Joining of OSCORE multicast groups in ACE
draft-tiloca-ace-oscoap-joining-01

Abstract

   This document describes a method to join a multicast group where
   communications are based on CoAP and secured with Object Security for
   Constrained RESTful Environments (OSCORE). The proposed method
   delegates the authentication and authorization of client nodes that
   join an OSCORE multicast group through a Group Manager server. This
   approach builds on the ACE framework for Authentication and
   Authorization, and leverages protocol-specific profiles of ACE to
   achieve communication security, proof-of-possession and server
   authentication.

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1. Introduction

   Object Security for Constrained RESTful Environments (OSCORE)
   [I-D.ietf-core-object-security] is a method for application layer
   protection of CoAP messages, using the CBOR Object Signing and
   Encryption (COSE) [RFC8152], and enabling end-to-end security of CoAP
   payload and options.

   OSCORE may also be used to protect group communication for CoAP over
   IP multicast, as described in [I-D.tiloca-core-multicast-oscoap].
   This relies on a Group Manager entity, which is responsible for
   managing a multicast group where members exchange CoAP messages
   secured with OSCORE. In particular, the Group Manager coordinates
   the join process of new group members and can be responsible for
   multiple groups.

   This document builds on the ACE framework for Authentication and
   Authorization [I-D.ietf-ace-oauth-authz] and specifies how a client
   joins an OSCORE multicast group through a resource server acting as
   Group Manager. The client acting as joining node relies on an Access
   Token, which is bound to a proof-of-possession key and authorizes the
   access to a specific join resource at the Group Manager.

   In order to achieve communication security, proof-of-possession and
   server authentication, the client and the Group Manager leverage

protocol-specific profiles of ACE such as the CoAP-DTLS profile
[I-D.ietf-ace-dtls-authorize], the OSCOAP profile
[I-D.seitz-ace-oscoap-profile], or the IPsec profile
[I-D.aragon-ace-ipsec-profile].

1.1. Terminology

The key words "MUST", "MUST NOT", "REQUIRED", "SHALL", "SHALL NOT",
"SHOULD", "SHOULD NOT", "RECOMMENDED", "NOT RECOMMENDED", "MAY", and
"OPTIONAL" in this document are to be interpreted as described in BCP
14 [RFC2119][RFC8174] when, and only when, they appear in all
capitals, as shown here.

Readers are expected to be familiar with the terms and concepts
described in the ACE framework for authentication and authorization
[I-D.ietf-ace-oauth-authz]. Message exchanges are presented as
RESTful protocol interactions, for which HTTP [RFC7231] provides
useful terminology.

The terminology for entities in the considered architecture is
defined in OAuth 2.0 [RFC6749] and [I-D.ietf-ace-actors]. In
particular, this includes Client (C), Resource Server (RS), and
Authorization Server (AS). Terminology for constrained environments,
such as "constrained device" and "constrained-node network", is
defined in [RFC7228].

Readers are expected to be familiar with the terms and concepts
related to the CoAP protocol described in [RFC7252][RFC7390]. Note
that the term "endpoint" is used here following its OAuth definition,
aimed at denoting resources such as /token and /introspect at the AS
and /authz-info at the RS. This document does not use the CoAP
definition of "endpoint", which is "An entity participating in the
CoAP protocol".

Readers are expected to be familiar with the terms and concepts
related to the DTLS protocol [RFC6347] and with the CoAP-DTLS profile
of ACE [I-D.ietf-ace-dtls-authorize].

Readers are expected to be familiar with the terms and concepts for
protection and processing of CoAP messages through OSCORE
[I-D.ietf-core-object-security] also in group communication contexts
[I-D.tiloca-core-multicast-oscoap]; and with the OSCOAP profile of
ACE [I-D.seitz-ace-oscoap-profile].

Readers are expected to be familiar with the terms and concepts
related to the IPsec protocol suite [RFC4301]; and with the IPsec
profile of ACE [I-D.aragon-ace-ipsec-profile].

This document refers also to the following terminology.

o   Joining node: a network node intending to join an OSCORE multicast
    group, where communication is based on CoAP [RFC7390] and secured
    with OSCORE as described in [I-D.tiloca-core-multicast-oscoap].

o   Join process: the process through which a joining node becomes a
    member of an OSCORE multicast group. The join process is enforced
    and assisted by the Group Manager responsible for that group.

o   Join resource: a resource hosted by the Group Manager, associated
    to an OSCORE multicast group under that Group Manager. A joining
    node accesses the join resource in order to start the join process
    and become a member of that group.

o   Join endpoint: an endpoint at the Group Manager associated to a
    join resource.

2. Protocol Overview

Group communication for CoAP over IP multicast has been enabled in
[RFC7390] and can be secured with Object Security for Constrained
RESTful Environments (OSCORE) [I-D.ietf-core-object-security] as
described in [I-D.tiloca-core-multicast-oscoap]. A network node
explicitly joins an OSCORE multicast group, by interacting with the
responsible Group Manager. Once registered in the group, the new
node can securely exchange (multicast) messages with other group
members.

This specification describes how a network node joins an OSCORE
multicast group leveraging the ACE framework for authentication and
authorization [I-D.ietf-ace-oauth-authz]. With reference to the ACE
framework and the terminology defined in OAuth 2.0 [RFC6749]:

o   The Group Manager acts as Resource Server (RS), and hosts one join
    resource for each OSCORE multicast group it manages. Each join
    resource is exported by a distinct join endpoint.

o   The joining node acts as Client (C), and requests to join an
    OSCORE multicast group by accessing the related join endpoint at
    the Group Manager.

o   The Authorization Server (AS) enables and enforces the authorized
    access of joining nodes to join endpoints at the Group Manager.
    Multiple Group Managers can be associated to the same AS.

If the joining node is authorized to join the multicast group, it
receives from the AS an Access Token bound with a proof-of-possession

key. After that, the joining node provides the Group Manager with
the Access Token. This step involves the opening of a secure
communication channel between the joining node and the Group Manager,
in case they have not already established one.

Finally, the joining node accesses the join endpoint at the Group
Manager, so starting the join process to become a member of the
OSCORE multicast group. A same Access Token can authorize the
joining node to access multiple groups under the same Group Manager.
In such a case, the joining node sequentially performs multiple join
processes with the Group Manager, separately for each multicast group
to join and by accessing the respective join endpoint.

The AS is not necessarily expected to release Access Tokens for any
other purpose than accessing join resources on registered Group
Managers. However, the AS may be configured also to release Access
Tokens for accessing resources at members of multicast groups.

The following steps are performed for joining an OSCORE multicast
group, by leveraging one of the available profiles of ACE, such as
the CoAP-DTLS profile [I-D.ietf-ace-dtls-authorize], the OSCOAP
profile [I-D.seitz-ace-oscoap-profile], or the IPsec profile
[I-D.aragon-ace-ipsec-profile].

1. The joining node retrieves an Access Token from the AS to access
    a join resource on the Group Manager (see Section 3). The
    response from the AS enables the joining node to start a secure
    channel with the Group Manager, if not already established. The
    joining node can also contact the AS for updating a previously
    released Access Token, in order to access further groups under
    the same Group Manager (see Section 6).

2. Authentication and authorization information is transferred
    between the joining node and the Group Manager, which establish a
    secure channel in case one is not already set up (see Section 4).
    That is, a joining node MUST establish a secure communication
    channel with a Group Manager, before joining an OSCORE multicast
    group under that Group Manager for the first time.

3. The joining node starts the join process to become a member of
    the OSCORE multicast group, by accessing the related join
    resource hosted by the Group Manager (see Section 4).

All communications between the involved entities rely on the CoAP
protocol and MUST be secured. In particular, communications between
the joining node and the AS (/token endpoint) and between the Group
Manager and the AS (/introspection endpoint) can be secured by
different means, for instance by means of DTLS [RFC6347], OSCORE (see

Sections 2.3 and 3 of [I-D.seitz-ace-oscoap-profile]), or IPsec (see Sections 3.2 and 3.4 of [I-D.aragon-ace-ipsec-profile]).

Further details on how the AS secures communications (with the joining node and the Group Manager) depend on the specifically used profile of ACE, and are out of the scope of this specification.

3. Joining Node to Authorization Server

This section considers a joining node that intends to contact the Group Manager for the first time. That is, the joining node has never attempted before to join an OSCORE multicast group under that Group Manager. Also, the joining node and the Group Manager do not have a secure communication channel established.

In case the specific AS associated to the Group Manager is unknown to the joining node, the latter can rely on mechanisms like the Unauthorized Resource Request message described in Section 2.1 of [I-D.ietf-ace-dtls-authorize] to discover the correct AS in charge of the Group Manager. As an alternative, the joining node may look up in a Resource Directory service [I-D.ietf-core-resource-directory].

The joining node contacts the AS, in order to request an Access Token for accessing the join resource(s) hosted by the Group Manager. In particular, the Access Token request sent to the /token endpoint specifies the join endpoint(s) of interest at the Group Manager.

The AS is responsible for authorizing the joining node, accordingly to group join policies enforced on behalf of the Group Manager. In case of successful authorization, the AS releases an Access Token bound to a proof-of-possession key associated to the joining node. The same Access Token can authorize the joining node to access multiple groups under the same Group Manager.

Then, the AS provides the joining node with the Access Token, together with an Access Token response. In particular, the Access Token response indicates how to secure communications with the Group Manager, when accessing the join resource(s) for which the Access Token is valid. Specifically, the Access Token response MUST specify one of the following alternatives:

o CoAP over DTLS, i.e. coaps://, indicating to consider the CoAP-
   DTLS profile of ACE, with asymmetric or symmetric proof-of-
   possession key (see Section 3 and Section 4 of
   [I-D.ietf-ace-dtls-authorize], respectively).

o OSCOAP, indicating to consider the OSCOAP profile of ACE with the
   symmetric proof-of-possession key used directly as Master Secret

in OSCORE [I-D.ietf-core-object-security], as described in
Section 2 of [I-D.seitz-ace-oscoap-profile].

o   IPsec, indicating to consider the IPsec profile of ACE, with
    symmetric or asymmetric proof-of-possession key (see Section 3.2.2
    and Section 3.2.3 of [I-D.aragon-ace-ipsec-profile],
    respectively).

Consistently with the profiles of ACE [I-D.ietf-ace-dtls-authorize][I
-D.seitz-ace-oscoap-profile][I-D.aragon-ace-ipsec-profile], a
symmetric proof-of-possession key is generated by the AS, which uses
it as proof-of-possession key bound to the Access Token, and provides
it to the joining node in the Access Token response.

Instead, consistently with the profiles of ACE
[I-D.ietf-ace-dtls-authorize][I-D.aragon-ace-ipsec-profile], in case
of asymmetric proof-of-possession key, the joining node provides its
own public key to the AS in the Access Token request. Then, the AS
uses it as proof-of-possession key bound to the Access Token, and
provides the joining node with the Group Manager's public key in the
Access Token response.

4. Joining Node to Group Manager

First, the joining node establishes a secure channel with the Group
Manager, according to what is specified in the Access Token response.
In particular:

o   If the CoAP-DTLS profile of ACE is specified, the joining node
    MUST upload the Access Token to the /authz-info resource, before
    starting the DTLS handshake and establishing a DTLS channel with
    the Group Manager. Then, the Group Manager processes the Access
    Token according to [I-D.ietf-ace-oauth-authz]. If this yields to
    a positive response, the joining node and the Group Manager
    establish a DTLS session, as described in Section 3 and Section 4
    of [I-D.ietf-ace-dtls-authorize], in case of either asymmetric or
    symmetric proof-of-possession key, respectively.

o   If the OSCOAP profile of ACE is specified, the joining node and
    the Group Manager establish an OSCORE Security Context, as
    described in Section 2.2 of [I-D.seitz-ace-oscoap-profile]. The
    Group Manager processes the Access Token as specified in
    [I-D.ietf-ace-oauth-authz] and proceeds as defined in Section 2.2
    of [I-D.seitz-ace-oscoap-profile].

o   If the IPsec profile of ACE is specified, the joining node MUST
    upload the Access Token to the /authz-info resource, before
    performing the key management protocol indicated by the AS (e.g.

IKEv2 [RFC7296]) to establish an IPsec Security Association pair
and an IPsec channel with the Group Manager. Then, the Group
Manager processes the Access Token according to
[I-D.ietf-ace-oauth-authz]. If this yields to a positive
response, the joining node and the Group Manager establish an
IPsec Security Association pair and an IPsec channel, as described
in Section 3.3.2 of [I-D.aragon-ace-ipsec-profile].

Once a secure communication channel with the Group Manager has been
established, the joining node requests to join the OSCORE multicast
groups of interest, by accessing the related join resources at the
Group Manager. That is, the joining node performs multiple join
processes with the Group Manager, separately for each multicast group
to join and by accessing the respective join endpoint.

In particular, for each OSCORE multicast group to join, the joining
node sends to the Group Manager a confirmable CoAP request, using the
method POST and targeting the join endpoint associated to that group.
The request payload conveys the information specified in Appendix C.1
of [I-D.tiloca-core-multicast-oscoap], which includes the intended
role(s) of the joining node in the multicast group, i.e. multicaster
and/or (pure) listener.

The Group Manager processes the request according to
[I-D.ietf-ace-oauth-authz]. If this yields to a positive response,
the Group Manager updates the group membership by registering the
joining node as a new member of the group. Then, the Group Manager
replies to the joining node providing the information specified in
Appendix C.1 of [I-D.tiloca-core-multicast-oscoap], which includes
the OSCORE Security Common Context associated to the joined multicast
group.

From then on, the joining node is registered as a member of the
multicast group, and can exchange group messages secured with OSCORE
as described in Section 5 of [I-D.tiloca-core-multicast-oscoap].

5. Public Keys of Joining Nodes

Source authentication of OSCORE messages exchanged within the
multicast group is ensured by means of digital counter signatures
[I-D.tiloca-core-multicast-oscoap]. Therefore, group members must be
able to retrieve each other's public key from a trusted key
repository, in order to verify the source authenticity of incoming
group messages.

Upon joining a multicast group, a joining node is expected to make
its own public key available to the other group members, either
through the Group Manager or through another trusted, publicly

available, key repository. However, this is not required for a node
that joins a group exclusively as pure listener.

As also discussed in Section 3 of [I-D.tiloca-core-multicast-oscoap],
it is recommended that the Group Manager is configured to store the
public keys of the group members and to provide them upon request.
If so, two cases can occur.

o The joining node and the Group Manager have used an asymmetric
   proof-of-possession key to establish a secure communication
   channel. In this case, the Group Manager stores the proof-of-
   possession key conveyed in the Access Token as the public key of
   the joining node.

o The joining node and the Group Manager have used a symmetric
   proof-of-possession key to establish a secure communication
   channel. In this case, upon performing a join process with that
   Group Manager for the first time, the joining node includes its
   own public key in the "Identity credentials" of the POST request
   targeting the join endpoint (see Appendix C.1 of
   [I-D.tiloca-core-multicast-oscoap]). Then, the Group Manager MUST
   verify that the joining node actually owns the associated private
   key, for instance by performing a proof-of-possession challenge-
   response.

Then, if the joining node has explicitly requested it, the Group
Manager provides also the public keys of the current members in the
joined group, when replying to the joining node during the same join
process (see Appendix C.1 of [I-D.tiloca-core-multicast-oscoap]).

Instead, in case the Group Manager is not configured to store public
keys of group members, the joining node provides the Group Manager
with its own certificate and with the identifier of the Certification
Authority that issued that certificate (see Appendix C.2 of
[I-D.tiloca-core-multicast-oscoap]).

6. Updating Authorization Information

At any point in time, a node might want to join further OSCORE
multicast groups under the same Group Manager. In such a case, the
joining node requests from the AS an updated Access Token for
accessing the new OSCORE multicast groups of interest.

The joining node uploads the new Access Token to the /authz-info
resource at the Group Manager, using the already established secure
communication channel. After that, the joining node performs the
joining process described in Section 4, separately for each OSCORE
multicast group to join.

Since the joining node and the Group Manager already share a secure
communication channel, they are not required to establish a new one.
However, according to the specific profile of ACE in use, the joining
node and the Group Manager may leverage the new Access Token to
establish a new secure communication channel or update the currently
existing one. For instance, Section 4.2 of
[I-D.ietf-ace-dtls-authorize] describes how the new Access Token can
be used to renegotiate an existing DTLS session or to establish a new
one by performing a new DTLS handshake.

7. Security Considerations

The method described in this document leverages the following
management aspects related to OSCORE multicast groups and discussed
in the sections of [I-D.tiloca-core-multicast-oscoap] indicated
below.

o Management of group keying material (Section 3.1). This includes
   the need to revoke and renew the keying material currently used in
   the OSCORE multicast group, upon changes in the group membership.
   In particular, renewing the keying material is required upon a new
   node joining the multicast group, in order to preserve backward
   security. The Group Manager is responsible to enforce rekeying
   policies and accordingly update the keying material within the
   multicast groups of its competence.

o Synchronization of sequence numbers (Section 6). This concerns
   how a listener node that has just joined an OSCORE multicast group
   can synchronize with the sequence number of multicasters in the
   same group.

o Provisioning and retrieval of public keys (Appendix C.2). This
   provides guidelines about how to ensure the availability of group
   members' public keys, possibly relying on the Group Manager as
   trusted key repository.

Further security considerations are inherited from the ACE framework
for Authentication and Authorization [I-D.ietf-ace-oauth-authz], as
well as from the profiles of ACE [I-D.ietf-ace-dtls-authorize][I-D.se
itz-ace-oscoap-profile][I-D.aragon-ace-ipsec-profile].

8. IANA Considerations

This document has no actions for IANA.

9. Acknowledgments

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