a method by which the credentials are
6856 refreshed.oic.sec.crm.pro - Credentials refreshed by a provisioning serviceoic.sec.crm.rdp -
6857 Credentials refreshed by a key agreement protocol and random PINoic.sec.crm.psk - Credentials
6858 refreshed by a key agreement protocoloic.sec.crm.skdc - Credentials refreshed by a key distribution
6859 serviceoic.sec.crm.pk10 - Credentials refreshed by a PKCS#10 request to a CA.",
6860                 "enum": [
6861                   "oic.sec.crm.pro",
6862                   "oic.sec.crm.psk",
6863                   "oic.sec.crm.rdp",
6864                   "oic.sec.crm.skdc",
6865                   "oic.sec.crm.pk10"
6866                 ],
6867                 "type": "string"
6868               },

```

```

6869         "type": "array"
6870     },
6871     "optionaldata": {
6872         "description": "Credential revocation status information\nOptional credential
6873 contents describes revocation status for this credential.",
6874         "properties": {
6875             "data": {
6876                 "description": "This is the encoded structure.",
6877                 "type": "string"
6878             },
6879             "encoding": {
6880                 "description": "A string specifying the encoding format of the data contained in
6881 the optdata.",
6882                 "x-detail-desc": [
6883                     "oic.sec.encoding.jwt - RFC7517 JSON web token (JWT) encoding.",
6884                     "oic.sec.encoding.cwt - RFC CBOR web token (CWT) encoding.",
6885                     "oic.sec.encoding.base64 - Base64 encoded object.",
6886                     "oic.sec.encoding.pem - Encoding for PEM encoded certificate or chain.",
6887                     "oic.sec.encoding.der - Encoding for DER encoded certificate.",
6888                     "oic.sec.encoding.raw - Raw hex encoded data."
6889                 ],
6890                 "enum": [
6891                     "oic.sec.encoding.jwt",
6892                     "oic.sec.encoding.cwt",
6893                     "oic.sec.encoding.base64",
6894                     "oic.sec.encoding.pem",
6895                     "oic.sec.encoding.der",
6896                     "oic.sec.encoding.raw"
6897                 ],
6898                 "type": "string"
6899             },
6900             "revstat": {
6901                 "description": "Revocation status flag - true = revoked.",
6902                 "type": "boolean"
6903             }
6904         },
6905         "required": [
6906             "revstat"
6907         ],
6908         "type": "object"
6909     },
6910     "period": {
6911         "description": "String with RFC5545 Period.",
6912         "type": "string"
6913     },
6914     "privatedata": {
6915         "description": "Private credential information\nCredential Resource non-public
6916 contents.",
6917         "properties": {
6918             "data": {
6919                 "description": "The encoded value.",
6920                 "maxLength": 3072,
6921                 "type": "string"
6922             },
6923             "encoding": {
6924                 "description": "A string specifying the encoding format of the data contained in
6925 the privdata.",
6926                 "x-detail-desc": [
6927                     "oic.sec.encoding.jwt - RFC7517 JSON web token (JWT) encoding.",
6928                     "oic.sec.encoding.cwt - RFC CBOR web token (CWT) encoding.",
6929                     "oic.sec.encoding.base64 - Base64 encoded object.",
6930                     "oic.sec.encoding.uri - URI reference.",
6931                     "oic.sec.encoding.handle - Data is contained in a storage sub-system
6932 referenced using a handle.",
6933                     "oic.sec.encoding.raw - Raw hex encoded data."
6934                 ],
6935                 "enum": [
6936                     "oic.sec.encoding.jwt",
6937                     "oic.sec.encoding.cwt",
6938                     "oic.sec.encoding.base64",
6939                     "oic.sec.encoding.uri",
6940                     "oic.sec.encoding.handle",

```

```

6941         "oic.sec.encoding.raw"
6942     ],
6943     "type": "string"
6944 },
6945     "handle": {
6946         "description": "Handle to a key storage Resource.",
6947         "type": "integer"
6948     }
6949 },
6950     "required": [
6951         "encoding"
6952     ],
6953     "type": "object"
6954 },
6955     "publicdata": {
6956         "description": "Public credential information.",
6957         "properties": {
6958             "data": {
6959                 "description": "This is the encoded value.",
6960                 "maxLength": 3072,
6961                 "type": "string"
6962             },
6963             "encoding": {
6964                 "description": "A string specifying the encoding format of the data contained in
6965 the pubdata.",
6966                 "x-detail-desc": [
6967                     "oic.sec.encoding.jwt - RFC7517 JSON web token (JWT) encoding.",
6968                     "oic.sec.encoding.cwt - RFC CBOR web token (CWT) encoding.",
6969                     "oic.sec.encoding.base64 - Base64 encoded object.",
6970                     "oic.sec.encoding.uri - URI reference.",
6971                     "oic.sec.encoding.pem - Encoding for PEM encoded certificate or chain.",
6972                     "oic.sec.encoding.der - Encoding for DER encoded certificate.",
6973                     "oic.sec.encoding.raw - Raw hex encoded data."
6974                 ],
6975                 "enum": [
6976                     "oic.sec.encoding.jwt",
6977                     "oic.sec.encoding.cwt",
6978                     "oic.sec.encoding.base64",
6979                     "oic.sec.encoding.uri",
6980                     "oic.sec.encoding.pem",
6981                     "oic.sec.encoding.der",
6982                     "oic.sec.encoding.raw"
6983                 ],
6984                 "type": "string"
6985             }
6986         },
6987         "type": "object"
6988     },
6989     "roleid": {
6990         "description": "The role this credential possesses\nSecurity role specified as an
6991 <Authority> & <Rolename>. A NULL <Authority> refers to the local entity or Device.",
6992         "properties": {
6993             "authority": {
6994                 "description": "The Authority component of the entity being identified. A NULL
6995 <Authority> refers to the local entity or Device.",
6996                 "type": "string"
6997             },
6998             "role": {
6999                 "description": "The ID of the role being identified.",
7000                 "type": "string"
7001             }
7002         },
7003         "required": [
7004             "role"
7005         ],
7006         "type": "object"
7007     },
7008     "subjectuuid": {
7009         "anyOf": [
7010             {
7011                 "description": "The id of the Device, which the cred entry applies to or \"*\n
7012 for wildcard identity.",

```

```

7013         "pattern": "^\\*$",
7014         "type": "string"
7015     },
7016     {
7017         "description": "Format pattern according to IETF RFC 4122.",
7018         "pattern": "^[a-fA-F0-9]{8}-[a-fA-F0-9]{4}-[a-fA-F0-9]{4}-[a-fA-F0-9]{4}-[a-fA-
7019 F0-9]{12}$",
7020         "type": "string"
7021     }
7022 ]
7023 }
7024 },
7025 "type": "object"
7026 },
7027 "type": "array"
7028 },
7029 "if": {
7030     "description": "The interface set supported by this Resource.",
7031     "items": {
7032         "enum": [ "oic.if.rw", "oic.if.baseline" ],
7033         "type": "string"
7034     },
7035     "minItems": 1,
7036     "readOnly": true,
7037     "type": "array"
7038 }
7039 },
7040 "type": "object",
7041 "required": ["roles"]
7042 },
7043 "Roles-update" : {
7044     "properties": {
7045         "roles": {
7046             "description": "List of role certificates.",
7047             "items": {
7048                 "properties": {
7049                     "credid": {
7050                         "description": "Local reference to a credential Resource.",
7051                         "type": "integer"
7052                     },
7053                     "credtype": {
7054                         "description": "Representation of this credential's type\nCredential Types - Cred
7055 type encoded as a bitmask.0 - Empty credential used for testing1 - Symmetric pair-wise key2 -
7056 Symmetric group key4 - Asymmetric signing key8 - Asymmetric signing key with certificate16 - PIN or
7057 password32 - Asymmetric encryption key.",
7058                         "maximum": 63,
7059                         "minimum": 0,
7060                         "type": "integer"
7061                     },
7062                     "credusage": {
7063                         "description": "A string that provides hints about how/where the cred is used\nThe
7064 type of credusage.oic.sec.cred.trustca - Trust certificateoic.sec.cred.cert -
7065 Certificateoic.sec.cred.rolecert - Role Certificateoic.sec.cred.mfgtrustca - Manufacturer
7066 Certificate Trust Anchoroic.sec.cred.mfgcert - Manufacturer Certificate.",
7067                         "enum": [
7068                             "oic.sec.cred.trustca",
7069                             "oic.sec.cred.cert",
7070                             "oic.sec.cred.rolecert",
7071                             "oic.sec.cred.mfgtrustca",
7072                             "oic.sec.cred.mfgcert"
7073                         ],
7074                         "type": "string"
7075                     },
7076                     "crms": {
7077                         "description": "The refresh methods that may be used to update this credential.",
7078                         "items": {
7079                             "description": "Each enum represents a method by which the credentials are
7080 refreshed.oic.sec.crm.pro - Credentials refreshed by a provisioning serviceoic.sec.crm.rdp -
7081 Credentials refreshed by a key agreement protocol and random PINoic.sec.crm.psk - Credentials
7082 refreshed by a key agreement protocoloic.sec.crm.skdc - Credentials refreshed by a key distribution
7083 serviceoic.sec.crm.pk10 - Credentials refreshed by a PKCS#10 request to a CA.",
7084                             "enum": [

```

```

7085         "oic.sec.crm.pro",
7086         "oic.sec.crm.psk",
7087         "oic.sec.crm.rdp",
7088         "oic.sec.crm.skdc",
7089         "oic.sec.crm.pk10"
7090     ],
7091     "type": "string"
7092 },
7093 "type": "array"
7094 },
7095 "optionaldata": {
7096     "description": "Credential revocation status information\nOptional credential
7097 contents describes revocation status for this credential.",
7098     "properties": {
7099         "data": {
7100             "description": "This is the encoded structure.",
7101             "type": "string"
7102         },
7103         "encoding": {
7104             "description": "A string specifying the encoding format of the data contained in
7105 the optdata.",
7106             "x-detail-desc": [
7107                 "oic.sec.encoding.jwt - RFC7517 JSON web token (JWT) encoding.",
7108                 "oic.sec.encoding.cwt - RFC CBOR web token (CWT) encoding.",
7109                 "oic.sec.encoding.base64 - Base64 encoded object.",
7110                 "oic.sec.encoding.pem - Encoding for PEM encoded certificate or chain.",
7111                 "oic.sec.encoding.der - Encoding for DER encoded certificate.",
7112                 "oic.sec.encoding.raw - Raw hex encoded data."
7113             ],
7114             "enum": [
7115                 "oic.sec.encoding.jwt",
7116                 "oic.sec.encoding.cwt",
7117                 "oic.sec.encoding.base64",
7118                 "oic.sec.encoding.pem",
7119                 "oic.sec.encoding.der",
7120                 "oic.sec.encoding.raw"
7121             ],
7122             "type": "string"
7123         },
7124         "revstat": {
7125             "description": "Revocation status flag - true = revoked.",
7126             "type": "boolean"
7127         }
7128     },
7129     "required": [
7130         "revstat"
7131     ],
7132     "type": "object"
7133 },
7134 "period": {
7135     "description": "String with RFC5545 Period.",
7136     "type": "string"
7137 },
7138 "privatedata": {
7139     "description": "Private credential information\nCredential Resource non-public
7140 contents.",
7141     "properties": {
7142         "data": {
7143             "description": "The encoded value.",
7144             "maxLength": 3072,
7145             "type": "string"
7146         },
7147         "encoding": {
7148             "description": "A string specifying the encoding format of the data contained in
7149 the privdata.",
7150             "x-detail-desc": [
7151                 "oic.sec.encoding.jwt - RFC7517 JSON web token (JWT) encoding.",
7152                 "oic.sec.encoding.cwt - RFC CBOR web token (CWT) encoding.",
7153                 "oic.sec.encoding.base64 - Base64 encoded object.",
7154                 "oic.sec.encoding.uri - URI reference.",
7155                 "oic.sec.encoding.handle - Data is contained in a storage sub-system
7156 referenced using a handle.",

```

```

7157         "oic.sec.encoding.raw - Raw hex encoded data."
7158     ],
7159     "enum": [
7160         "oic.sec.encoding.jwt",
7161         "oic.sec.encoding.cwt",
7162         "oic.sec.encoding.base64",
7163         "oic.sec.encoding.uri",
7164         "oic.sec.encoding.handle",
7165         "oic.sec.encoding.raw"
7166     ],
7167     "type": "string"
7168 },
7169 "handle": {
7170     "description": "Handle to a key storage Resource.",
7171     "type": "integer"
7172 },
7173 },
7174 "required": [
7175     "encoding"
7176 ],
7177 "type": "object"
7178 },
7179 "publicdata": {
7180     "description": "Public credential information.",
7181     "properties": {
7182         "data": {
7183             "description": "The encoded value.",
7184             "maxLength": 3072,
7185             "type": "string"
7186         },
7187         "encoding": {
7188             "description": "A string specifying the encoding format of the data contained in
7189 the pubdata.",
7190             "x-detail-desc": [
7191                 "oic.sec.encoding.jwt - RFC7517 JSON web token (JWT) encoding.",
7192                 "oic.sec.encoding.cwt - RFC CBOR web token (CWT) encoding.",
7193                 "oic.sec.encoding.base64 - Base64 encoded object.",
7194                 "oic.sec.encoding.uri - URI reference.",
7195                 "oic.sec.encoding.pem - Encoding for PEM encoded certificate or chain.",
7196                 "oic.sec.encoding.der - Encoding for DER encoded certificate.",
7197                 "oic.sec.encoding.raw - Raw hex encoded data."
7198             ],
7199             "enum": [
7200                 "oic.sec.encoding.jwt",
7201                 "oic.sec.encoding.cwt",
7202                 "oic.sec.encoding.base64",
7203                 "oic.sec.encoding.uri",
7204                 "oic.sec.encoding.pem",
7205                 "oic.sec.encoding.der",
7206                 "oic.sec.encoding.raw"
7207             ],
7208             "type": "string"
7209         }
7210     },
7211     "type": "object"
7212 },
7213 "roleid": {
7214     "description": "The role this credential possesses\nSecurity role specified as an
7215 <Authority> & <Rolename>. A NULL <Authority> refers to the local entity or Device.",
7216     "properties": {
7217         "authority": {
7218             "description": "The Authority component of the entity being identified. A NULL
7219 <Authority> refers to the local entity or Device.",
7220             "type": "string"
7221         },
7222         "role": {
7223             "description": "The ID of the role being identified.",
7224             "type": "string"
7225         }
7226     },
7227     "required": [
7228         "role"

```

```

7229         ],
7230         "type": "object"
7231     },
7232     "subjectuuid": {
7233         "anyOf": [
7234             {
7235                 "description": "The id of the Device, which the cred entry applies to or \"*\
7236 for wildcard identity.",
7237                 "pattern": "^\\*$",
7238                 "type": "string"
7239             },
7240             {
7241                 "description": "Format pattern according to IETF RFC 4122.",
7242                 "pattern": "^[a-fA-F0-9]{8}-[a-fA-F0-9]{4}-[a-fA-F0-9]{4}-[a-fA-F0-9]{4}-[a-fA-
7243 F0-9]{12}$",
7244                 "type": "string"
7245             }
7246         ]
7247     },
7248 },
7249 "type": "object"
7250 },
7251 "type": "array"
7252 }
7253 },
7254 "type": "object",
7255 "required": ["roles"]
7256 }
7257 }
7258 }
7259

```

7260 C.7.5 Property definition

7261 Table C-11 defines the Properties that are part of the "oic.r.roles" Resource Type.

7262 **Table C-11 – The Property definitions of the Resource with type "rt" = "oic.r.roles".**

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	
id	multiple types: see schema	No	Read Write	
roles	array: see schema	Yes	Read Write	List of role certificates.
if	array: see schema	No	Read Only	The interface set supported by this Resource.
roles	array: see schema	Yes	Read Write	List of role certificates.

7263 C.7.6 CRUDN behaviour

7264 Table C-12 defines the CRUDN operations that are supported on the "oic.r.roles" Resource Type.

7265 **Table C-12 – The CRUDN operations of the Resource with type "rt" = "oic.r.roles".**

Create	Read	Update	Delete	Notify
	get	post	delete	observe

C.8 Security Profile

C.8.1 Introduction

Resource specifying supported and active security profile(s).

C.8.2 Well-known URI

/oic/sec/sp

C.8.3 Resource type

The Resource Type is defined as: "oic.r.sp".

C.8.4 OpenAPI 2.0 definition

```
{
  "swagger": "2.0",
  "info": {
    "title": "Security Profile",
    "version": "2019-02-08",
    "license": {
      "name": "OCF Data Model License",
      "url":
        "https://github.com/openconnectivityfoundation/core/blob/e28a9e0a92e17042ba3e83661e4c0fbce8bdc4ba/LI
        CENSE.md",
      "x-copyright": "copyright 2016-2017, 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/sec/sp" : {
      "get": {
        "description": "Resource specifying supported and active security profile(s).\n",
        "parameters": [
          {"$ref": "#/parameters/interface"}
        ],
        "responses": {
          "200": {
            "description": "",
            "x-example":
              {
                "rt": ["oic.r.sp"],
                "supportedprofiles" : ["1.3.6.1.4.1.51414.0.0.1.0", " 1.3.6.1.4.1.51414.0.0.2.0"],
                "currentprofile" : "1.3.6.1.4.1.51414.0.0.1.0"
              },
            "schema": { "$ref": "#/definitions/SP" }
          },
          "400": {
            "description": "The request is invalid."
          }
        }
      },
      "post": {
        "description": "Sets or updates Device provisioning status data.\n",
        "parameters": [
          {"$ref": "#/parameters/interface"},
          {
            "name": "body",
            "in": "body",
            "required": true,
            "schema": { "$ref": "#/definitions/SP-Update" },
            "x-example":
              {
                "supportedprofiles" : ["1.3.6.1.4.1.51414.0.0.1.0", " 1.3.6.1.4.1.51414.0.0.2.0"],
                "currentprofile" : "1.3.6.1.4.1.51414.0.0.1.0"
              }
          }
        ]
      }
    }
  }
}
```



```

7329         }
7330     },
7331 ],
7332 "responses": {
7333     "200": {
7334         "description": "",
7335         "x-example":
7336             {
7337                 "rt": ["oic.r.sp"],
7338                 "supportedprofiles" : ["1.3.6.1.4.1.51414.0.0.1.0", " 1.3.6.1.4.1.51414.0.0.2.0"],
7339                 "currentprofile" : "1.3.6.1.4.1.51414.0.0.1.0"
7340             },
7341         "schema": { "$ref": "#/definitions/SP" }
7342     },
7343     "400": {
7344         "description": "The request is invalid."
7345     }
7346 }
7347 },
7348 },
7349 },
7350 "parameters": {
7351     "interface" : {
7352         "in" : "query",
7353         "name" : "if",
7354         "type" : "string",
7355         "enum" : [ "oic.if.rw", "oic.if.baseline" ]
7356     }
7357 },
7358 "definitions": {
7359     "SP" : {
7360         "properties": {
7361             "rt": {
7362                 "description": "Resource Type of the Resource.",
7363                 "items": {
7364                     "maxLength": 64,
7365                     "type": "string",
7366                     "enum": ["oic.r.sp"]
7367                 },
7368                 "minItems": 1,
7369                 "readOnly": true,
7370                 "type": "array"
7371             },
7372             "n": {
7373                 "$ref":
7374 "https://openconnectivityfoundation.github.io/core/schemas/oic.common.properties.core-
7375 schema.json#/definitions/n"
7376             },
7377             "id": {
7378                 "$ref":
7379 "https://openconnectivityfoundation.github.io/core/schemas/oic.common.properties.core-
7380 schema.json#/definitions/id"
7381             },
7382             "currentprofile": {
7383                 "description": "Security Profile currently active.",
7384                 "type": "string"
7385             },
7386             "supportedprofiles": {
7387                 "description": "Array of supported Security Profiles.",
7388                 "items": {
7389                     "type": "string"
7390                 },
7391                 "type": "array"
7392             },
7393             "if": {
7394                 "description": "The interface set supported by this Resource.",
7395                 "items": {
7396                     "enum": [ "oic.if.rw", "oic.if.baseline" ],
7397                     "type": "string"
7398                 },
7399                 "minItems": 1,
7400                 "readOnly": true,

```

```

7401         "type": "array"
7402     }
7403 },
7404 "type" : "object",
7405 "required": ["supportedprofiles", "currentprofile"]
7406 },
7407 "SP-Update" : {
7408     "properties": {
7409         "currentprofile": {
7410             "description": "Security Profile currently active.",
7411             "type": "string"
7412         },
7413         "supportedprofiles": {
7414             "description": "Array of supported Security Profiles.",
7415             "items": {
7416                 "type": "string"
7417             },
7418             "type": "array"
7419         }
7420     },
7421     "type" : "object"
7422 }
7423 }
7424 }
7425

```

7426 C.8.5 Property definition

7427 Table C-13 defines the Properties that are part of the "oic.r.sp" Resource Type.

7428 **Table C-13 – The Property definitions of the Resource with type "rt" = "oic.r.sp".**

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	
id	multiple types: see schema	No	Read Write	
currentprofile	string	Yes	Read Write	Security Profile currently active.
supportedprofiles	array: see schema	Yes	Read Write	Array of supported Security Profiles.
if	array: see schema	No	Read Only	The interface set supported by this Resource.
currentprofile	string		Read Write	Security Profile currently active.
supportedprofiles	array: see schema		Read Write	Array of supported Security Profiles.

7429 C.8.6 CRUDN behaviour

7430 Table C-14 defines the CRUDN operations that are supported on the "oic.r.sp" Resource Type.

7431 **Table C-14 – The CRUDN operations of the Resource with type "rt" = "oic.r.sp".**

Create	Read	Update	Delete	Notify
	get	post		observe

C.9 Auditable Event List

C.9.1 Introduction

This Resource contains the Auditable Events that have been logged on the Device.

C.9.2 Well-known URI

/oic/sec/ael

C.9.3 Resource type

The Resource Type is defined as: "oic.r.ael".

C.9.4 OpenAPI 2.0 definition

```
{
  "swagger": "2.0",
  "info": {
    "title": "Auditable Event List",
    "version": "2019-10-03",
    "license": {
      "name": "OCF Data Model License",
      "url":
"https://github.com/openconnectivityfoundation/core/blob/e28a9e0a92e17042ba3e83661e4c0fbce8bdc4ba/LI
CENSE.md",
      "x-copyright": "Copyright 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": {
    "/AelResURI": {
      "get": {
        "description": "This Resource contains the Auditable Events that have
been logged on the Device.",
        "parameters": [{" $ref": "#/parameters/interface"}],
        "responses": {
          "200": {
            "description": "Example response payload. In this
example, 'oic.d.light' Device has logged 2 Auditable Event Entries: Update attempt against
'/room1/led1' Resource was denied, and Delete attempt against '/room1/led1' Resource was denied.
Both Auditable Event Entries belong to 'AccessControl (0x01)' category and 'WARN' priority (2).",
            "x-example": {
              "rt": [ "oic.r.ael" ],
              "events": [
                {
                  "aeid": "AC-1",
                  "category": 1,
                  "priority": 2,
                  "timestamp": "2018-11-
13T20:22:39+00:00",
                  "message": "Access Denied",
                  "auxiliaryinfo":
[ "[2001::1]:1234", "0f33887b-f7d6-4fdb-9125-dd4b60d5aaae", "/room1/led1", "UPDATE", "RFNOP", "No
roles asserted" ]
                },
                {
                  "aeid": "AC-1",
                  "category": 1,
                  "priority": 2,
                  "timestamp": "2018-11-
13T20:20:00+00:00",
                  "message": "Access Denied",
                  "auxiliaryinfo":
[ "[2001::1]:1234", "0f33887b-f7d6-4fdb-9125-dd4b60d5aaae", "/room1/led1", "DELETE", "RFNOP", "No
roles asserted" ]
                }
              ]
            }
          }
        }
      }
    }
  }
}
```

```

7495         ],
7496         "usedspace": 2,
7497         "maxspace": 5,
7498         "categoryfilter": 3,
7499         "priorityfilter": 1
7500     },
7501     "schema": { "$ref": "#/definitions/Ael" }
7502 }
7503 }
7504 },
7505 "post": {
7506     "description": "An UPDATE operation may set the 'categoryfilter'
7507 and/or 'priorityfilter' Properties.",
7508     "parameters": [
7509         {
7510             "$ref": "#/parameters/interface"
7511         },
7512         {
7513             "in": "body",
7514             "name": "body",
7515             "required": true,
7516             "schema": { "$ref": "#/definitions/Ael-Update" },
7517             "x-example": {
7518                 "categoryfilter": 3,
7519                 "priorityfilter": 1
7520             }
7521         }
7522     ],
7523     "responses": {
7524         "204": {
7525             "description": "The new categoryfilter and
7526 priorityfilter were set."
7527         }
7528     }
7529 }
7530 },
7531 },
7532 "parameters": {
7533     "interface": {
7534         "in": "query",
7535         "name": "if",
7536         "type": "string",
7537         "enum": [ "oic.if.rw", "oic.if.baseline" ]
7538     }
7539 },
7540 "definitions": {
7541     "Aee": {
7542         "description": "Auditable Event Entry logged by a Device",
7543         "type": "object",
7544         "properties": {
7545             "aeid": {
7546                 "description": "Identity of the logged event",
7547                 "type": "string",
7548                 "readOnly": true
7549             },
7550             "category": {
7551                 "description": "Category of this Auditable Event: 0x01
7552 (Access Control), 0x02 (Onboarding), 0x04 (Device), 0x08 (Authentication), 0x10 (SVR Modification),
7553 0x20 (Cloud), 0x40 (Communication), 0x80 (Reserved)",
7554                 "type": "integer",
7555                 "enum": [
7556                     1, 2, 4, 8, 16, 32, 64, 128
7557                 ],
7558                 "readOnly": true
7559             },
7560             "priority": {
7561                 "description": "Priority of this Auditable Event: 0 (CRIT), 1
7562 (ERR), 2 (WARN), 3 (INFO), 4 (DEBUG)",
7563                 "type": "integer",
7564                 "enum": [
7565                     0, 1, 2, 3, 4
7566                 ],

```

```

7567         "readOnly": true
7568     },
7569     "timestamp": {
7570         "description": "Time when this Auditable Event occurred",
7571         "type": "string",
7572         "format": "date-time",
7573         "readOnly": true
7574     },
7575     "message": {
7576         "description": "Description for this Auditable Event",
7577         "type": "string",
7578         "readOnly": true
7579     },
7580     "auxiliaryinfo": {
7581         "description": "Supplementary info for Auditable Event
7582 message. (e.g. URI of specific Resource in ACE2 for 'Access Denied' message)",
7583         "type": "array",
7584         "minItems": 0,
7585         "items": {
7586             "type": "string"
7587         },
7588         "readOnly": true
7589     }
7590 },
7591 "required": [
7592     "aeid", "message", "auxiliaryinfo", "category", "priority",
7593 "timestamp"
7594 ],
7595 },
7596
7597 "Ael": {
7598     "description": "Resource for storing Auditable Events List",
7599     "type": "object",
7600     "properties": {
7601         "rt": {
7602             "description": "Resource Type",
7603             "type": "array",
7604             "minItems": 1,
7605             "uniqueItems": true,
7606             "items": {
7607                 "maxLength": 64,
7608                 "type": "string",
7609                 "enum": [ "oic.r.ael" ]
7610             },
7611             "readOnly": true
7612         },
7613         "n": {
7614             "$ref":
7615 "https://openconnectivityfoundation.github.io/core/schemas/oic.common.properties.core-
7616 schema.json#/definitions/n"
7617         },
7618         "id": {
7619             "$ref":
7620 "https://openconnectivityfoundation.github.io/core/schemas/oic.common.properties.core-
7621 schema.json#/definitions/id"
7622         },
7623         "if": {
7624             "description": "The OCF Interface set supported by this
7625 Resource",
7626             "type": "array",
7627             "minItems": 2,
7628             "uniqueItems": true,
7629             "items": {
7630                 "type": "string",
7631                 "enum": [ "oic.if.rw", "oic.if.baseline" ]
7632             },
7633             "readOnly": true
7634         },
7635         "events": {
7636             "description": "This list stores AEEs whose 'category'
7637 Property value is filtered by 'categoryfilter' Property and 'priority' Property value is equal or
7638 less than the value of 'priorityfilter' Property.",

```

```

7639         "type": "array",
7640         "uniqueItems": true,
7641         "items": {
7642             "$ref": "#/definitions/Aee"
7643         }
7644     },
7645     "usedspace": {
7646         "description": "Current used space for logged AEEs. The
7647 Device updates this Property whenever new AEEs are logged.",
7648         "type": "integer",
7649         "default": 0,
7650         "readOnly": true
7651     },
7652     "maxspace": {
7653         "description": "This means the maximum allowable storage size
7654 for AEEs that can be stored in 'events' list. The Manufacturer chooses this value.",
7655         "type": "integer",
7656         "readOnly": true
7657     },
7658     "unit": {
7659         "description": "The unit for 'usedspace' and 'maxspace'
7660 Properties. The Manufacturer chooses this value.",
7661         "type": "string",
7662         "enum": [
7663             "Kbyte",
7664             "Byte"
7665         ],
7666         "default": "Byte",
7667         "readOnly": true
7668     },
7669     "categoryfilter": {
7670         "description": "This value decides what categories of AEEs
7671 are to be logged. Meaning of each bit: 0x01 (Access Control), 0x02 (Onboarding), 0x04 (Device), 0x08
7672 (Authentication), 0x10 (SVR Modification), 0x20 (Cloud), 0x40 (Communication), 0x80 (Reserved).
7673 e.g.) if categoryfilter == 0xff: log all events of all categories, e.g.) if categoryfilter == 0x03:
7674 log all events of 'AC (== 0x01)' and 'OB (==0x02)' categories ",
7675         "type": "integer",
7676         "default": 255
7677     },
7678     "priorityfilter": {
7679         "description": "The AEEs whose 'priority' values are equal to
7680 or smaller than this value are logged. A smaller value means a higher priority. Meaning of each
7681 value: 0 (CRIT), 1 (ERR), 2 (WARN), 3 (INFO), 4 (DEBUG). e.g.) if priorityfilter is set to DEBUG
7682 (==4) all AEEs will be logged, e.g.) if priorityfilter is set to 1, CRIT (==0) and ERR (==1) AEEs
7683 will be logged ",
7684         "type": "integer",
7685         "default": 4,
7686         "enum": [
7687             0, 1, 2, 3, 4
7688         ]
7689     },
7690     },
7691     "required": [
7692         "events", "usedspace", "maxspace", "categoryfilter", "priorityfilter"
7693     ],
7694 },
7695 "Ael-Update": {
7696     "type": "object",
7697     "properties": {
7698         "categoryfilter": {
7699             "description": "This value decides what categories of AEEs
7700 are to be logged. Meaning of each bit: 0x01 (Access Control), 0x02 (Onboarding), 0x04 (Device), 0x08
7701 (Authentication), 0x10 (SVR Modification), 0x20 (Cloud), 0x40 (Communication). e.g.) if
7702 categoryfilter == 0xff: log all events of all categories, e.g.) if categoryfilter == 0x03: log all
7703 events of 'AC (== 0x01)' and 'OB (==0x02)' categories ",
7704             "type": "integer",
7705             "default": 255
7706         },
7707         "priorityfilter": {
7708             "description": "The AEEs whose 'priority' values are equal to
7709 or smaller than this value are logged. A smaller value means a higher priority. Meaning of each
7710 value: 0 (CRIT), 1 (ERR), 2 (WARN), 3 (INFO), 4 (DEBUG). e.g.) if priorityfilter is set to DEBUG

```

```

7711 (==4) all AEEs will be logged, e.g.) if priorityfilter is set to 1, CRIT (==0) and ERR (==1) AEEs
7712 will be logged ",
7713         "type": "integer",
7714         "default": 4,
7715         "enum": [
7716             0, 1, 2, 3, 4
7717         ]
7718     },
7719     "required": [
7720         "categoryfilter", "priorityfilter"
7721     ]
7722 }
7723 }
7724 }
7725 }
7726 }
7727 }

```

7728 C.9.5 Property definition

7729 Table C-15 defines the Properties that are part of the "oic.r.ael" Resource Type.

7730 **Table C-15 – The Property definitions of the Resource with type "rt" = "oic.r.ael".**

Property name	Value type	Mandatory	Access mode	Description
aeid	string	Yes	Read Only	Identity of the logged event
category	integer	Yes	Read Only	Category of this Auditable Event: 0x01 (Access Control), 0x02 (Onboarding), 0x04 (Device), 0x08 (Authentication), 0x10 (SVR Modification), 0x20 (Cloud), 0x40 (Communication), 0x80 (Reserved)
priority	integer	Yes	Read Only	
timestamp	string	Yes	Read Only	Time when this Auditable Event occurred
message	string	Yes	Read Only	Description for this Auditable Event
auxiliaryinfo	array: see schema	Yes	Read Only	Supplementary info for Auditable Event message. (e.g. URI of specific Resource in ACE2 for 'Access Denied' message)
rt	array: see schema	No	Read Only	Resource Type
n	multiple types: see schema	No	Read Write	
id	multiple types: see schema	No	Read Write	
if	array: see schema	No	Read Only	The OCF Interface set supported by this Resource
events	array: see schema	Yes	Read Write	This list stores AEEs whose 'category' Property value is filtered by

				'categoryfilter' Property and 'priority' Property value is equal or less than the value of 'priorityfilter' Property.
usedspace	integer	Yes	Read Only	Current used space for logged AEEs. The Device updates this Property whenever new AEEs are logged.
maxspace	integer	Yes	Read Only	This means the maximum allowable storage size for AEEs that can be stored in 'events' list. The Manufacturer chooses this value.
unit	string	No	Read Only	The unit for 'usedspace' and 'maxspace' Properties. The Manufacturer chooses this value.
categoryfilter	integer	Yes	Read Write	This value decides what categories of AEEs are to be logged. Meaning of each bit: 0x01 (Access Control), 0x02 (Onboarding), 0x04 (Device), 0x08 (Authentication), 0x10 (SVR Modification), 0x20 (Cloud), 0x40 (Communication), 0x80 (Reserved). e.g.) if categoryfilter == 0xff: log all events of all categories, e.g.) if categoryfilter == 0x03: log all events of 'AC' (== 0x01) and 'OB' (==0x02) categories
priorityfilter	integer	Yes	Read Write	The AEEs whose 'priority' values are equal to or smaller than this value are logged. A smaller value means a higher priority. Meaning of each value: 0 (CRIT), 1 (ERR), 2 (WARN), 3 (INFO), 4 (DEBUG). e.g.) if priorityfilter is set to DEBUG (==4) all AEEs will be logged, e.g.) if priorityfilter is set to 1, CRIT (==0) and

				ERR (==1) AEEs will be logged
categoryfilter	integer	Yes	Read Write	This value decides what categories of AEEs are to be logged. Meaning of each bit: 0x01 (Access Control), 0x02 (Onboarding), 0x04 (Device), 0x08 (Authentication), 0x10 (SVR Modification), 0x20 (Cloud), 0x40 (Communication). e.g.) if categoryfilter == 0xff: log all events of all categories, e.g.) if categoryfilter == 0x03: log all events of 'AC (== 0x01)' and 'OB (==0x02)' categories
priorityfilter	integer	Yes	Read Write	The AEEs whose 'priority' values are equal to or smaller than this value are logged. A smaller value means a higher priority. Meaning of each value: 0 (CRIT), 1 (ERR), 2 (WARN), 3 (INFO), 4 (DEBUG). e.g.) if priorityfilter is set to DEBUG (==4) all AEEs will be logged, e.g.) if priorityfilter is set to 1, CRIT (==0) and ERR (==1) AEEs will be logged

C.9.6 CRUDN behaviour

Table C-16 defines the CRUDN operations that are supported on the "oic.r.ael" Resource Type.

Table C-16 – The CRUDN operations of the Resource with type "rt" = "oic.r.ael".

Create	Read	Update	Delete	Notify
	get	post		observe

C.10 Security Domain Information

C.10.1 Introduction

This Resource contains the information that identifies the OCF Security Domain to which the device belongs.

C.10.2 Well-known URI

/oic/sec/sdi

C.10.3 Resource type

The Resource Type is defined as: "oic.r.sdi".

C.10.4 OpenAPI 2.0 definition

```
{
  "swagger": "2.0",
  "info": {
    "title": "Security Domain Information",
    "version": "2019-10-01",
    "license": {
      "name": "OCF Data Model License",
      "url":
"https://github.com/openconnectivityfoundation/core/blob/e28a9e0a92e17042ba3e83661e4c0fbce8bdc4ba/LI
CENSE.md",
      "x-copyright": "copyright 2016-2017, 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/sec/sdi" : {
      "get": {
        "description": "This Resource contains the information that identifies the OCF Security
Domain to which the device belongs.\n",
        "parameters": [
          {"$ref": "#/parameters/interface"}
        ],
        "responses": {
          "200": {
            "description": "Success",
            "x-example":
{
  "rt": ["oic.r.sdi"],
  "uuid": "de305d54-75b4-431b-adb2-eb6b9e546014",
  "name": "Home",
  "priv": true
},
            "schema": { "$ref": "#/definitions/Sdi" }
          },
          "400": {
            "description": "The request is invalid."
          }
        }
      },
      "post": {
        "description": "Provision the OCF Security Domain information.\n",
        "parameters": [
          {"$ref": "#/parameters/interface"},
          {
            "name": "body",
            "in": "body",
            "required": true,
            "schema": { "$ref": "#/definitions/Sdi-Update" },
            "x-example": {
              "uuid": "de305d54-75b4-431b-adb2-eb6b9e546014",
              "name": "Home",
              "priv": false
            }
          }
        ],
        "responses": {
          "400": {
            "description": "The request is invalid."
          },
          "204": {
            "description": "The SDI is updated.",
            "schema": { "$ref": "#/definitions/Sdi-Update" },

```

```

7810         "x-example": {
7811             "uuid": "de305d54-75b4-431b-adb2-eb6b9e546014",
7812             "name": "Home",
7813             "priv": false
7814         }
7815     }
7816 }
7817 }
7818 },
7819 },
7820 "parameters": {
7821     "interface" : {
7822         "in" : "query",
7823         "name" : "if",
7824         "type" : "string",
7825         "enum" : [ "oic.if.rw", "oic.if.baseline" ]
7826     }
7827 },
7828 "definitions": {
7829     "Sdi" : {
7830         "properties": {
7831             "uuid": {
7832                 "$ref": "https://openconnectivityfoundation.github.io/core/schemas/oic.types-
7833 schema.json#/definitions/uuid"
7834             },
7835             "name": {
7836                 "description": "Human-friendly name for the Security Domain, set by DOTS during
7837 onboarding.",
7838                 "type": "string"
7839             },
7840             "rt": {
7841                 "description": "Resource Type of the Resource.",
7842                 "items": {
7843                     "maxLength": 64,
7844                     "type": "string",
7845                     "enum": ["oic.r.sdi"]
7846                 },
7847                 "minItems": 1,
7848                 "readOnly": true,
7849                 "type": "array"
7850             },
7851             "n": {
7852                 "$ref":
7853 "https://openconnectivityfoundation.github.io/core/schemas/oic.common.properties.core-
7854 schema.json#/definitions/n"
7855             },
7856             "id": {
7857                 "$ref":
7858 "https://openconnectivityfoundation.github.io/core/schemas/oic.common.properties.core-
7859 schema.json#/definitions/id"
7860             },
7861             "priv": {
7862                 "description": "Flag to indicate whether the Security Domain Information is copied to
7863 \"/oic/res\", and thus, whether it is publicly visible or private.",
7864                 "type": "boolean"
7865             },
7866             "if" : {
7867                 "description": "The interface set supported by this Resource.",
7868                 "items": {
7869                     "enum": [ "oic.if.rw", "oic.if.baseline" ],
7870                     "type": "string"
7871                 },
7872                 "minItems": 1,
7873                 "readOnly": true,
7874                 "type": "array"
7875             }
7876         },
7877         "type" : "object",
7878         "required": [ "uuid", "name", "priv" ]
7879     },
7880
7881     "Sdi-Update" : {

```

```

7882     "properties": {
7883         "uuid": {
7884             "$ref": "https://openconnectivityfoundation.github.io/core/schemas/oic.types-
7885 schema.json#/definitions/uuid"
7886         },
7887         "name": {
7888             "description": "Human-friendly name for the Security Domain, set by DOTS during
7889 onboarding.",
7890             "type": "string"
7891         },
7892         "priv": {
7893             "description": "Flag to indicate whether the Security Domain Information is copied to
7894 \"/oic/res\", and thus, whether it is publicly visible or private.",
7895             "type": "boolean"
7896         }
7897     },
7898     "type": "object",
7899     "required": [ "name", "priv" ]
7900 }
7901 }
7902 }
7903

```

7904 C.10.5 Property definition

7905 Table C-17 defines the Properties that are part of the "oic.r.sdi" Resource Type.

7906 **Table C-17 – The Property definitions of the Resource with type "rt" = "oic.r.sdi".**

Property name	Value type	Mandatory	Access mode	Description
uuid	multiple types: see schema	Yes	Read Write	
name	string	Yes	Read Write	Human-friendly name for the Security Domain, set by DOTS during onboarding.
rt	array: see schema	No	Read Only	Resource Type of the Resource.
n	multiple types: see schema	No	Read Write	
id	multiple types: see schema	No	Read Write	
priv	boolean	Yes	Read Write	Flag to indicate whether the Security Domain Information is copied to "/oic/res", and thus, whether it is publicly visible or private.
if	array: see schema	No	Read Only	The interface set supported by this Resource.
uuid	multiple types: see schema	No	Read Write	
name	string	Yes	Read Write	Human-friendly name for the Security Domain, set by DOTS during onboarding.
priv	boolean	Yes	Read Write	Flag to indicate whether the Security Domain Information is copied to

				"/oic/res", and thus, whether it is publicly visible or private.
--	--	--	--	------------------------------------------------------------------

C.10.6 CRUDN behaviour

Table C-18 defines the CRUDN operations that are supported on the "oic.r.sdi" Resource Type.

Table C-18 – The CRUDN operations of the Resource with type "rt" = "oic.r.sdi".

Create	Read	Update	Delete	Notify
	get	post		observe

Annex D (informative)

OID definitions

This annex captures the OIDs defined throughout the document. The OIDs listed are intended to be used within the context of an X.509 v3 certificate. MAX is an upper bound for SEQUENCES of UTF8Strings and OBJECT IDENTIFIERS and should not exceed 255.

```
id-OCF OBJECT IDENTIFIER ::= { iso(1) identified-organization(3) dod(6) internet(1)
    private(4) enterprise(1) OCF(51414) }

-- OCF Security specific OIDs

id-ocfSecurity OBJECT IDENTIFIER ::= { id-OCF 0 }
id-ocfX509Extensions OBJECT IDENTIFIER ::= { id-OCF 1 }

-- OCF Security Categories

id-ocfSecurityProfile ::= { id-ocfSecurity 0 }
id-ocfCertificatePolicy ::= { id-ocfSecurity 1 }

-- OCF Security Profiles

sp-unspecified ::= OBJECT IDENTIFIER { id-ocfSecurityProfile 0 }
sp-baseline ::= OBJECT IDENTIFIER { id-ocfSecurityProfile 1 }
sp-black ::= OBJECT IDENTIFIER { id-ocfSecurityProfile 2 }
sp-blue ::= OBJECT IDENTIFIER { id-ocfSecurityProfile 3 }
sp-purple ::= OBJECT IDENTIFIER { id-ocfSecurityProfile 4 }

sp-unspecified-v0 ::= ocfSecurityProfileOID {id-sp-unspecified 0}
sp-baseline-v0 ::= ocfSecurityProfileOID {id-sp-baseline 0}
sp-black-v0 ::= ocfSecurityProfileOID {id-sp-black 0}
sp-blue-v0 ::= ocfSecurityProfileOID {id-sp-blue 0}
sp-purple-v0 ::= ocfSecurityProfileOID {id-sp-purple 0}

ocfSecurityProfileOID ::= UTF8String

-- OCF Security Certificate Policies

ocfCertificatePolicy-v1 ::= { id-ocfCertificatePolicy 2}

-- OCF X.509v3 Extensions

id-ocfX509Extensions OBJECT IDENTIFIER ::= { id-OCF 1 }
id-ocfCompliance OBJECT IDENTIFIER ::= { id-ocfX509Extensions 0 }
id-ocfSecurityClaims OBJECT IDENTIFIER ::= { id-ocfX509Extensions 1 }
id-ocfCPLAttributes OBJECT IDENTIFIER ::= { id-ocfX509Extensions 2 }

ocfVersion ::= SEQUENCE {
    major    INTEGER,
    minor    INTEGER,
    build     INTEGER}

ocfCompliance ::= SEQUENCE {
    version      ocfVersion,
    securityProfile SEQUENCE SIZE (1..MAX) OF ocfSecurityProfileOID,
    deviceName    UTF8String,
    deviceManufacturer UTF8String}

claim-secure-boot ::= ocfSecurityClaimsOID { id-ocfSecurityClaims 0 }
claim-hw-backed-cred-storage ::= ocfSecurityClaimsOID { id-ocfSecurityClaims 1 }
```

```

7972
7973 ocfSecurityClaimsOID ::= OBJECT IDENTIFIER
7974
7975 ocfSecurityClaims ::= SEQUENCE SIZE (1..MAX) of ocfSecurityClaimsOID
7976
7977 cpl-at-IANAPen ::= OBJECT IDENTIFIER { id-ocfCPLAttributes 0 }
7978 cpl-at-model ::= OBJECT IDENTIFIER { id-ocfCPLAttributes 1 }
7979 cpl-at-version ::= OBJECT IDENTIFIER { id-ocfCPLAttributes 2 }
7980
7981 ocfCPLAttributes ::= SEQUENCE {
7982     cpl-at-IANAPen UTF8String,
7983     cpl-at-model UTF8String,
7984     cpl-at-version UTF8String}

```

Annex E (informative)

Security considerations specific to Bridged Protocols

The text in this Annex is provided for information only. This Annex has no normative impact. This information is applicable at the time of initial publication and may become out of date.

E.1 Security Considerations specific to the AllJoyn Protocol

This clause intentionally left empty.

E.2 Security Considerations specific to the Bluetooth LE Protocol

BLE GAP supports two security modes, security mode 1 and security mode 2. Each security mode has several security levels (see Table E.1)

Security mode 1 and Security level 2 or higher would typically be considered secure from an OCF perspective. The appropriate selection of security mode and level is left to the vendor.

Table E.1 GAP security mode

GAP security mode	security level
Security mode 1	1 (no security)
	2 (Unauthenticated pairing with encryption)
	3 (Authenticated pairing with encryption)
	4 (Authenticated LE Secure Connections pairing with encryption)
Security mode 2	1 (Unauthenticated pairing with data signing)
	2 (Authenticated pairing with data signing)

Figure E-1 shows how communications in both ecosystems of OCF-BLE Bridge Platform are secured by their own security.

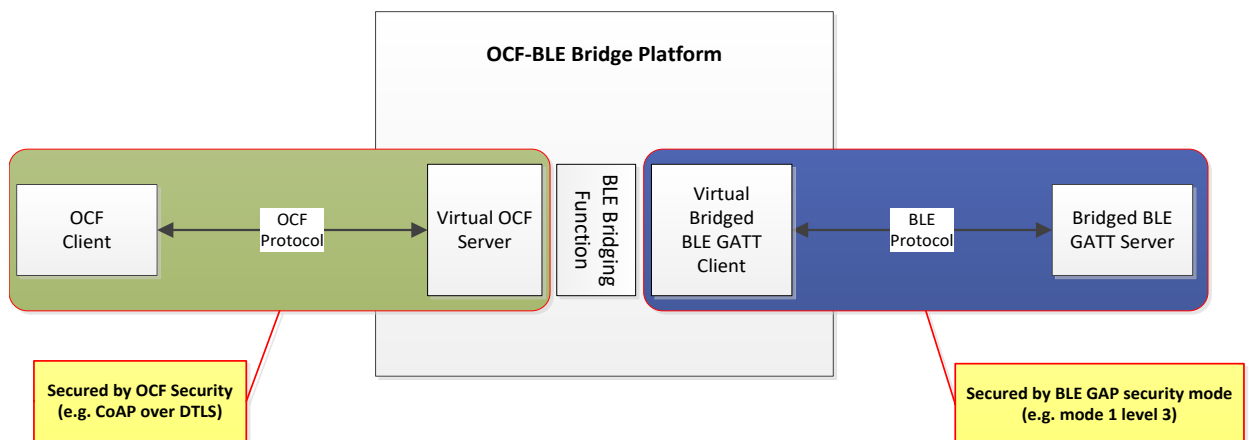


Figure E-1 Security Considerations for BLE Bridge

E.3 Security Considerations specific to the oneM2M Protocol

This clause intentionally left empty.

E.4 Security Considerations specific to the U+ Protocol

A U+ server supports one of the TLS 1.2 cipher suites as in Table E.2 defined in IETF RFC 5246.

8007

Table E.2 TLS 1.2 Cipher Suites used by U+

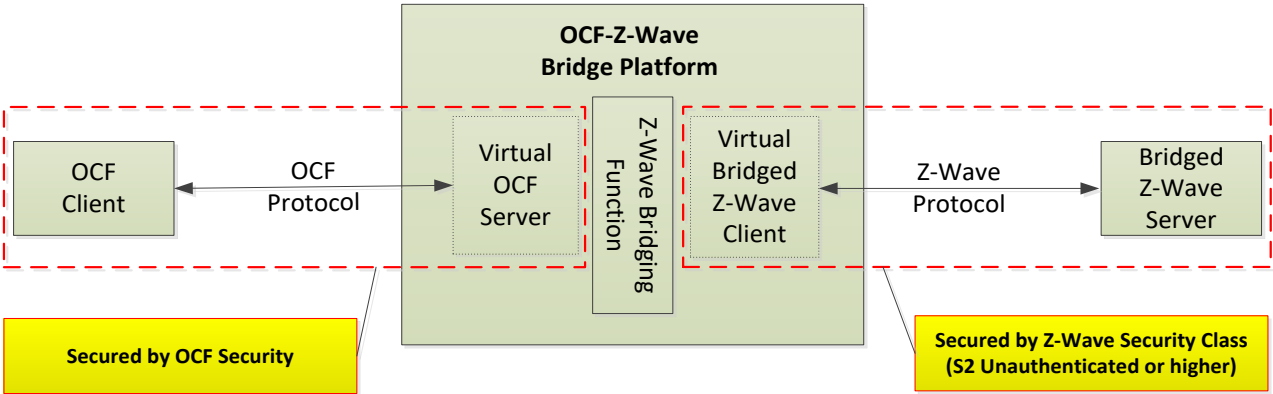
Cipher Suite
TLS_RSA_WITH_AES_128_CBC_SHA256
TLS_RSA_WITH_AES_256_CBC_SHA256
TLS_RSA_WITH_AES_256_CCM
TLS_RSA_WITH_AES_256_CCM_8
TLS_RSA_WITH_AES_256_GCM_SHA384
TLS_DHE_RSA_WITH_AES_256_CBC_SHA256
TLS_DHE_RSA_WITH_AES_256_GCM_SHA384
TLS_ECDH_ECDSA_WITH_AES_256_CBC_SHA384
TLS_ECDH_ECDSA_WITH_AES_256_GCM_SHA384
TLS_ECDH_RSA_WITH_AES_256_CBC_SHA384
TLS_ECDH_RSA_WITH_AES_256_GCM_SHA384
TLS_ECDHE_ECDSA_WITH_AES_256_CBC_SHA384
TLS_ECDHE_ECDSA_WITH_AES_256_CCM
TLS_ECDHE_ECDSA_WITH_AES_256_CCM_8
TLS_ECDHE_ECDSA_WITH_AES_256_GCM_SHA384
TLS_ECDHE_RSA_WITH_AES_256_CBC_SHA384
TLS_ECDHE_RSA_WITH_AES_256_GCM_SHA384
TLS_DHE_RSA_WITH_AES_256_CCM
TLS_DHE_RSA_WITH_AES_256_CCM_8

8008 The security of the Haier U+ Protocol is proprietary, and further details are presently unavailable.

8009 **E.5 Security Considerations specific to the Z-Wave Protocol**

8010 Z-Wave currently supports two kinds of security class which are S0 Security Class and S2 Security Class, as shown in Table E.3. Bridged Z-wave Servers using S2 Security Class for communication
8011 with a Virtual Bridged Client would typically be considered secure from an OCF perspective. The
8012 appropriate selection for S2 Security Class and Class Name is left to the vendor.
8013

8014 Figure E-2 presents how OCF Client and Bridged Z-Wave Server communicate based upon their
8015 own security.



8016

8017

Figure E-2 Security Considerations for Z-Wave Bridge

8018 All 3 types of S2 Security Class such as S2 Access Control, S2 Authenticated and S2
8019 Unauthenticated provides the following advantages from the security perspective;

- 8020 – The unique device specific key for every secure device enables validation of device identity and
8021 prevents man-in-the-middle compromises to security
- 8022 – The Secure cryptographic key exchange methods during inclusion achieves high level of
8023 security between the Virtual Z-Wave Client and the Bridged Z-Wave Server.
- 8024 – Out of band key exchange for product authentication which is combined with device specific
8025 key prevents eavesdropping and man-in-the-middle attack vectors.

8026 See Table E.3 for a summary of Z-Wave Security Classes.

8027 **Table E.3 Z-Wave Security Class**

Security Class	Class Name	Validation of device identity	Key Exchange	Message Encapsulation
S2	S2 Access Control	Device Specific key	Out-of-band inclusion	Encrypted command transmission
	S2 Authenticated	Device Specific key	Out-of-band inclusion	Encrypted command transmission
	S2 Unauthenticated	Device Specific key	Z-wave RF band used for inclusion	Encrypted command transmission
S0	S0 Authenticated	N/A	Z-wave RF band used for inclusion	Encrypted command transmission

8028 On the other hand, S0 Security Class has the vulnerability of security during inclusion by
8029 exchanging of temporary 'well-known key' (e.g. 1234). As a result of that, it could lead the
8030 disclosure of the network key if the log of key exchange methods is captured, so Z-Wave devices
8031 might be no longer secure in that case.

8032 **E.6 Security Considerations specific to the Zigbee Protocol**

8033 The Zigbee 3.0 stack supports multiple security levels. A security level is supported by both the
8034 network (NWK) layer and application support (APS) layer. A security attribute in the Zigbee 3.0
8035 stack, "nwkSecurityLevel", represents the security level of a device.

8036 The security level nwkSecurityLevel > 0x04 provides message integrity code (MIC) and/or AES128-
8037 CCM encryption (ENC). Zigbee Servers using nwkSecurityLevel > 0x04 would typically be
8038 considered secure from an OCF perspective. The appropriate selection for nwkSecurityLevel is left
8039 to the vendor.

8040 See Table E.4 for a summary of the Zigbee Security Levels.

8041 **Table E.4 Zigbee 3.0 Security Levels to the Network, and Application Support layers**

Security Level Identifier	Security Level Sub-Field	Security Attributes	Data Encryption	Frame Integrity (Length of M of MIC, in Number of Octets)
0x00	'000'	None	OFF	NO (M=0)
0x01	'001'	MIC-32	OFF	YES(M=4)
0x02	'010'	MIC-64	OFF	YES(M=8)
0x03	'011'	MIC-128	OFF	YES(M=16)

0x04	'100'	ENC	ON	NO(M=0)
0x05	'101'	ENC-MIC-32	ON	YES(M=4)
0x06	'110'	ENC-MIC-64	ON	YES(M=8)
0x07	'111'	ENC-MIC-128	ON	YES(M=16)

Figure E-3 shows how communications in both ecosystems of OCF-Zigbee Bridge Platform are secured by their own security.

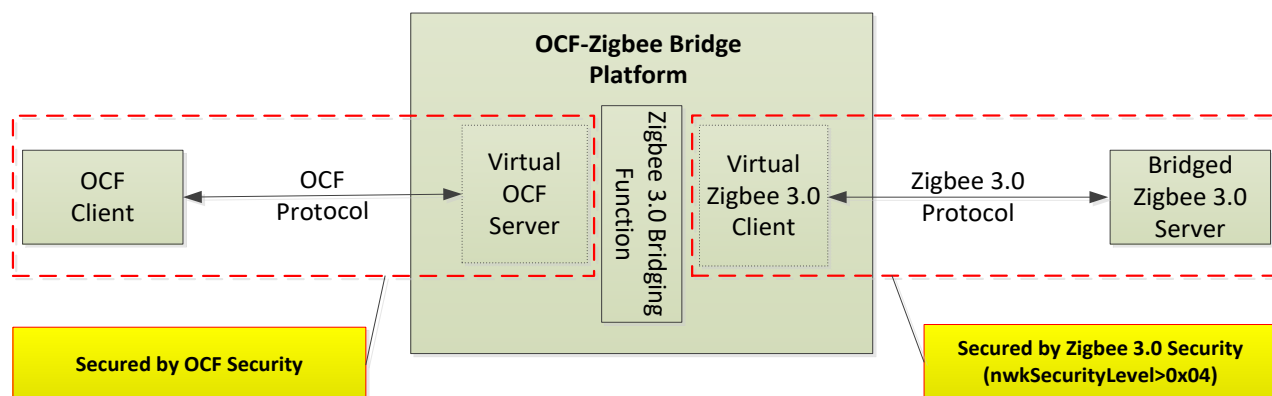


Figure E-3 Security Considerations for Zigbee Bridge

E.7 Security Considerations specific to the the EnOcean Radio Protocol

The EnOcean Radio Protocol supports four different security levels. The security level depends on which security mechanisms are used. Table E.5 defines them

Table E.5 EnOcean Radio Protocol security levels

Level	Features	Replay Attack Vulnerability	Eavesdropping Vulnerability
0	No Features (Unsecure)	Yes	Yes
1	With Encryption only	Yes	No
2	Without Encryption but with RLC and CMAC	No	Yes
3	With Encryption, RLC and CMAC	No	No

The security levels 1 and 2 have been declared deprecated and shall not longer be used. Security level 3 uses Variable AES Encryption, Rolling Code (RLC) and a cipher-based message authentication code (CMAC) with private keys and public vectors. Technically each feature can be combined with every other feature, even if it is obsolete or unreasonable.

Figure E-4 shows how communications in both ecosystems of OCF- EnOcean Bridge Platform are secured by their own security

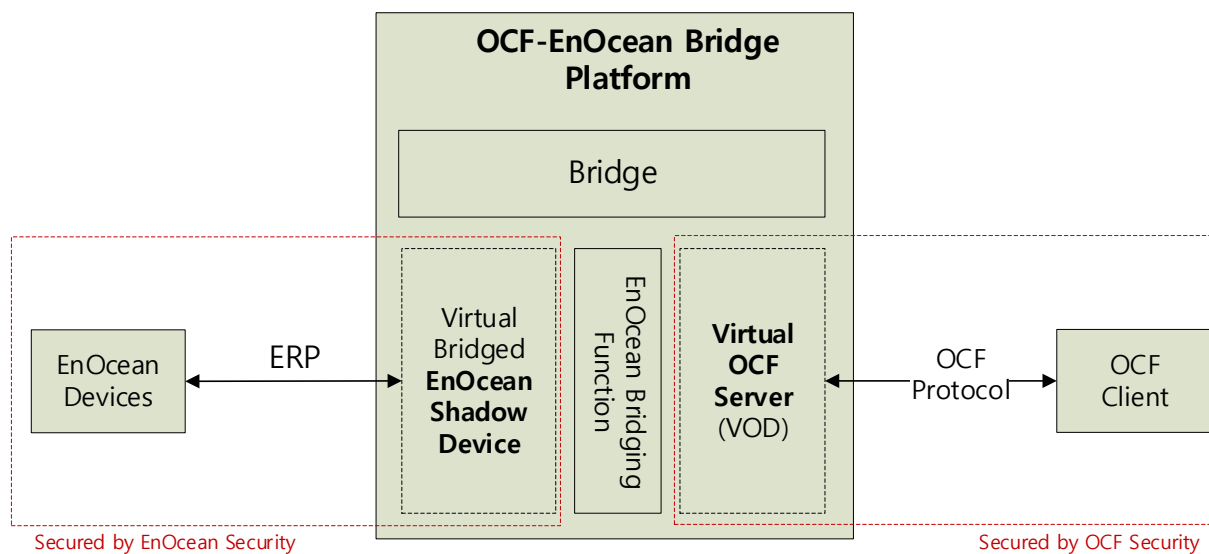


Figure E-4 Security Considerations for EnOcean Bridge