Workgroup: CoRE Working Group
Internet-Draft:
draft-tiloca-core-oscore-capable-proxies-07
Updates: 8613 (if approved)
Published: 10 July 2023
Intended Status: Standards Track
Expires: 11 January 2024
Authors: M. Tiloca
RISE AB
R. Höglund
RISE AB

OSCORE-capable Proxies

Abstract

Object Security for Constrained RESTful Environments (OSCORE) can be used to protect CoAP messages end-to-end between two endpoints at the application layer, also in the presence of intermediaries such as proxies. This document defines how to use OSCORE for protecting CoAP messages also between an origin application endpoint and an intermediary, or between two intermediaries. Also, it defines how to secure a CoAP message by applying multiple, nested OSCORE protections, e.g., both end-to-end between origin application endpoints, as well as between an application endpoint and an intermediary or between two intermediaries. Thus, this document updates RFC 8613. The same approach can be seamlessly used with Group OSCORE, for protecting CoAP messages when group communication with intermediaries is used.

Discussion Venues

This note is to be removed before publishing as an RFC.

Discussion of this document takes place on the Constrained RESTful Environments Working Group mailing list (core@ietf.org), which is archived at https://mailarchive.ietf.org/arch/browse/core/.

Source for this draft and an issue tracker can be found at https://gitlab.com/crimson84/draft-tiloca-core-oscore-to-proxies.

Status of This Memo

This Internet-Draft is submitted in full conformance with the provisions of BCP 78 and BCP 79.

Internet-Drafts are working documents of the Internet Engineering Task Force (IETF). Note that other groups may also distribute working documents as Internet-Drafts. The list of current Internet-Drafts is at https://datatracker.ietf.org/drafts/current/.

Internet-Drafts are draft documents valid for a maximum of six months and may be updated, replaced, or obsoleted by other documents at any time. It is inappropriate to use Internet-Drafts as reference material or to cite them other than as "work in progress."

This Internet-Draft will expire on 11 January 2024.

Copyright Notice

Copyright (c) 2023 IETF Trust and the persons identified as the document authors. All rights reserved.

This document is subject to BCP 78 and the IETF Trust's Legal Provisions Relating to IETF Documents (https://trustee.ietf.org/license-info) in effect on the date of publication of this document. Please review these documents carefully, as they describe your rights and restrictions with respect to this document. Code Components extracted from this document must include Revised BSD License text as described in Section 4.e of the Trust Legal Provisions and are provided without warranty as described in the Revised BSD License.

Table of Contents

1. Introduction
  1.1. Terminology
2. Use Cases
  2.1. CoAP Group Communication with Proxies
  2.2. CoAP Observe Notifications over Multicast
  2.3. LwM2M Client and External Application Server
  2.4. LwM2M Gateway
  2.5. Further Use Cases
3. Message Processing
  3.1. General Rules on Protecting Options
  3.2. Processing an Outgoing Request
  3.3. Processing an Incoming Request
  3.4. Processing an Outgoing Response
  3.5. Processing an Incoming Response
4. Caching of OSCORE-Protected Responses
5. Establishment of OSCORE Security Contexts
6. CoAP Header Compression with SCHC
7. Security Considerations
8. IANA Considerations
9. References
  9.1. Normative References
  9.2. Informative References
Appendix A. Examples
  A.1. Example 1
  A.2. Example 2

A.3. Example 3
A.4. Example 4
A.5. Example 5
Appendix B. State Diagram of the Incoming Request Processing
Acknowledgments
Authors' Addresses

1. Introduction

The Constrained Application Protocol (CoAP) [RFC7252] supports the presence of intermediaries, such as forward-proxies and reverse-proxies, which assist origin clients by performing requests to origin servers on their behalf, and forwarding back the related responses.

CoAP supports also group communication scenarios [I-D.ietf-core-groupcomm-bis], where clients can send a one-to-many request targeting all the servers in the group, e.g., by using IP multicast. Like for one-to-one communication, group settings can also rely on intermediaries [I-D.tiloca-core-groupcomm-proxy].

The protocol Object Security for Constrained RESTful Environments (OSCORE) [RFC8613] can be used to protect CoAP messages between two endpoints at the application layer, especially achieving end-to-end security in the presence of (non-trusted) intermediaries. When CoAP group communication is used, the same can be achieved by means of the protocol Group OSCORE [I-D.ietf-core-oscore-groupcomm].

For a number of use cases (see Section 2), it is required and/or beneficial that communications are secured also between an application endpoint (i.e., a CoAP origin client/server) and an intermediary, as well as between two adjacent intermediaries in a chain. This especially applies to the communication leg between the CoAP origin client and the adjacent intermediary acting as next hop towards the CoAP origin server.

In such cases, and especially if the origin client already uses OSCORE to achieve end-to-end security with the origin server, it would be convenient that OSCORE is used also to secure communications between the origin client and its next hop. However, the original specification [RFC8613] does not define how OSCORE can be used to protect CoAP messages in such communication leg, which would require to consider also the intermediary as an "OSCORE endpoint".

This document fills this gap, and updates [RFC8613] as follows.

* It defines how to use OSCORE for protecting a CoAP message in the communication leg between: i) an origin client/server and an intermediary; or ii) two adjacent intermediaries in an

intermediary chain. That is, besides origin clients/servers, it allows also intermediaries to be possible "OSCORE endpoints".

* It admits a CoAP message to be secured by multiple, nested OSCORE protections applied in sequence, as an "OSCORE-in-OSCORE" process. For instance, this is the case when the message is OSCORE-protected end-to-end between the origin client and origin server, and the result is further OSCORE-protected over the leg between the current and next hop (e.g., the origin client and the adjacent intermediary acting as next hop towards the origin server).

This document does not specify any new signaling method to guide the message processing on the different endpoints. In particular, every endpoint is always able to understand what steps to take on an incoming message depending on the presence of the OSCORE Option, as exclusively included or instead combined together with CoAP options intended for an intermediary.

The approach defined in this document can be seamlessly adopted also when Group OSCORE is used, for protecting CoAP messages in group communication scenarios that rely on intermediaries.

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 related to CoAP [RFC7252]; OSCORE [RFC8613] and Group OSCORE [I-D.ietf-core-oscore-groupcomm]. This document especially builds on concepts and mechanics related to intermediaries such as CoAP forward-proxies.

In addition, this document uses the following terms.

* Source application endpoint: an origin client producing a request, or an origin server producing a response.

* Destination application endpoint: an origin server intended to consume a request, or an origin client intended to consume a response.

* Application endpoint: a source or destination application endpoint.

* Source OSCORE endpoint: an endpoint protecting a message with OSCORE or Group OSCORE.

* Destination OSCORE endpoint: an endpoint unprotecting a message with OSCORE or Group OSCORE.

* OSCORE endpoint: a source/destination OSCORE endpoint. An OSCORE endpoint is not necessarily also an application endpoint with respect to a certain message.

* Proxy-related options: either of the following (set of) CoAP options used for proxying a CoAP request.

  - The Proxy-Uri Option. This is relevant when using a forward-proxy.

  - The set of CoAP options comprising the Proxy-Scheme Option together with any of the Uri-* Options. This is relevant when using a forward-proxy.

  - One or more Uri-Path Options, when used not together with the Proxy-Scheme Option. This is relevant when using a reverse-proxy.

* OSCORE-in-OSCORE: the process by which a message protected with (Group) OSCORE is further protected with (Group) OSCORE. This means that, if such a process is used, a successful decryption/verification of an OSCORE-protected message might yield an OSCORE-protected message.

2. Use Cases

The approach defined in this document has been motivated by a number of use cases, which are summarized below.

2.1. CoAP Group Communication with Proxies

CoAP supports also one-to-many group communication, e.g., over IP multicast [I-D.ietf-core-groupcomm-bis], which can be protected end-to-end between origin client and origin servers by using Group OSCORE [I-D.ietf-core-oscore-groupcomm].

This communication model can be assisted by intermediaries such as a CoAP forward-proxy or reverse-proxy, which relays a group request to the origin servers. If Group OSCORE is used, the proxy is intentionally not a member of the OSCORE group. Furthermore, [I-D.tiloca-core-groupcomm-proxy] defines a signaling protocol between origin client and proxy, to ensure that responses from the different origin servers are forwarded back to the origin client

within a time interval set by the client, and that they can be distinguished from one another.

In particular, it is required that the proxy identifies the origin client as allowed-listed, before forwarding a group request to the servers (see Section 4 of [I-D.tiloca-core-groupcomm-proxy]). This requires a security association between the origin client and the proxy, which would be convenient to provide with a dedicated OSCORE Security Context between the two, since the client is possibly using also Group OSCORE with the origin servers.

2.2. CoAP Observe Notifications over Multicast

The Observe extension for CoAP [RFC7641] allows a client to register its interest in "observing" a resource at a server. The server can then send back notification responses upon changes to the resource representation, all matching with the original observation request.

In some applications, such as pub-sub [I-D.ietf-core-coap-pubsub], multiple clients are interested to observe the same resource at the same server. Hence, [I-D.ietf-core-observe-multicast-notifications] defines a method that allows the server to send a multicast notification to all the observer clients at once, e.g., over IP multicast. To this end, the server synchronizes the clients by providing them with a common "phantom observation request", against which the following multicast notifications will match.

In case the clients and the server use Group OSCORE for end-to-end security and a proxy is also involved, an additional step is required (see Section 12 of [I-D.ietf-core-observe-multicast-notifications]). That is, clients are in turn required to provide the proxy with the obtained "phantom observation request", thus enabling the proxy to receive the multicast notifications from the server.

Therefore, it is preferable to have a security association also between each client and the proxy, to especially ensure the integrity of that information provided to the proxy (see Section 15.3 of [I-D.ietf-core-observe-multicast-notifications]). Like for the use case in Section 2.1, this would be conveniently achieved with a dedicated OSCORE Security Context between a client and the proxy, since the client is also using Group OSCORE with the origin server.

2.3. LwM2M Client and External Application Server

The Lightweight Machine-to-Machine (LwM2M) protocol [LwM2M-Core] enables a LwM2M Client device to securely bootstrap and then register at a LwM2M Server, with which it will perform most of its following communication exchanges. As per the transport bindings

specification of LwM2M [LwM2M-Transport], the LwM2M Client and LwM2M Server can use CoAP and OSCORE to secure their communications at the application layer, including during the device registration process.

Furthermore, Section 5.5.1 of [LwM2M-Transport] specifies that: "OSCORE MAY also be used between LwM2M endpoint and non-LwM2M endpoint, e.g., between an Application Server and a LwM2M Client via a LwM2M server. Both the LwM2M endpoint and non-LwM2M endpoint MUST implement OSCORE and be provisioned with an OSCORE Security Context."

In such a case, the LwM2M Server can practically act as forward-proxy between the LwM2M Client and the external Application Server. At the same time, the LwM2M Client and LwM2M Server must continue protecting communications on their leg using their Security Context. Like for the use case in Section 2.1, this also allows the LwM2M Server to identify the LwM2M Client, before forwarding its request outside the LwM2M domain and towards the external Application Server.

2.4. LwM2M Gateway

The specification [LwM2M-Gateway] extends the LwM2M architecture by defining the LwM2M Gateway functionality. That is, a LwM2M Server can manage end IoT devices "behind" the LwM2M Gateway. While it is outside the scope of such specification, it is possible for the LwM2M Gateway to use any suitable protocol with its connected end IoT devices, as well as to carry out any required protocol translation.

Practically, the LwM2M Server can send a request to the LwM2M Gateway, asking to forward it to an end IoT device. With particular reference to the CoAP protocol and the related transport binding specified in [LwM2M-Transport], the LwM2M Server acting as CoAP client sends its request to the LwM2M Gateway acting as CoAP server.

If CoAP is used in the communication leg between the LwM2M Gateway and the end IoT devices, then the LwM2M Gateway fundamentally acts as a reverse-proxy (see Section 5.7.3 of [RFC7252]). That is, in addition to its own resources, the LwM2M Gateway serves the resources of each end IoT device behind itself, as exposed under a dedicated URI-Path. As per [LwM2M-Gateway], the first URI-Path segment is used as "prefix" to identify the specific IoT device, while the remaining URI-Path segments specify the target resource at the IoT device.

As per Section 7 of [LwM2M-Gateway], message exchanges between the LwM2M Server and the L2M2M Gateway are secured using the LwM2M-defined technologies, while the LwM2M protocol does not provide end-

to-end security between the LwM2M Server and the end IoT devices. However, the approach defined in this document makes it possible to achieve both goals, by allowing the LwM2M Server to use OSCORE for protecting a message both end-to-end for the targeted end IoT device as well as for the LwM2M Gateway acting as reverse-proxy.

2.5. Further Use Cases

The approach defined in this document can be useful also in the following use cases relying on a proxy.

* A server aware of a suitable cross proxy can rely on it as a third-party service, in order to indicate transports for CoAP available to that server (see Section 4 of [I-D.ietf-core-transport-indication]).

  From a security point of view, it would be convenient if the proxy could provide suitable credentials to the client, as a general trusted proxy for the system. At the same time, it can be desirable to limit the use of such a proxy to a set of clients which have permission to use it, and that the proxy can identify through a secure communication association.

  However, in order for OSCORE to be an applicable security mechanism for this scenario, OSCORE has to be terminated at the proxy. That is, it would be required for a client and the proxy to share a dedicated OSCORE Security Context and to use it for protecting their communication leg.

* The method specified in [I-D.ietf-core-coap-pm] relies on the Performance Measurement Option to enable network telemetry for CoAP communications. This makes it possible to efficiently measure Round-Trip Time and message losses, both end-to-end and hop-by-hop. In particular, on-path probes such as intermediary proxies can be deployed to perform measurements hop-by-hop.

  When OSCORE is used in deployments including on-path probes, an inner Performance Measurement Option is protected end-to-end between the two application endpoints and enables end-to-end measurements between those. At the same time, an outer Performance Measurement Option allows also hop-by-hop measurements to be performed by reying on an on-path probe.

  Therefore, it is preferable to have a secure association with an on-path probe, in order to also ensure the integrity of the hop-by-hop measurements exchanged with the probe.

* The method specified in [I-D.ietf-ace-coap-est-oscore] enables public-key certificate enrollment for Internet of Things deployments. This leverages payload formats defined in Enrollment

over Secure Transport (EST) [RFC7030], while relying on CoAP for message transfer and on OSCORE for message protection.

In real-world deployments, an EST server issuing public-key certificates may reside outside a constrained network that includes devices acting as EST clients. In particular, the EST clients are expected to support only CoAP, while the EST server in a non-constrained network is expected to support only HTTP. This requires a CoAP-to-HTTP proxy to be deployed between the EST clients and the EST server, in order to map CoAP messages with HTTP messages across the two networks.

Even in such a scenario, the EST server and every EST client can still effectively use OSCORE to protect their communications end-to-end. At the same time, it is desirable to have an additional secure association between the EST client and the CoAP-to-HTTP proxy, especially in order for the proxy to identify the EST client before forwarding EST messages out of the CoAP boundary of the constrained network and towards the EST server.

* A proxy may be deployed to act as an entry point to a firewalled network, which only authenticated clients can join. In particular, authentication can rely on the used secure communication association between a client and the proxy. If the proxy could share a dedicated OSCORE Security Context with each client, the proxy can rely on it to identify the client, before forwarding its messages to any other member of the firewalled network.

* The approach defined in this document does not pose a limit to the number of OSCORE protections applied to the same CoAP message. This enables more privacy-oriented scenarios based on proxy chains, where the origin client protects a CoAP request using first the OSCORE Security Context shared with the origin server, and then the dedicated OSCORE Security Context shared with each of the different hops in the chain. Once received at a chain hop, the request would be stripped of the OSCORE protection associated with that hop before being forwarded to the next one.

3. Message Processing

As mentioned in Section 1, this document introduces the following two main deviations from the original OSCORE specification [RFC8613].

1. An "OSCORE endpoint", i.e., a producer/consumer of an OSCORE Option can be not only an application endpoint (i.e., an origin client or server), but also an intermediary such as a proxy.

Hence, OSCORE can be used between an origin client/server and a proxy, as well as between two proxies in an intermediary chain.

2. A CoAP message can be secured by multiple OSCORE protections applied in sequence. Therefore, the final result is a message with nested OSCORE protections, as the output of an "OSCORE-in-OSCORE" process. Hence, following a decryption, the resulting message might legitimately include an OSCORE Option, and thus have in turn to be decrypted.

   The most common case is expected to consider a message protected with up to two OSCORE layers, i.e.: i) an inner layer, protecting the message end-to-end between the origin client and the origin server acting as application endpoints; and ii) an outer layer, protecting the message between a certain OSCORE endpoint and the other OSCORE endpoint adjacent in the intermediary chain.

   However, a message can also be protected with a higher arbitrary number of nested OSCORE layers, e.g., in scenarios relying on a longer chain of intermediaries. For instance, the origin client can sequentially apply multiple OSCORE layers to a request, each of which to be consumed and removed by one of the intermediaries in the chain, until the origin server is reached and it consumes the innermost OSCORE layer.

Appendix A provides a number of examples where the approach defined in this document is used to protect message exchanges.

3.1. General Rules on Protecting Options

Let us consider a sender endpoint that, when protecting an outgoing message, applies the i-th OSCORE layer in sequence, by using the OSCORE Security Context shared with another OSCORE endpoint X.

In addition to the CoAP options specified as class E in [RFC8613] or in the document defining them, the sender endpoint MUST encrypt and integrity-protect the following CoAP options. That is, even if they are originally specified as class U or class I for OSCORE, such options are processed like if they were specified as class E.

*Any CoAP option such that both the following conditions hold.

1. The sender endpoint has added the option to the message either:

   -Following a message protection previously performed for an OSCORE endpoint different than X; or

-Before a message protection previously performed for an OSCORE endpoint different than X, where the option was treated as Class U or I.

2. The option is not intended to be consumed by the other OSCORE endpoint X.

Examples of such CoAP options are:

-The OSCORE Option present as the result of the OSCORE layer immediately previously applied for an OSCORE endpoint different than X, when the sender endpoint is an origin endpoint.

-The EDHOC Option defined in [I-D.ietf-core-oscore-edhoc], when the sender endpoint is the origin client.

-The Request-Hash Option defined in [I-D.amsuess-core-cachable-oscore], when X is not an origin endpoint).

*Any CoAP option such that all the following conditions hold.

1. The sender endpoint has added the option to the message.

2. The option is intended to be consumed by the other OSCORE endpoint X.

3. At the other OSCORE endpoint X, the option does not play a role in processing the message before having removed the i-th OSCORE layer or in removing the i-th OSCORE layer altogether.

Examples of such CoAP options are:

-The Proxy-Uri, Proxy-Scheme, Uri-Host and Uri-Port Options defined in [RFC7252].

-The Listen-To-Multicast-Notifications Option defined in [I-D.ietf-core-observe-multicast-notifications].

-The Multicast-Timeout, Response-Forwarding and Group-ETag Options defined in [I-D.tiloca-core-groupcomm-proxy].

*Any CoAP option such that the sender endpoint has not added the option to the message.

Examples of such CoAP options are:

- The OSCORE Option present as the result of the OSCORE layer immediately previously applied for an OSCORE endpoint different than X, when the sender endpoint is not an origin endpoint.

- The EDHOC Option defined in [I-D.ietf-core-oscore-edhoc], when the sender endpoint is not the origin client.

3.2. Processing an Outgoing Request

The rules from Section 3.1 apply when processing an outgoing request message, with the following addition.

When an application endpoint applies multiple OSCORE layers in sequence to protect an outgoing request, and it uses an OSCORE Security Context shared with the other application endpoint, then the first OSCORE layer MUST be applied by using that Security Context.

3.3. Processing an Incoming Request

Upon receiving a request REQ, the recipient endpoint performs the actions described in the following steps.

1. If REQ includes proxy-related options, the endpoint moves to step 2. Otherwise, the endpoint moves to step 3.

2. The endpoint proceeds as defined below, depending on which of the two following conditions holds.

   * REQ includes either the Proxy-Uri Option, or the Proxy-Scheme Option together with any of the Uri-* Options.

     If the endpoint is not configured to be a forward-proxy, it MUST stop processing the request and MUST respond with a 5.05 (Proxying Not Supported) error response to (the previous hop towards) the origin client, as per Section 5.10.2 of [RFC7252]. This may result in protecting the error response over that communication leg, as per Section 3.4.

     Otherwise, the endpoint MUST check whether forwarding this request to (the next hop towards) the origin server is an authorized operation. This check can be based, for instance, on the specific OSCORE Security Context that the endpoint used to decrypt the incoming message, before performing this step.

In case the authentication check fails, the endpoint MUST stop processing the request and MUST respond with a 4.01 (Unauthorized) error response to (the previous hop towards) the origin client, as per Section 5.10.2 of [RFC7252]. This may result in protecting the error response over that communication leg, as per Section 3.4.

Otherwise, the endpoint consumes the proxy-related options as per Section 5.7.2 of [RFC7252] and forwards REQ to (the next hop towards) the origin server, unless differently indicated in REQ, e.g., by means of any of its CoAP options. For instance, a forward-proxy does not forward a request that includes proxy-related options together with the Listen-To-Multicast-Notifications Option (see Section 12 of [I-D.ietf-core-observe-multicast-notifications]).

If the endpoint forwards REQ to (the next hop towards) the origin server, this may result in (further) protecting REQ over that communication leg, as per Section 3.2.

After that, the endpoint does not take any further action.

*REQ includes one or more Uri-Path Options but not the Proxy-Scheme Option.

If the endpoint is not configured to be a reverse-proxy or its resource targeted by the Uri-Path Options is not intended to support reverse-proxy functionalities, then the endpoint proceeds to step 3.

Otherwise, the endpoint MUST check whether forwarding this request to (the next hop towards) the origin server is an authorized operation. This check can be based, for instance, on the specific OSCORE Security Context that the endpoint used to decrypt the incoming message, before performing this step.

In case the authentication check fails, the endpoint MUST stop processing the request and MUST respond with a 4.01 (Unauthorized) error response to (the previous hop towards) the origin client, as per Section 5.10.2 of [RFC7252]. This may result in protecting the error response over that communication leg, as per Section 3.4.

Otherwise, the endpoint consumes the Uri-Path options as per Section 5.7.3 of [RFC7252], and forwards REQ to (the next hop towards) the origin server, unless differently indicated in REQ, e.g., by means of any of its CoAP options.

If the endpoint forwards REQ to (the next hop towards) the origin server, this may result in (further) protecting REQ over that communication leg, as per Section 3.2.

After that, the endpoint does not take any further action.

Note that, when forwarding REQ, the endpoint might not remove all the Uri-Path Options originally present, e.g., in case the next hop towards the origin server is a further reverse-proxy.

3. The endpoint proceeds as defined below, depending on which of the two following conditions holds.

   * REQ does not include an OSCORE Option.

     If the endpoint does not have an application to handle REQ, it MUST stop processing the request and MAY respond with a 4.00 (Bad Request) error response to (the previous hop towards) the origin client. This may result in protecting the error response over that communication leg, as per Section 3.4.

     Otherwise, the endpoint delivers REQ to the application.

   * REQ includes an OSCORE Option.

     If REQ includes any URI-Path Options, the endpoint MUST stop processing the request and MAY respond with a 4.00 (Bad Request) error response to (the previous hop towards) the origin client. This may result in protecting the error response over that communication leg, as per Section 3.4.

     Otherwise, the endpoint decrypts REQ using the OSCORE Security Context indicated by the OSCORE Option, i.e., REQ* = dec(REQ). After that, the possible presence of an OSCORE Option in the decrypted request REQ* is not treated as an error situation.

     If the OSCORE processing results in an error, the endpoint MUST stop processing the request and performs error handling as per Section 8.2 of [RFC8613] or Sections 8.2 and 9.4 of [I-D.ietf-core-oscore-groupcomm], in case OSCORE or Group OSCORE is used, respectively. In case the endpoint sends an error response to (the previous hop towards) the origin client, this may result in protecting the error response over that communication leg, as per Section 3.4.

     Otherwise, REQ takes REQ*, and the endpoint moves to step 1.

Appendix B provides an overview of the process defined above as a state diagram.

3.4. Processing an Outgoing Response

The rules from Section 3.1 apply when processing an outgoing response message, with the following additions.

When an application endpoint applies multiple OSCORE layers in sequence to protect an outgoing response, and it uses an OSCORE Security Context shared with the other application endpoint, then the first OSCORE layer MUST be applied by using that Security Context.

The sender endpoint protects the response by applying the same OSCORE layers that it removed from the corresponding incoming request, but in the reverse order than the one they were removed.

In case the response is an error response, the sender endpoint protects it by applying the same OSCORE layers that it successfully removed from the corresponding incoming request, but in the reverse order than the one they were removed.

3.5. Processing an Incoming Response

The recipient endpoint removes the same OSCORE layers that it added when protecting the corresponding outgoing request, but in the reverse order than the one they were removed.

When doing so, the possible presence of an OSCORE Option in the decrypted response following the removal of an OSCORE layer is not treated as an error situation, unless it occurs after having removed as many OSCORE layers as were added in the outgoing request. In such a case, the endpoint MUST stop processing the response.

4. Caching of OSCORE-Protected Responses

Although not possible as per the original OSCORE specification [RFC8613], cacheability of OSCORE-protected responses at proxies can be achieved. To this end, the approach defined in [I-D.amsuess-core-cachable-oscore] can be used, as based on Deterministic Requests protected with the pairwise mode of Group OSCORE [I-D.ietf-core-oscore-groupcomm] used end-to-end between an origin client and an origin server. The applicability of this approach is limited to requests that are safe (in the RESTful sense) to process and do not yield side effects at the origin server.

In particular, this approach requires both the origin client and the origin server to have already joined the correct OSCORE group. Then, starting from the same plain CoAP request, different clients in the

OSCORE group are able to deterministically generate a same request protected with Group OSCORE, which is sent to a proxy for being forwarded to the origin server. The proxy can effectively cache the resulting OSCORE-protected response from the server, since the same plain CoAP request will result again in the same Deterministic Request and thus will produce a cache hit.

When using this approach, the following also applies in addition to what is defined in Section 3, when processing incoming messages at a proxy that implements caching of responses.

* Upon receiving a request from (the previous hop towards) the origin client, the proxy checks if specifically the message available during the execution of step 2 in Section 3.3 produces a cache hit.

  That is, such a message: i) is exactly the one to be forwarded to (the next hop towards) the origin server, if no cache hit has occurred; and ii) is the result of an OSCORE decryption at the proxy, if OSCORE is used on the communication leg between the proxy and (the previous hop towards) the origin client.

* Upon receiving a response from (the next hop towards) the origin server, the proxy first removes the same OSCORE layers that it added when protecting the corresponding outgoing request, as defined in Section 3.5.

  Then, the proxy stores specifically that resulting response message in its cache. That is, such a message is exactly the one to be forwarded to (the previous hop towards) the origin client.

The specific rules about serving a request with a cached response are defined in Section 5.6 of [RFC7252], as well as in Section 7 of [I-D.tiloca-core-groupcomm-proxy] for group communication scenarios.

5. Establishment of OSCORE Security Contexts

Like the original OSCORE specification [RFC8613], this document is not devoted to any particular approach that two OSCORE endpoints use for establishing an OSCORE Security Context.

At the same time, the following applies, depending on the two peers using OSCORE or Group OSCORE [I-D.ietf-core-oscore-groupcomm] to protect their communications.

* When using OSCORE, the establishment of the OSCORE Security Context can rely on the authenticated key establishment protocol EDHOC [I-D.ietf-lake-edhoc].

Assuming the use of OSCORE both between the two origin application endpoints as well as between the origin client and the first proxy in the chain, it is expected that the origin client first runs EDHOC with the first proxy in the chain, and then with the origin server through the chain of proxies (see the example in Appendix A.4).

Furthermore, the additional use of the combined EDHOC + OSCORE request defined in [I-D.ietf-core-oscore-edhoc] is particularly beneficial in this case (see the example in Appendix A.5), and especially when relying on a long chain of proxies.

* The use of Group OSCORE is expected to be limited between the origin applications endpoints, e.g., between the origin client and multiple origin servers. In order to join the same OSCORE group and obtain the corresponding Group OSCORE Security Context, those endpoints can use the approach defined in [I-D.ietf-ace-key-groupcomm-oscore] and based on the ACE framework for authentication and authorization in constrained environments [RFC9200].

  For the purposes of this document, there is no need for a proxy to also be a member of the OSCORE group whose Group OSCORE Security Context is used by the origin application endpoints for protecting communications end-to-end.

6. CoAP Header Compression with SCHC

The method defined in this document enables and results in the possible protection of the same CoAP message with multiple, nested OSCORE layers. Especially when this happens, it is desirable to compress the header of protected CoAP messages, in order to improve performance and ensure that CoAP is usable also in Low-Power Wide-Area Networks (LPWANs).

To this end, it is possible to use the Static Context Header Compression and fragmentation (SCHC) framework [RFC8724]. In particular, [RFC8824] specifies how to use SCHC for compressing headers of CoAP messages, also when messages are protected with OSCORE. As further clarified in [I-D.tiloca-schc-8824-update], the SCHC Compression/Decompression is applicable also in the presence of CoAP proxies, and especially to the two following cases.

* In case OSCORE is not used at all, the SCHC processing occurs hop-by-hop, by relying on SCHC Rules that are consistently shared between two adjacent hops.

* In case OSCORE is used only end-to-end between the application endpoints, then an Inner SCHC Compression/Decompression and an

Outer SCHC Compression/Decompression are performed (see Section 7.2 of [RFC8824]). In particular, the following holds.

The SCHC processing occurs end-to-end as to the Inner SCHC Compression/Decompression. This relies on Inner SCHC Rules that are shared between the two application endpoints, which act as OSCORE endpoints and share the used OSCORE Security Context.

The SCHC processing occurs hop-by-hop as to the Outer SCHC Compression/Decompression. This relies on Outer SCHC Rules that are shared between two adjacent hops.

When using the method defined in this document, and thus enabling also an intermediary proxy to be an OSCORE endpoint, the SCHC processing above is generalized as specified below.

When processing an outgoing CoAP message, a sender endpoint proceeds as follows.

* The sender endpoint performs one Inner SCHC Compression for each OSCORE layer applied to the outgoing message. Each Inner SCHC Compression occurs before protecting the message with that OSCORE layer, and relies on the SCHC Rules that are shared with the other OSCORE endpoint.

* The sender endpoint performs exactly one Outer SCHC Compression. This occurs after having performed all the intended OSCORE protections of the outgoing message, and relies on the SCHC Rules that are shared with the (next hop towards the) recipient application endpoint.

That is, with respect to the SCHC Compression/Decompression processing, the following holds.

* An Inner SCHC Compression is intended to a recipient OSCORE endpoint, which will: first, decrypt an incoming message with the OSCORE Security Context shared with the other OSCORE endpoint; and then, perform the corresponding Inner SCHC Decompression, by relying on the SCHC Rules shared with the other OSCORE endpoint.

* An Outer SCHC Compression is intended to the (next hop towards the) recipient application endpoint, which will: first, perform a corresponding Outer SCHC Decompression on an incoming message, by relying on the SCHC Rules shared with the (previous hop towards the) recipient application endpoint; then, perform a new Outer SCHC Compression on the result, by relying on the SCHC Rules shared with the (next hop towards the) recipient application endpoint; and, finally, send the result to the (next-hop towards the) recipient application endpoint.

Note that the generalization above does not alter the core approach, design choices, and features of the SCHC Compression/Decompression applied to CoAP headers.

7. Security Considerations

The same security considerations from CoAP [RFC7252] apply to this document. The same security considerations from [RFC8613] and [I-D.ietf-core-oscore-groupcomm] apply to this document, when using OSCORE or Group OSCORE to protect exchanged messages.

Further security considerations to take into account are inherited from the specifically used CoAP options, extensions, and methods employed when relying on OSCORE or Group OSCORE.

This document does not change the security properties of OSCORE and Group OSCORE. That is, given any two OSCORE endpoints, the method defined in this document provides them with the same security guarantees that OSCORE and Group OSCORE provide in the case where such endpoints are specifically application endpoints.

8. IANA Considerations

This document has no actions for IANA.

9. References

9.1. Normative References

[I-D.ietf-core-oscore-groupcomm] Tiloca, M., Selander, G., Palombini, F., Mattsson, J. P., and J. Park, "Group Object Security for Constrained RESTful Environments (Group OSCORE)", Work in Progress, Internet-Draft, draft-ietf-core-oscore-groupcomm-18, 22 June 2023, <https://datatracker.ietf.org/doc/html/draft-ietf-core-oscore-groupcomm-18>.

[RFC2119] Bradner, S., "Key words for use in RFCs to Indicate Requirement Levels", BCP 14, RFC 2119, DOI 10.17487/RFC2119, March 1997, <https://www.rfc-editor.org/rfc/rfc2119>.

[RFC7252] Shelby, Z., Hartke, K., and C. Bormann, "The Constrained Application Protocol (CoAP)", RFC 7252, DOI 10.17487/RFC7252, June 2014, <https://www.rfc-editor.org/rfc/rfc7252>.

[RFC8174] Leiba, B., "Ambiguity of Uppercase vs Lowercase in RFC 2119 Key Words", BCP 14, RFC 8174, DOI 10.17487/RFC8174, May 2017, <https://www.rfc-editor.org/rfc/rfc8174>.

[RFC8613] Selander, G., Mattsson, J., Palombini, F., and L. Seitz, "Object Security for Constrained RESTful Environments (OSCORE)", RFC 8613, DOI 10.17487/RFC8613, July 2019, <https://www.rfc-editor.org/rfc/rfc8613>.

[RFC8724] Minaburo, A., Toutain, L., Gomez, C., Barthel, D., and JC. Zuniga, "SCHC: Generic Framework for Static Context Header Compression and Fragmentation", RFC 8724, DOI 10.17487/RFC8724, April 2020, <https://www.rfc-editor.org/rfc/rfc8724>.

[RFC8824] Minaburo, A., Toutain, L., and R. Andreasen, "Static Context Header Compression (SCHC) for the Constrained Application Protocol (CoAP)", RFC 8824, DOI 10.17487/RFC8824, June 2021, <https://www.rfc-editor.org/rfc/rfc8824>.

9.2. Informative References

[I-D.amsuess-core-cachable-oscore] Amsüss, C. and M. Tiloca, "Cacheable OSCORE", Work in Progress, Internet-Draft, draft-amsuess-core-cachable-oscore-06, 11 January 2023, <https://datatracker.ietf.org/doc/html/draft-amsuess-core-cachable-oscore-06>.

[I-D.ietf-ace-coap-est-oscore] Selander, G., Raza, S., Furuhed, M., Vučinić, M., and T. Claeys, "Protecting EST Payloads with OSCORE", Work in Progress, Internet-Draft, draft-ietf-ace-coap-est-oscore-02, 9 July 2023, <https://datatracker.ietf.org/doc/html/draft-ietf-ace-coap-est-oscore-02>.

[I-D.ietf-ace-key-groupcomm-oscore] Tiloca, M., Park, J., and F. Palombini, "Key Management for OSCORE Groups in ACE", Work in Progress, Internet-Draft, draft-ietf-ace-key-groupcomm-oscore-16, 6 March 2023, <https://datatracker.ietf.org/doc/html/draft-ietf-ace-key-groupcomm-oscore-16>.

[I-D.ietf-core-coap-pm] Fioccola, G., Zhou, T., Cociglio, M., Bulgarella, F., Nilo, M., and F. Milan, "Constrained Application Protocol (CoAP) Performance Measurement Option", Work in Progress, Internet-Draft, draft-ietf-core-coap-pm-00, 19 April 2023, <https://datatracker.ietf.org/doc/html/draft-ietf-core-coap-pm-00>.

[I-D.ietf-core-coap-pubsub] Koster, M., Keränen, A., and J. Jimenez, "A publish-subscribe architecture for the Constrained

Application Protocol (CoAP)", Work in Progress, Internet-Draft, draft-ietf-core-coap-pubsub-12, 13 March 2023, <https://datatracker.ietf.org/doc/html/draft-ietf-core-coap-pubsub-12>.

[I-D.ietf-core-groupcomm-bis] Dijk, E., Wang, C., and M. Tiloca, "Group Communication for the Constrained Application Protocol (CoAP)", Work in Progress, Internet-Draft, draft-ietf-core-groupcomm-bis-08, 11 January 2023, <https://datatracker.ietf.org/doc/html/draft-ietf-core-groupcomm-bis-08>.

[I-D.ietf-core-observe-multicast-notifications] Tiloca, M., Höglund, R., Amsüss, C., and F. Palombini, "Observe Notifications as CoAP Multicast Responses", Work in Progress, Internet-Draft, draft-ietf-core-observe-multicast-notifications-06, 26 April 2023, <https://datatracker.ietf.org/doc/html/draft-ietf-core-observe-multicast-notifications-06>.

[I-D.ietf-core-oscore-edhoc] Palombini, F., Tiloca, M., Höglund, R., Hristozov, S., and G. Selander, "Using EDHOC with CoAP and OSCORE", Work in Progress, Internet-Draft, draft-ietf-core-oscore-edhoc-07, 13 March 2023, <https://datatracker.ietf.org/doc/html/draft-ietf-core-oscore-edhoc-07>.

[I-D.ietf-core-transport-indication] Amsüss, C., "CoAP Protocol Indication", Work in Progress, Internet-Draft, draft-ietf-core-transport-indication-02, 13 March 2023, <https://datatracker.ietf.org/doc/html/draft-ietf-core-transport-indication-02>.

[I-D.ietf-lake-edhoc] Selander, G., Mattsson, J. P., and F. Palombini, "Ephemeral Diffie-Hellman Over COSE (EDHOC)", Work in Progress, Internet-Draft, draft-ietf-lake-edhoc-20, 7 July 2023, <https://datatracker.ietf.org/doc/html/draft-ietf-lake-edhoc-20>.

[I-D.tiloca-core-groupcomm-proxy] Tiloca, M. and E. Dijk, "Proxy Operations for CoAP Group Communication", Work in Progress, Internet-Draft, draft-tiloca-core-groupcomm-proxy-08, 28 February 2023, <https://datatracker.ietf.org/doc/html/draft-tiloca-core-groupcomm-proxy-08>.

[I-D.tiloca-schc-8824-update] Tiloca, M., Toutain, L., and I. Martinez, "Clarifications and Updates on using Static Context Header Compression (SCHC) for the Constrained

Application Protocol (CoAP)", Work in Progress, Internet-Draft, draft-tiloca-schc-8824-update-00, 3 April 2023, <https://datatracker.ietf.org/doc/html/draft-tiloca-schc-8824-update-00>.

[LwM2M-Core] Open Mobile Alliance, "Lightweight Machine to Machine Technical Specification - Core, Approved Version 1.2, OMA-TS-LightweightM2M_Core-V1_2-20201110-A", November 2020, <http://www.openmobilealliance.org/release/LightweightM2M/V1_2-20201110-A/OMA-TS-LightweightM2M_Core-V1_2-20201110-A.pdf>.

[LwM2M-Gateway] Open Mobile Alliance, "Lightweight Machine to Machine Gateway Technical Specification - Approved Version 1.1, OMA-TS-LWM2M_Gateway-V1_1-20210518-A", May 2021, <https://www.openmobilealliance.org/release/LwM2M_Gateway/V1_1-20210518-A/OMA-TS-LWM2M_Gateway-V1_1-20210518-A.pdf>.

[LwM2M-Transport] Open Mobile Alliance, "Lightweight Machine to Machine Technical Specification - Transport Bindings, Approved Version 1.2, OMA-TS-LightweightM2M_Transport-V1_2-20201110-A", November 2020, <http://www.openmobilealliance.org/release/LightweightM2M/V1_2-20201110-A/OMA-TS-LightweightM2M_Transport-V1_2-20201110-A.pdf>.

[RFC7030] Pritikin, M., Ed., Yee, P., Ed., and D. Harkins, Ed., "Enrollment over Secure Transport", RFC 7030, DOI 10.17487/RFC7030, October 2013, <https://www.rfc-editor.org/rfc/rfc7030>.

[RFC7641] Hartke, K., "Observing Resources in the Constrained Application Protocol (CoAP)", RFC 7641, DOI 10.17487/RFC7641, September 2015, <https://www.rfc-editor.org/rfc/rfc7641>.

[RFC8742] Bormann, C., "Concise Binary Object Representation (CBOR) Sequences", RFC 8742, DOI 10.17487/RFC8742, February 2020, <https://www.rfc-editor.org/rfc/rfc8742>.

[RFC9200] Seitz, L., Selander, G., Wahlstroem, E., Erdtman, S., and H. Tschofenig, "Authentication and Authorization for Constrained Environments Using the OAuth 2.0 Framework (ACE-OAuth)", RFC 9200, DOI 10.17487/RFC9200, August 2022, <https://www.rfc-editor.org/rfc/rfc9200>.

Appendix A. Examples

This section provides a number of examples where the approach defined in this document is used to protect message exchanges.

The presented examples build on the example shown in Appendix A.1 of [RFC8613], and illustrate an origin client requesting the alarm status from an origin server, through a forward-proxy.

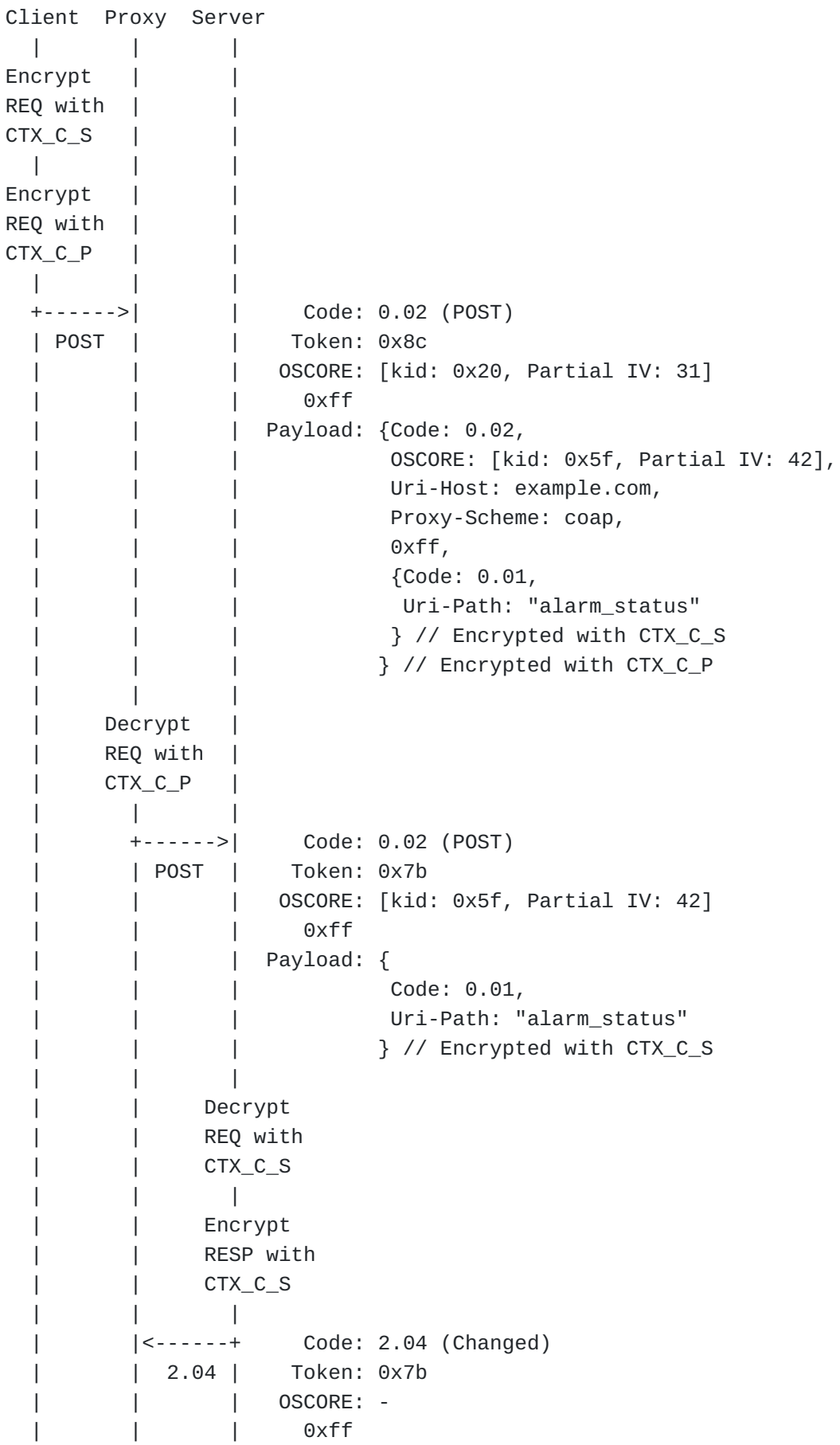
The abbreviations "REQ" and "RESP" are used to denote a request message and a response message, respectively.

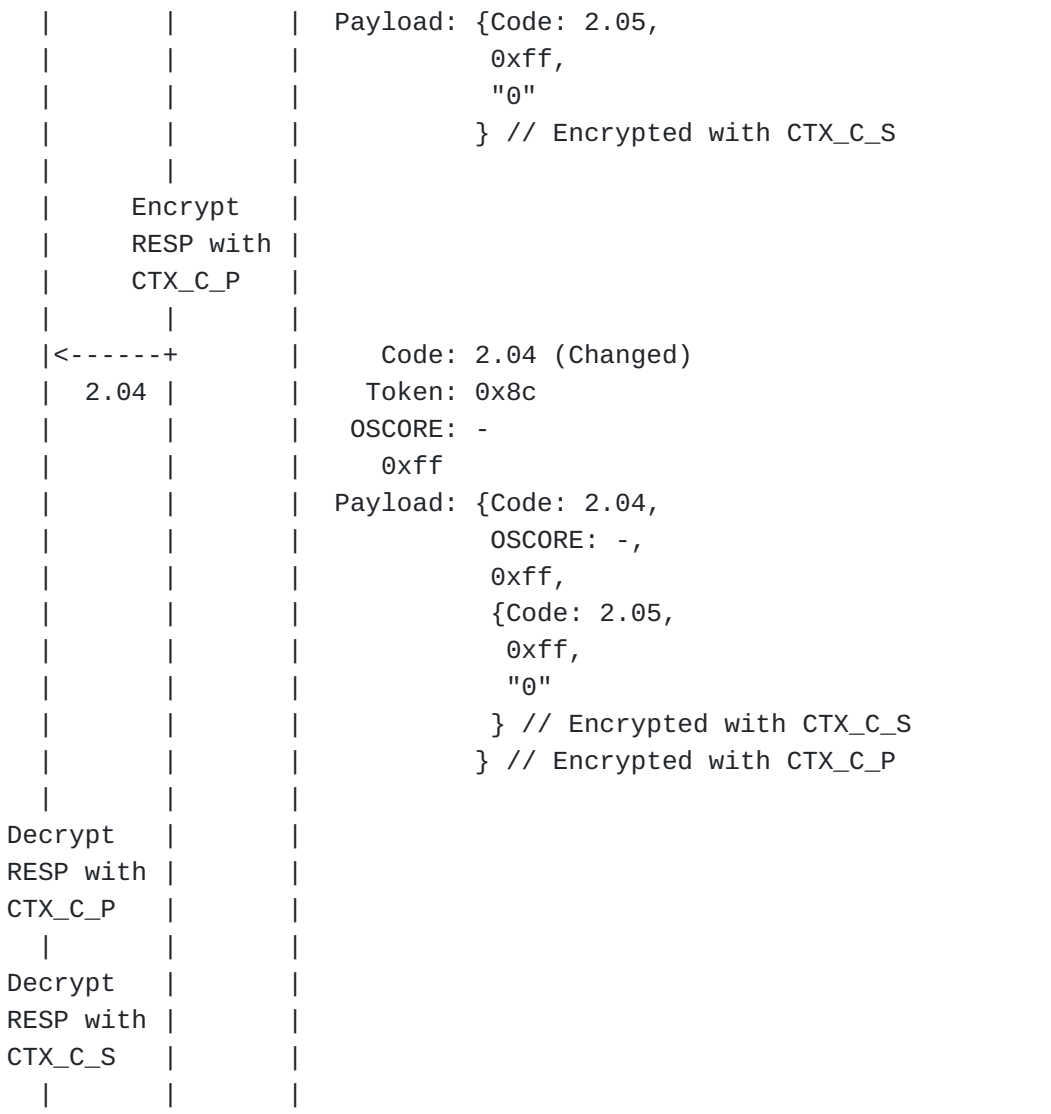
A.1. Example 1

In the example shown in Figure 1, message exchanges are protected with OSCORE over the following legs.

* End-to-end, between the client and the server, using the OSCORE Security Context CTX_C_S. The client uses the OSCORE Sender ID 0x5f when using OSCORE with the server.

* Between the client and the proxy, using the OSCORE Security Context CTX_C_P. The client uses the OSCORE Sender ID 0x20 when using OSCORE with the proxy.


Client Proxy Server
Encrypt
REQ with
CTX_C_S
Encrypt
REQ with
CTX_C_P
POST
Code: 0.02 (POST)
Token: 0x8c
OSCORE: [kid: 0x20, Partial IV: 31]
0xff
Payload: {Code: 0.02,
OSCORE: [kid: 0x5f, Partial IV: 42],
Uri-Host: example.com,
Proxy-Scheme: coap,
0xff,
{Code: 0.01,
Uri-Path: "alarm_status"
} // Encrypted with CTX_C_S
} // Encrypted with CTX_C_P
Decrypt
REQ with
CTX_C_P
POST
Code: 0.02 (POST)
Token: 0x7b
OSCORE: [kid: 0x5f, Partial IV: 42]
0xff
Payload: {
Code: 0.01,
Uri-Path: "alarm_status"
} // Encrypted with CTX_C_S
Decrypt
REQ with
CTX_C_S
Encrypt
RESP with
CTX_C_S
2.04
Code: 2.04 (Changed)
Token: 0x7b
OSCORE: -
0xff



Square brackets [...] indicate content of compressed COSE object.
Curly brackets { ... } indicate encrypted data.

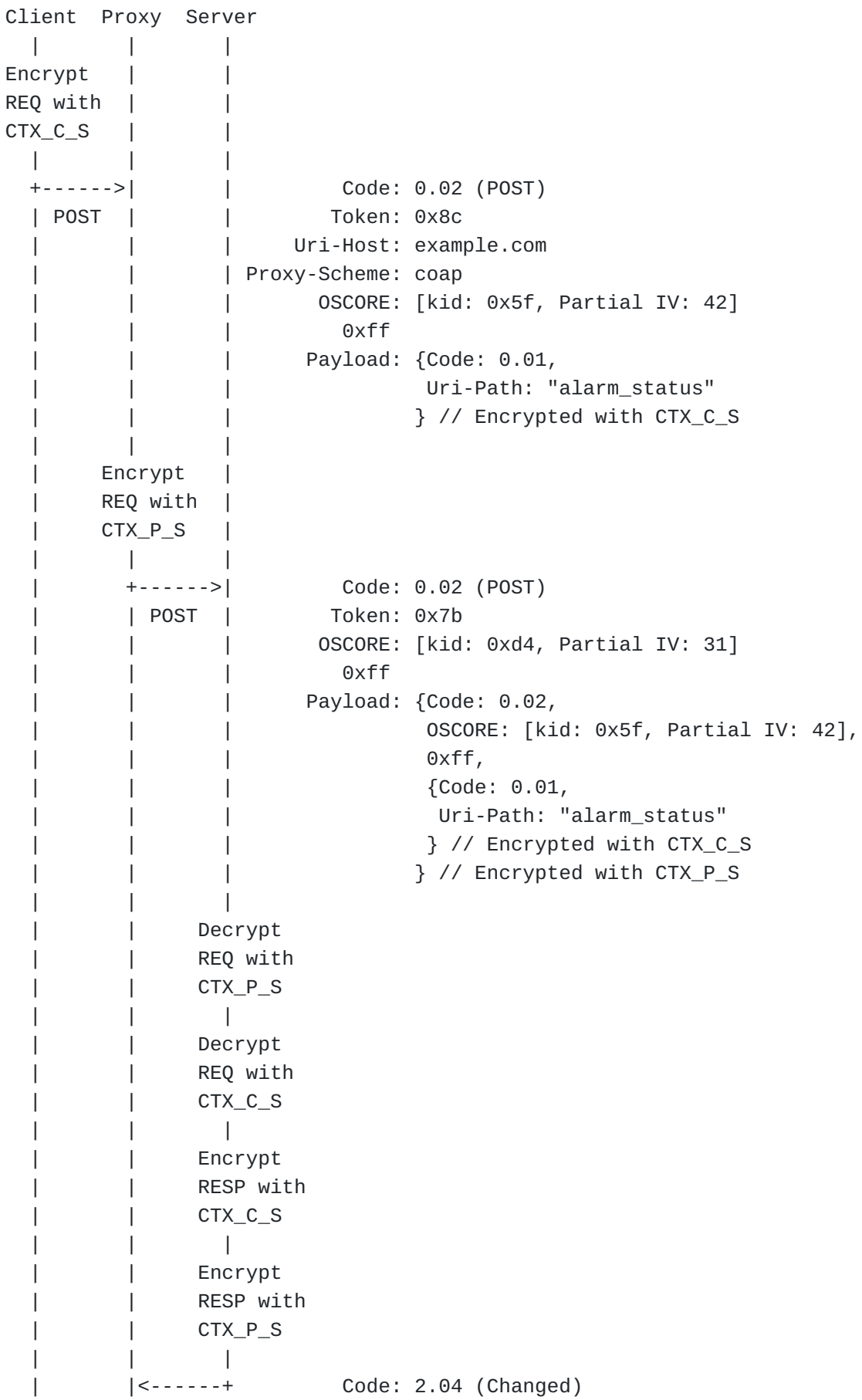
Figure 1: Use of OSCORE between Client-Server and Client-Proxy

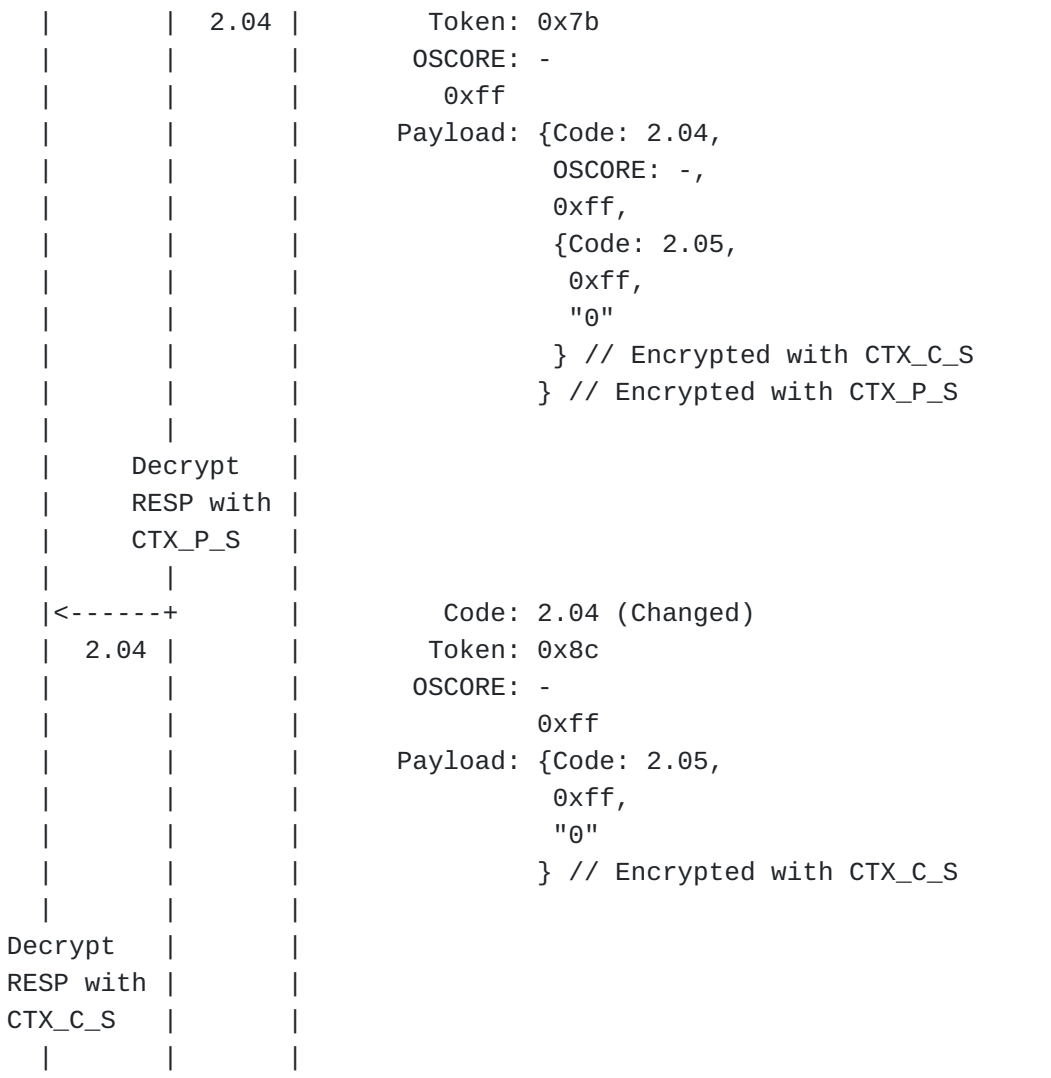
A.2. Example 2

In the example shown in Figure 2, message exchanges are protected with OSCORE over the following legs.

- End-to-end between the client and the server, using the OSCORE Security Context CTX_C_S. The client uses the OSCORE Sender ID 0x5f when using OSCORE with the server.

- Between the proxy and the server, using the OSCORE Security Context CTX_P_S. The proxy uses the OSCORE Sender ID 0xd4 when using OSCORE with the server.


Client Proxy Server
Encrypt
REQ with
CTX_C_S
POST
Code: 0.02 (POST)
Token: 0x8c
Uri-Host: example.com
Proxy-Scheme: coap
OSCORE: [kid: 0x5f, Partial IV: 42]
0xff
Payload: {Code: 0.01,
Uri-Path: "alarm_status"
} // Encrypted with CTX_C_S
Encrypt
REQ with
CTX_P_S
POST
Code: 0.02 (POST)
Token: 0x7b
OSCORE: [kid: 0xd4, Partial IV: 31]
0xff
Payload: {Code: 0.02,
OSCORE: [kid: 0x5f, Partial IV: 42],
0xff,
{Code: 0.01,
Uri-Path: "alarm_status"
} // Encrypted with CTX_C_S
} // Encrypted with CTX_P_S
Decrypt
REQ with
CTX_P_S
Decrypt
REQ with
CTX_C_S
Encrypt
RESP with
CTX_C_S
Encrypt
RESP with
CTX_P_S
Code: 2.04 (Changed)



Square brackets [...] indicate content of compressed COSE object.
Curly brackets { ... } indicate encrypted data.

Figure 2: Use of OSCORE between Client-Server and Proxy-Server

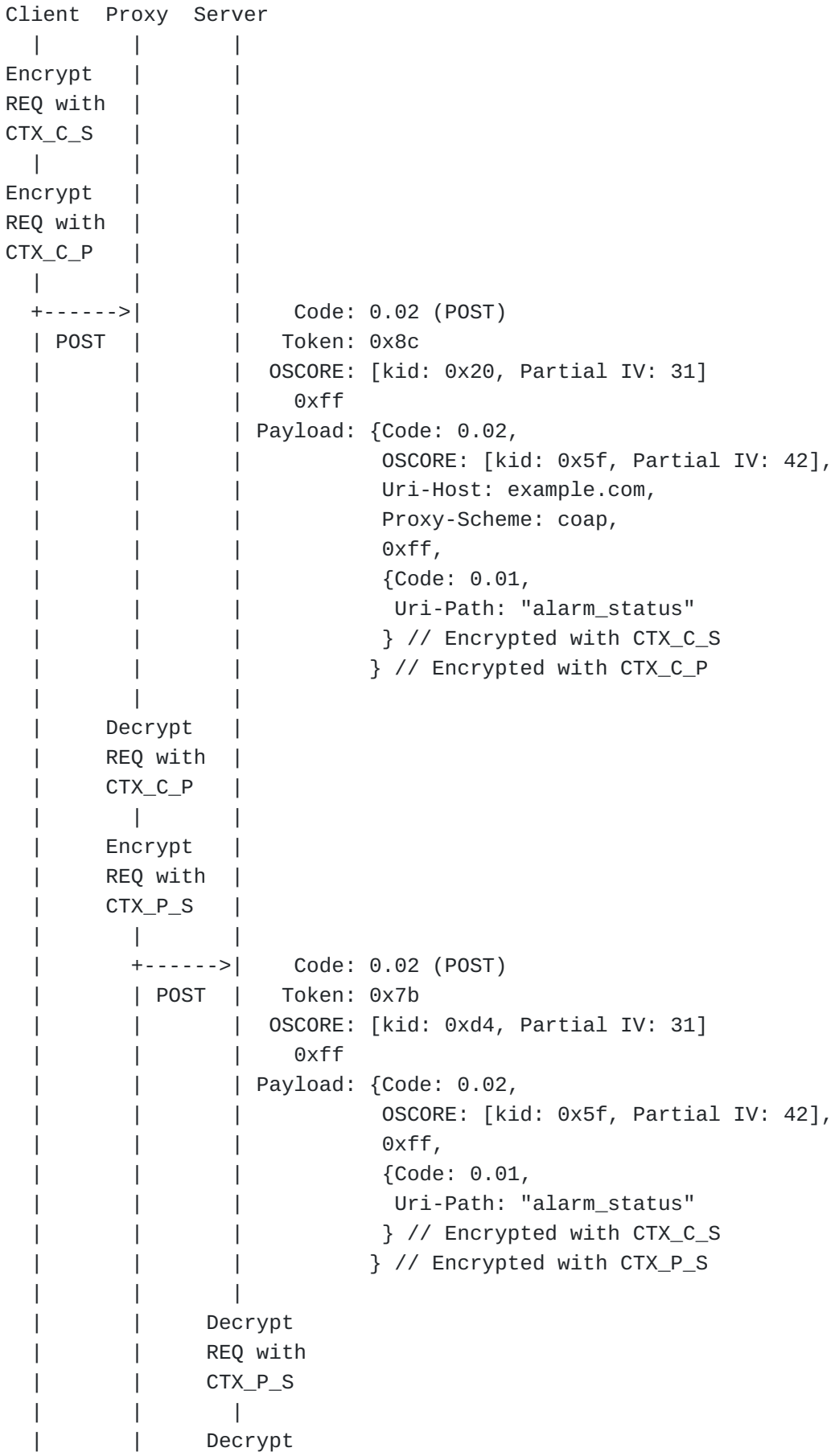
A.3. Example 3

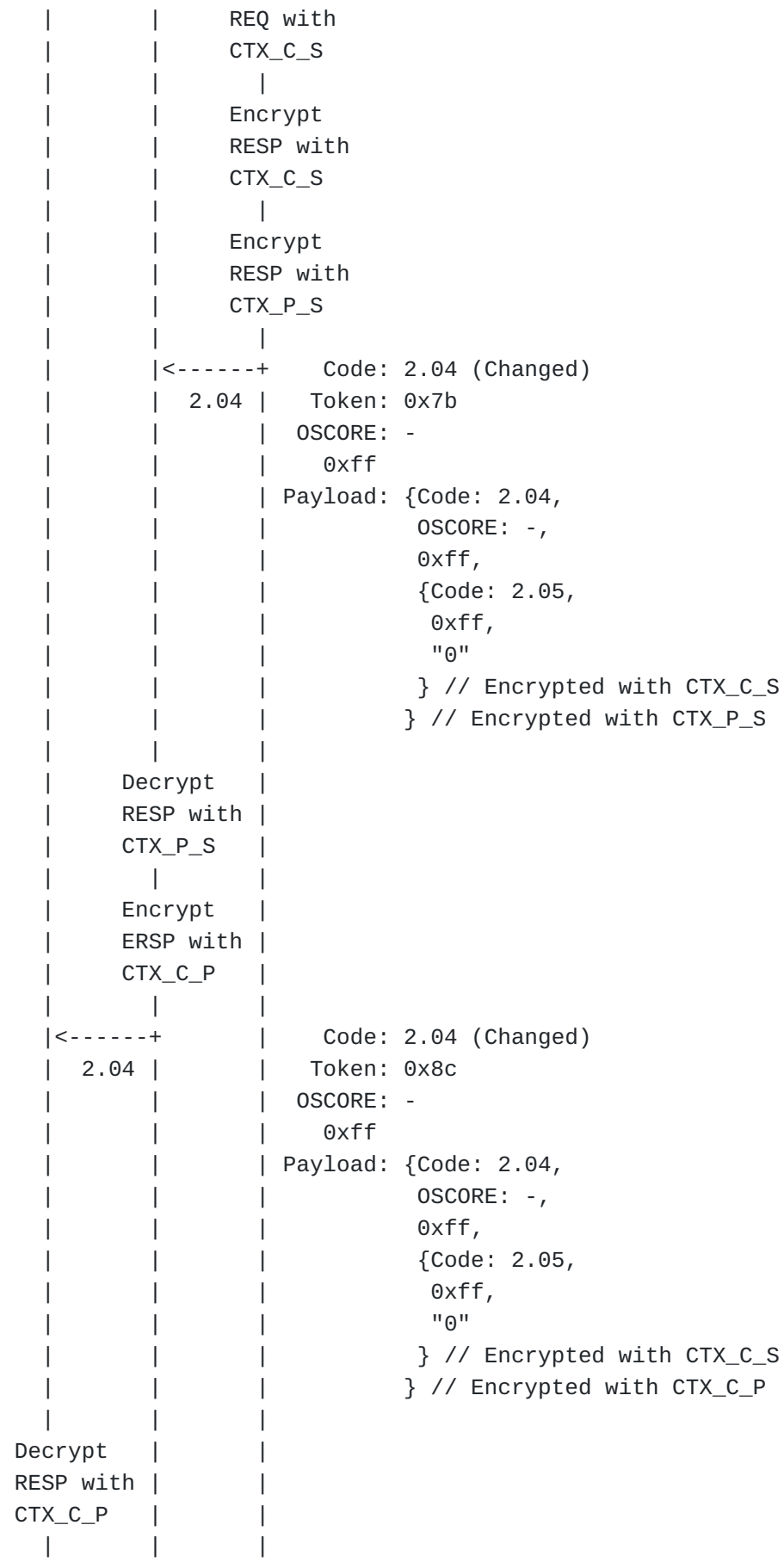
In the example shown in Figure 3, message exchanges are protected with OSCORE over the following legs.

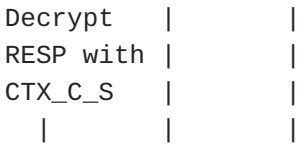
- End-to-end between the client and the server, using the OSCORE Security Context CTX_C_S. The client uses the OSCORE Sender ID 0x5f when using OSCORE with the server.

- Between the client and the proxy, using the OSCORE Security Context CTX_C_P. The client uses the OSCORE Sender ID 0x20 when using OSCORE with the proxy.

- Between the proxy and the server, using the OSCORE Security Context CTX_P_S. The proxy uses the OSCORE Sender ID 0xd4 when using OSCORE with the server.


Client Proxy Server
Encrypt
REQ with
CTX_C_S
Encrypt
REQ with
CTX_C_P
POST
Code: 0.02 (POST)
Token: 0x8c
OSCORE: [kid: 0x20, Partial IV: 31]
0xff
Payload: {Code: 0.02,
OSCORE: [kid: 0x5f, Partial IV: 42],
Uri-Host: example.com,
Proxy-Scheme: coap,
0xff,
{Code: 0.01,
Uri-Path: "alarm_status"
} // Encrypted with CTX_C_S
} // Encrypted with CTX_C_P
Decrypt
REQ with
CTX_C_P
Encrypt
REQ with
CTX_P_S
POST
Code: 0.02 (POST)
Token: 0x7b
OSCORE: [kid: 0xd4, Partial IV: 31]
0xff
Payload: {Code: 0.02,
OSCORE: [kid: 0x5f, Partial IV: 42],
0xff,
{Code: 0.01,
Uri-Path: "alarm_status"
} // Encrypted with CTX_C_S
} // Encrypted with CTX_P_S
Decrypt
REQ with
CTX_P_S
Decrypt


REQ with
CTX_C_S
Encrypt
RESP with
CTX_C_S
Encrypt
RESP with
CTX_P_S
2.04
Code: 2.04 (Changed)
Token: 0x7b
OSCORE: -
0xff
Payload: {Code: 2.04,
OSCORE: -,
0xff,
{Code: 2.05,
0xff,
"0"
} // Encrypted with CTX_C_S
} // Encrypted with CTX_P_S
Decrypt
RESP with
CTX_P_S
Encrypt
ERSP with
CTX_C_P
2.04
Code: 2.04 (Changed)
Token: 0x8c
OSCORE: -
0xff
Payload: {Code: 2.04,
OSCORE: -,
0xff,
{Code: 2.05,
0xff,
"0"
} // Encrypted with CTX_C_S
} // Encrypted with CTX_C_P
Decrypt
RESP with
CTX_C_P



Square brackets [...] indicate content of compressed COSE object.
Curly brackets { ... } indicate encrypted data.

Figure 3: Use of OSCORE between Client-Server, Client-Proxy and Proxy-Server

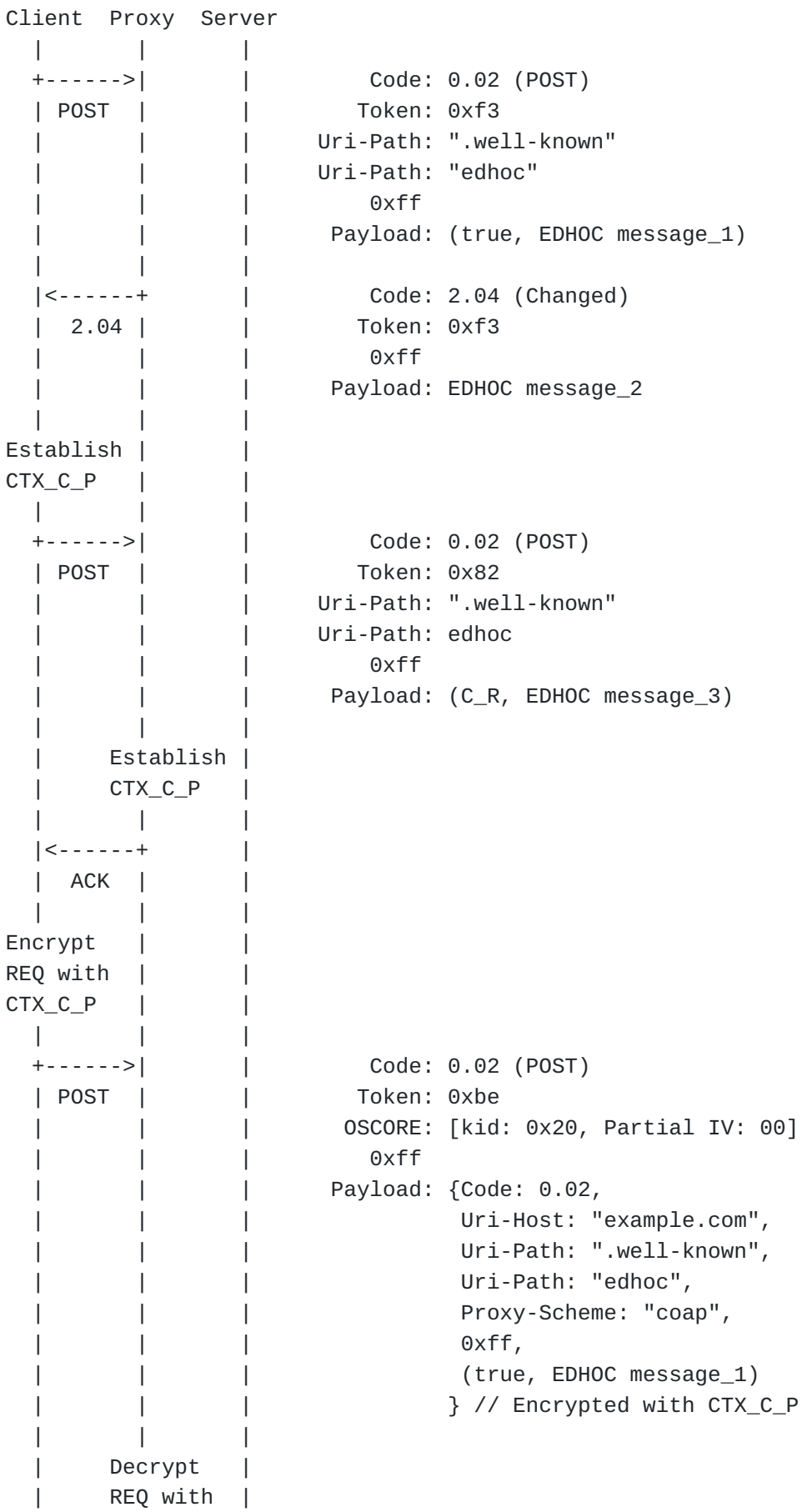
A.4. Example 4

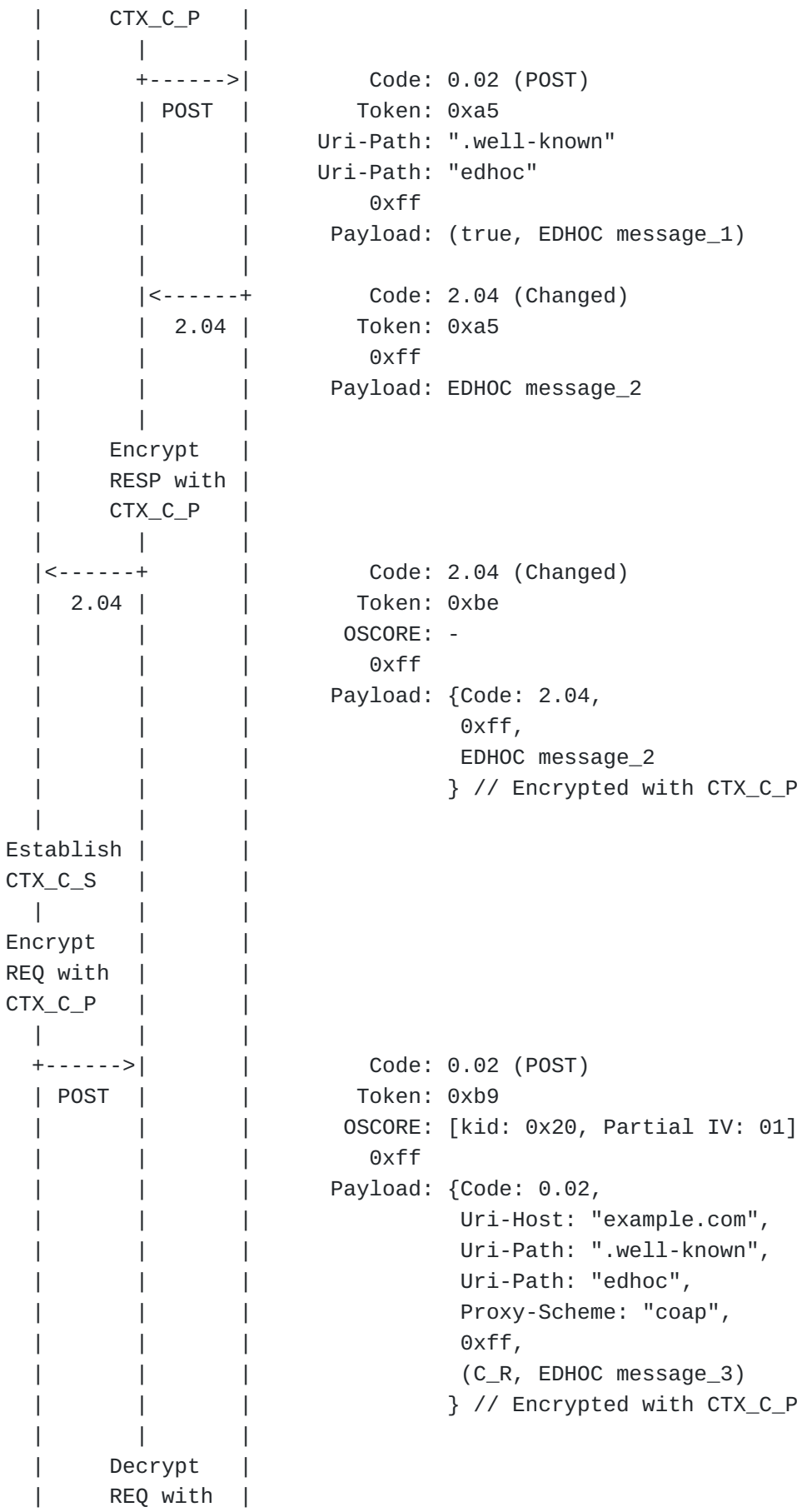
In the example shown in Figure 4, message exchanges are protected over the following legs.

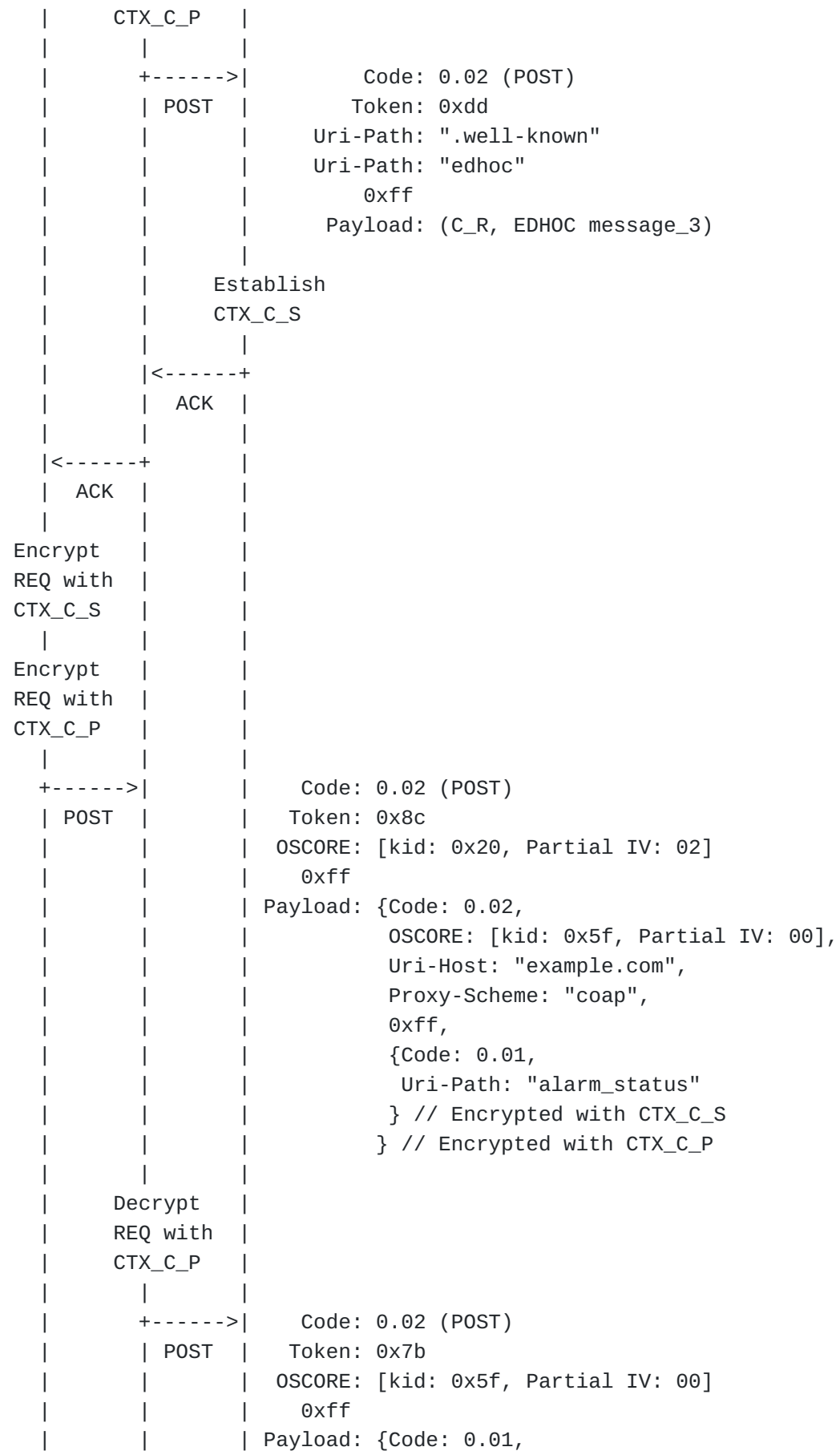
- End-to-end, between the client and the server, using the OSCORE Security Context CTX_C_S. The client uses the OSCORE Sender ID 0x5f when using OSCORE with the server.

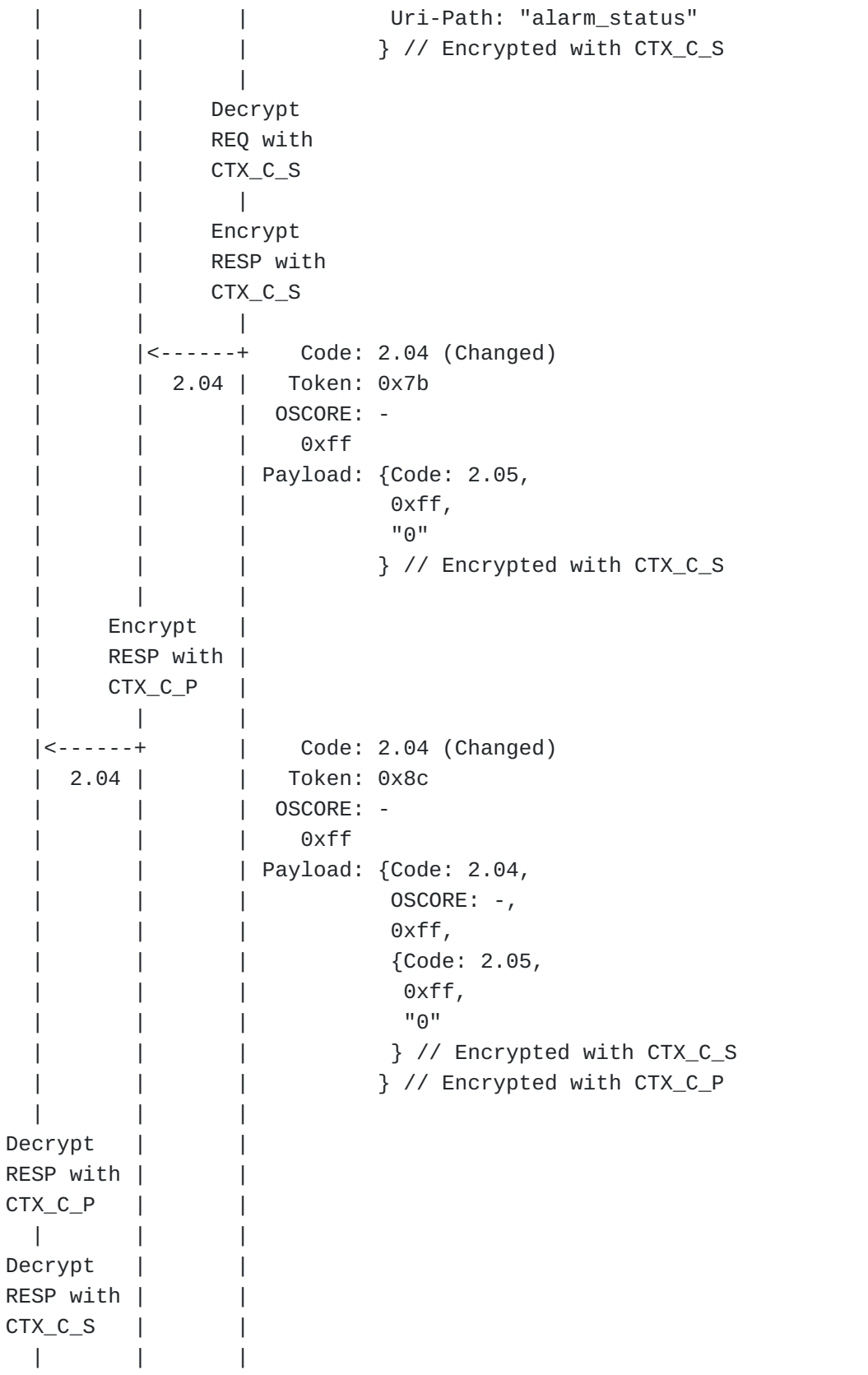
- Between the client and the proxy, using the OSCORE Security Context CTX_C_P. The client uses the OSCORE Sender ID 0x20 when using OSCORE with the proxy.

The example also shows how the client establishes an OSCORE Security Context CTX_C_P with the proxy and CTX_C_S with the server, by using the key establishment protocol EDHOC [I-D.ietf-lake-edhoc].


Client Proxy Server
POST
Code: 0.02 (POST)
Token: 0xf3
Uri-Path: ".well-known"
Uri-Path: "edhoc"
0xff
Payload: (true, EDHOC message_1)
2.04
Code: 2.04 (Changed)
Token: 0xf3
0xff
Payload: EDHOC message_2
Establish CTX_C_P
POST
Code: 0.02 (POST)
Token: 0x82
Uri-Path: ".well-known"
Uri-Path: edhoc
0xff
Payload: (C_R, EDHOC message_3)
Establish CTX_C_P
ACK
Encrypt REQ with CTX_C_P
POST
Code: 0.02 (POST)
Token: 0xbe
OSCORE: [kid: 0x20, Partial IV: 00]
0xff
Payload: {Code: 0.02,
Uri-Host: "example.com",
Uri-Path: ".well-known",
Uri-Path: "edhoc",
Proxy-Scheme: "coap",
0xff,
(true, EDHOC message_1)
} // Encrypted with CTX_C_P
Decrypt REQ with


CTX_C_P
POST
Code: 0.02 (POST)
Token: 0xa5
Uri-Path: ".well-known"
Uri-Path: "edhoc"
0xff
Payload: (true, EDHOC message_1)
2.04
Code: 2.04 (Changed)
Token: 0xa5
0xff
Payload: EDHOC message_2
Encrypt RESP with CTX_C_P
2.04
Code: 2.04 (Changed)
Token: 0xbe
OSCORE: -
0xff
Payload: {Code: 2.04,
0xff,
EDHOC message_2
} // Encrypted with CTX_C_P
Establish CTX_C_S
Encrypt REQ with CTX_C_P
POST
Code: 0.02 (POST)
Token: 0xb9
OSCORE: [kid: 0x20, Partial IV: 01]
0xff
Payload: {Code: 0.02,
Uri-Host: "example.com",
Uri-Path: ".well-known",
Uri-Path: "edhoc",
Proxy-Scheme: "coap",
0xff,
(C_R, EDHOC message_3)
} // Encrypted with CTX_C_P
Decrypt REQ with


CTX_C_P
POST
Code: 0.02 (POST)
Token: 0xdd
Uri-Path: ".well-known"
Uri-Path: "edhoc"
0xff
Payload: (C_R, EDHOC message_3)
Establish
CTX_C_S
ACK
ACK
Encrypt
REQ with
CTX_C_S
Encrypt
REQ with
CTX_C_P
POST
Code: 0.02 (POST)
Token: 0x8c
OSCORE: [kid: 0x20, Partial IV: 02]
0xff
Payload: {Code: 0.02,
OSCORE: [kid: 0x5f, Partial IV: 00],
Uri-Host: "example.com",
Proxy-Scheme: "coap",
0xff,
{Code: 0.01,
Uri-Path: "alarm_status"
} // Encrypted with CTX_C_S
} // Encrypted with CTX_C_P
Decrypt
REQ with
CTX_C_P
POST
Code: 0.02 (POST)
Token: 0x7b
OSCORE: [kid: 0x5f, Partial IV: 00]
0xff
Payload: {Code: 0.01,



Square brackets [...] indicate content of compressed COSE object.
Curly brackets { ... } indicate encrypted data.
Round brackets (...) indicate a CBOR sequence [RFC 8742].

Figure 4: Use of OSCORE between Client-Server and Proxy-Server, with OSCORE Security Contexts established through EDHOC

A.5. Example 5

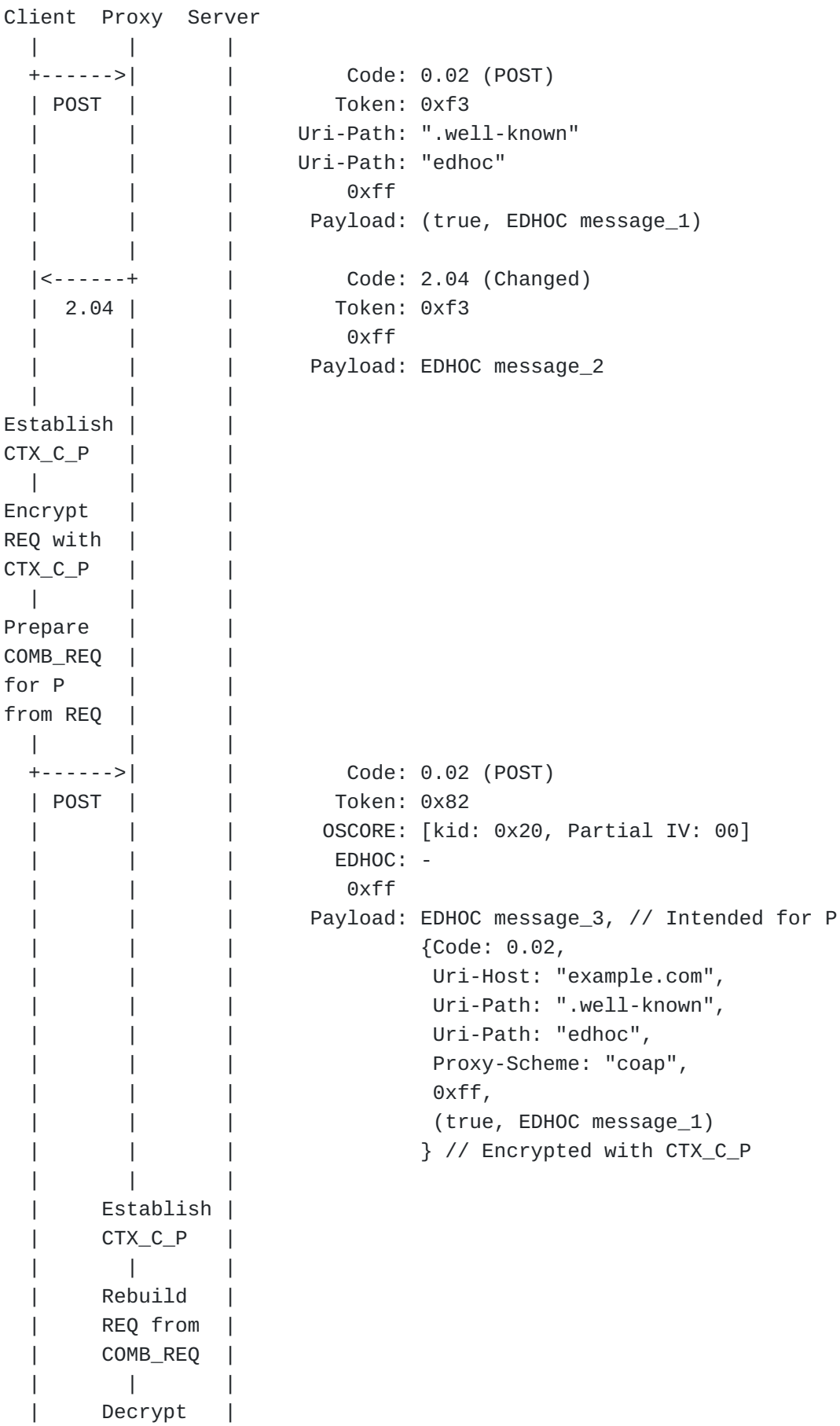
In the example shown in Figure 5, message exchanges are protected over the following legs.

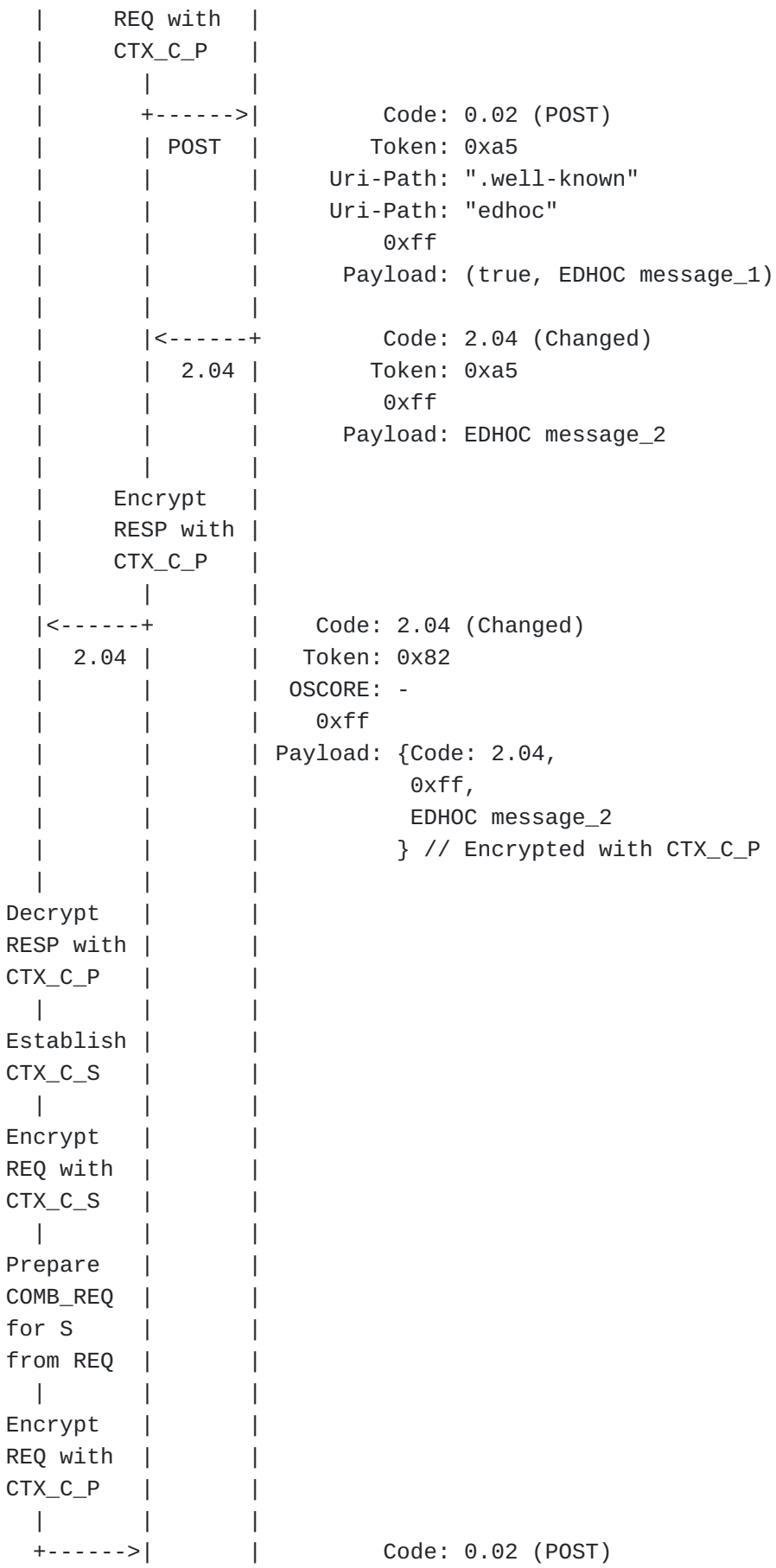
- End-to-end, between the client and the server. The client uses the OSCORE Sender ID 0x5f when using OSCORE with the server.

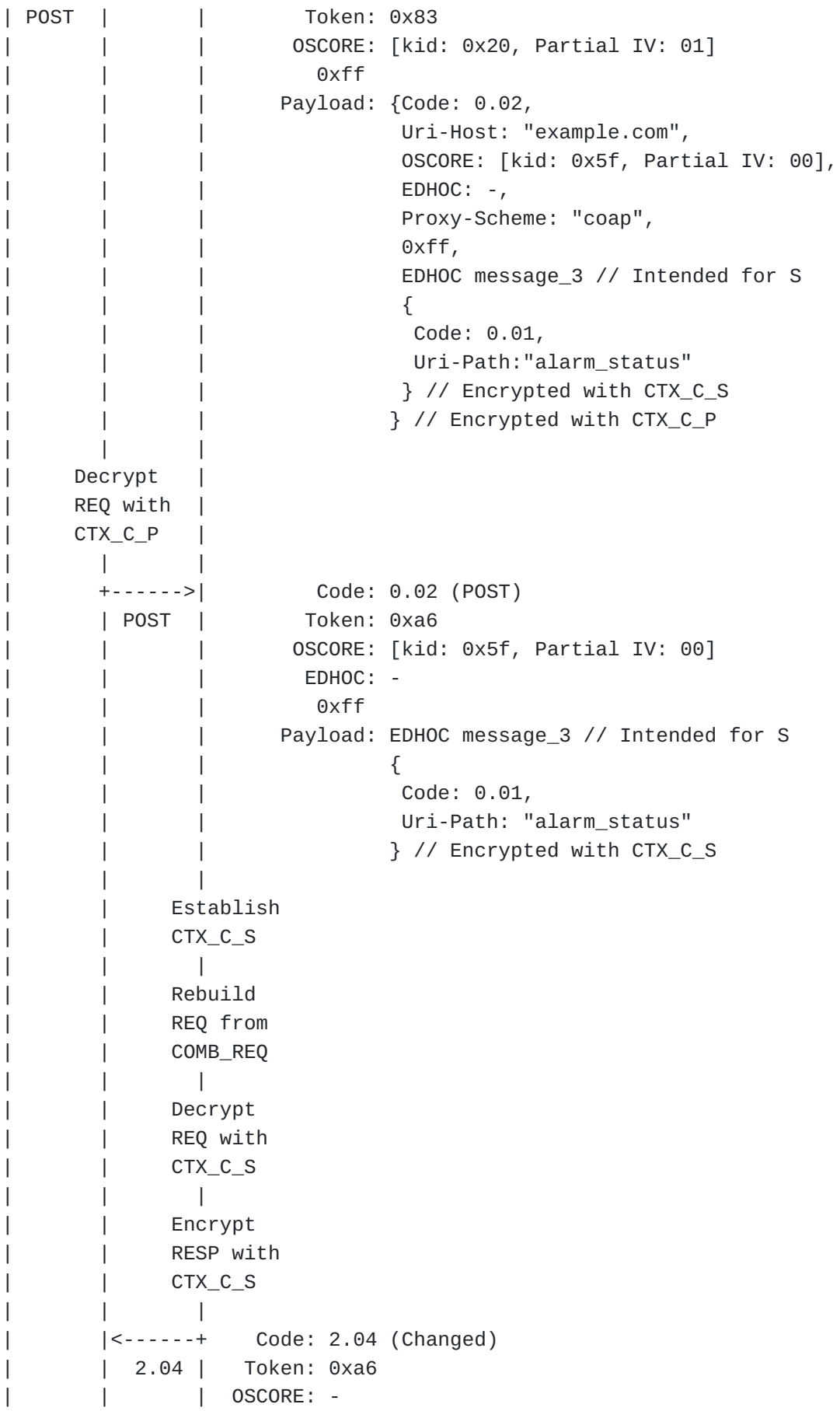
- Between the client and the proxy. The client uses the OSCORE Sender ID 0x20 when using OSCORE with the proxy.

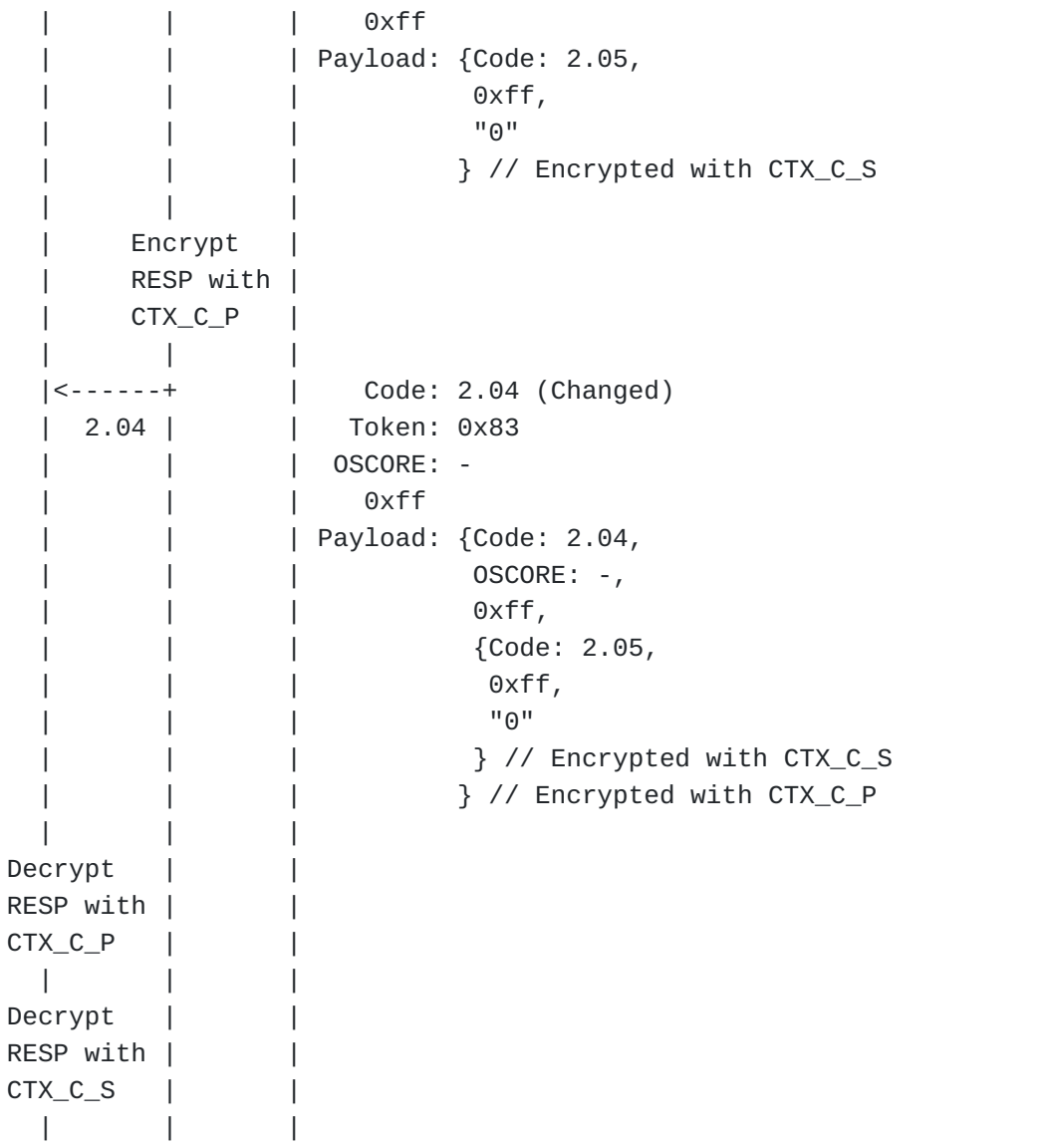
The example also shows how the client establishes an OSCORE Security Context CTX_C_P with the proxy and CTX_C_S with the server, by using the key establishment protocol EDHOC [I-D.ietf-lake-edhoc].

In particular, the client relies on the EDHOC + OSCORE request defined in [I-D.ietf-core-oscore-edhoc] and denoted as COMB_REQ, in order to transport the last EDHOC message_3 and the first OSCORE-protected application CoAP request combined together.


Client Proxy Server
POST
Code: 0.02 (POST)
Token: 0xf3
Uri-Path: ".well-known"
Uri-Path: "edhoc"
0xff
Payload: (true, EDHOC message_1)
2.04
Code: 2.04 (Changed)
Token: 0xf3
0xff
Payload: EDHOC message_2
Establish CTX_C_P
Encrypt REQ with CTX_C_P
Prepare COMB_REQ for P from REQ
POST
Code: 0.02 (POST)
Token: 0x82
OSCORE: [kid: 0x20, Partial IV: 00]
EDHOC: -
0xff
Payload: EDHOC message_3, // Intended for P
{Code: 0.02,
Uri-Host: "example.com",
Uri-Path: ".well-known",
Uri-Path: "edhoc",
Proxy-Scheme: "coap",
0xff,
(true, EDHOC message_1)
} // Encrypted with CTX_C_P
Establish CTX_C_P
Rebuild REQ from COMB_REQ
Decrypt


REQ with
CTX_C_P
POST
Code: 0.02 (POST)
Token: 0xa5
Uri-Path: ".well-known"
Uri-Path: "edhoc"
0xff
Payload: (true, EDHOC message_1)
2.04
Code: 2.04 (Changed)
Token: 0xa5
0xff
Payload: EDHOC message_2
Encrypt
RESP with
CTX_C_P
Code: 2.04 (Changed)
Token: 0x82
OSCORE: -
0xff
Payload: {Code: 2.04,
0xff,
EDHOC message_2
} // Encrypted with CTX_C_P
Decrypt
RESP with
CTX_C_P
Establish
CTX_C_S
Encrypt
REQ with
CTX_C_S
Prepare
COMB_REQ
for S
from REQ
Encrypt
REQ with
CTX_C_P
Code: 0.02 (POST)


POST
Token: 0x83
OSCORE: [kid: 0x20, Partial IV: 01]
0xff
Payload: {Code: 0.02,
Uri-Host: "example.com",
OSCORE: [kid: 0x5f, Partial IV: 00],
EDHOC: -,
Proxy-Scheme: "coap",
0xff,
EDHOC message_3 // Intended for S
{
Code: 0.01,
Uri-Path:"alarm_status"
} // Encrypted with CTX_C_S
} // Encrypted with CTX_C_P
Decrypt
REQ with
CTX_C_P
POST
Code: 0.02 (POST)
Token: 0xa6
OSCORE: [kid: 0x5f, Partial IV: 00]
EDHOC: -
0xff
Payload: EDHOC message_3 // Intended for S
{
Code: 0.01,
Uri-Path: "alarm_status"
} // Encrypted with CTX_C_S
Establish
CTX_C_S
Rebuild
REQ from
COMB_REQ
Decrypt
REQ with
CTX_C_S
Encrypt
RESP with
CTX_C_S
2.04
Code: 2.04 (Changed)
Token: 0xa6
OSCORE: -

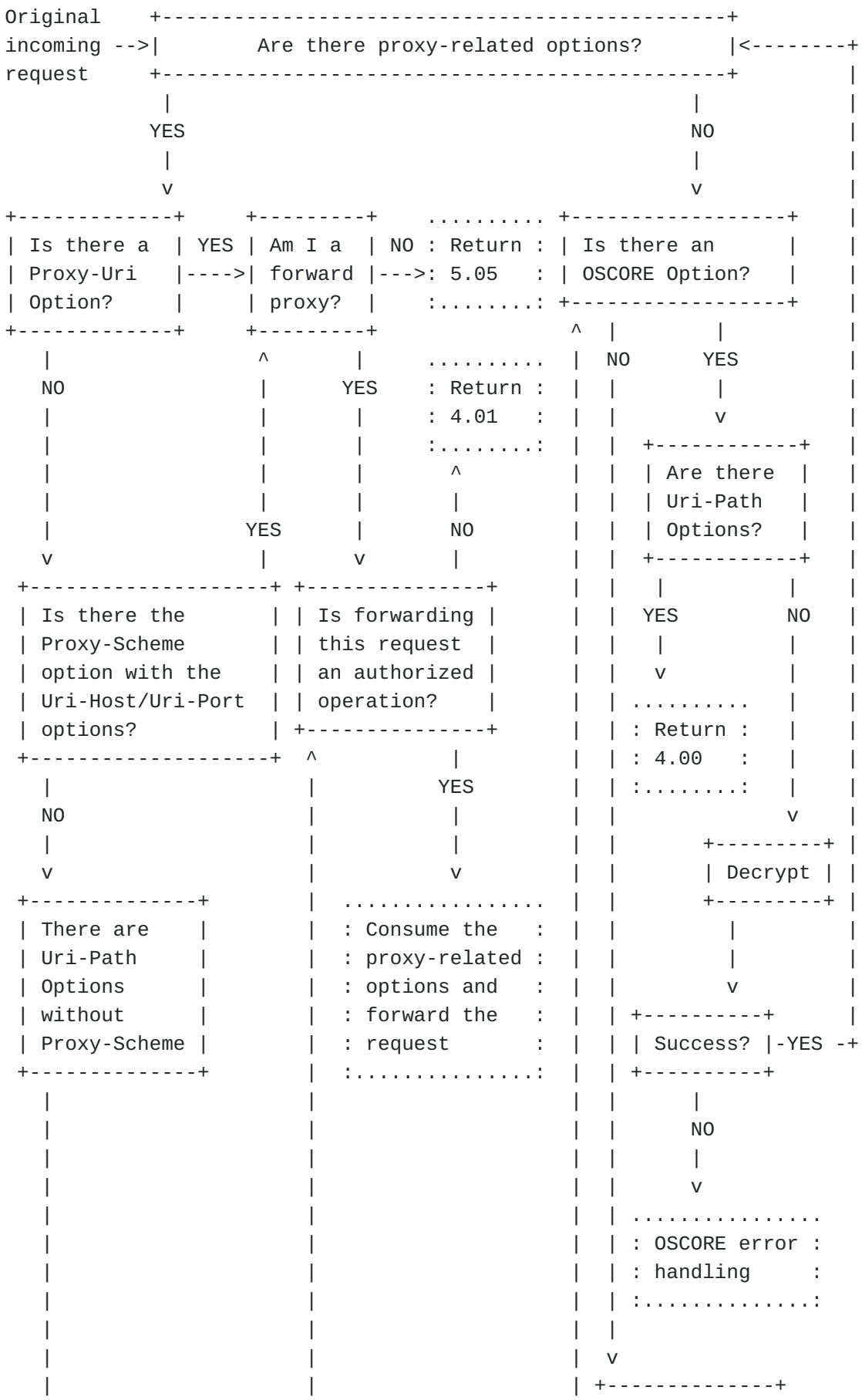


Square brackets [...] indicate content of compressed COSE object.
Curly brackets { ... } indicate encrypted data.
Round brackets (...) indicate a CBOR sequence [RFC 8742].

Figure 5: Use of OSCORE between Client-Server and Proxy-Server, with OSCORE Security Contexts established through EDHOC using the EDHOC + OSCORE request

Appendix B. State Diagram of the Incoming Request Processing

Figure 6 overviews the processing of an incoming request, as specified in Section 3.3. The dotted boxes indicate ending states where the processing terminates.


Original incoming request
Are there proxy-related options?
YES
NO
Is there a Proxy-Uri Option?
YES
Am I a forward proxy?
NO
Return : 5.05
Is there an OSCORE Option?
NO
YES
Return : 4.01
Are there Uri-Path Options?
Is there the Proxy-Scheme option with the Uri-Host/Uri-Port options?
Is forwarding this request an authorized operation?
YES
NO
Return : 4.00
Decrypt
There are Uri-Path Options without Proxy-Scheme
Consume the proxy-related options and forward the request
Success?
YES
NO
OSCORE error handling

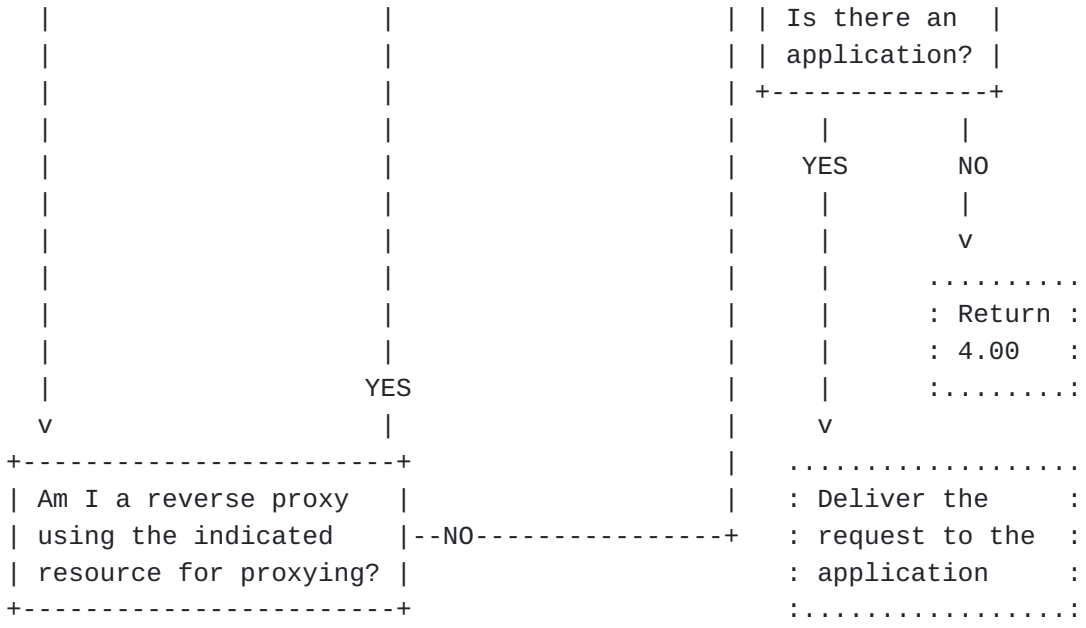

Is there an application?
YES
NO
Return 4.00
Deliver the request to the application
Am I a reverse proxy using the indicated resource for proxying?
YES
NO

Figure 6: Processing of an incoming request.

Acknowledgments

The authors sincerely thank Christian Amsüss, Peter Blomqvist, David Navarro and Göran Selander for their comments and feedback.

The work on this document has been partly supported by VINNOVA and the Celtic-Next project CRITISEC; and by the H2020 project SIFIS-Home (Grant agreement 952652).

Authors' Addresses

Marco Tiloca
RISE AB
Isafjordsgatan 22
SE-16440 Kista
Sweden

Email: marco.tiloca@ri.se

Rikard Höglund
RISE AB
Isafjordsgatan 22
SE-16440 Kista
Sweden

Email: rikard.hoglund@ri.se