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Notification of Revoked Access Tokens in the Authentication and Authorization for Constrained Environments (ACE) Framework draft-tiloca-ace-revoked-token-notification-04

Abstract

This document specifies a method of the Authentication and Authorization for Constrained Environments (ACE) framework, which allows an Authorization Server to notify Clients and Resource Servers (i.e., registered devices) about revoked Access Tokens. The method relies on resource observation for the Constrained Application Protocol (CoAP), with Clients and Resource Servers observing a Token Revocation List on the Authorization Server. Resulting unsolicited notifications of revoked Access Tokens complement alternative approaches such as token introspection, while not requiring additional endpoints on Clients and Resource Servers.

Status of This Memo

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

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This Internet-Draft will expire on August 26, 2021.

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1. Introduction

Authentication and Authorization for Constrained Environments (ACE) [I-D.ietf-ace-oauth-authz] is a framework that enforces access control on IoT devices acting as Resource Servers. In order to use ACE, both Clients and Resource Servers have to register with an Authorization Server and become a registered device. Once registered, a Client can send a request to the Authorization Server, to obtain an Access Token for a Resource Server. For a Client to access the Resource Server, the Client must present the issued Access Token at the Resource Server, which then validates and stores it.

Even though Access Tokens have expiration times, there are circumstances by which an Access Token may need to be revoked before its expiration time, such as: (1) a registered device has been compromised, or is suspected of being compromised; (2) a registered device is decommissioned; (3) there has been a change in the ACE profile for a registered device; (4) there has been a change in access policies for a registered device; and (5) there has been a change in the outcome of policy evaluation for a registered device (e.g., if policy assessment depends on dynamic conditions in the execution environment, the user context, or the resource utilization).

As discussed in Section 6.1 of [I-D.ietf-ace-oauth-authz], only client-initiated revocation is currently specified [RFC7009] for OAuth 2.0 [RFC6749], based on the assumption that Access Tokens in OAuth are issued with a relatively short lifetime. However, this may not be the case for constrained, intermittently connected devices, that need Access Tokens with relatively long lifetimes.

This document specifies a method for allowing registered devices to access and observe a Token Revocation List (TRL) resource on the Authorization Server, in order to get an updated list of revoked, but yet not expired, pertaining Access Tokens. In particular, registered devices rely on resource observation [RFC7641] for the Constrained Application Protocol (CoAP) [RFC7252]. The benefits of this method are that it complements token introspection and does not require any additional endpoints on the registered devices.

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], as well as with terms and concepts related to CBOR Web Tokens (CWTs) [RFC8392], and JSON Web Tokens (JWTs) [RFC7519]. The terminology for entities in the considered architecture is defined in OAuth 2.0 [RFC6749]. In particular, this includes Client, Resource Server, and Authorization Server.

Readers are also expected to be familiar with the terms and concepts related to CBOR [RFC8949], JSON [RFC8259], the CoAP protocol [RFC7252], CoAP Observe [RFC7641], and the use of hash functions to name objects as defined in [RFC6920].

Note that, unless otherwise indicated, the term "endpoint" is used here following its OAuth definition, aimed at denoting resources such as /token and /introspect at the Authorization Server, and /authz-info at the Resource Server. This document does not use the CoAP definition of "endpoint", which is "An entity participating in the CoAP protocol."

This specification also refers to the following terminology.

- Token hash: identifier of an Access Token, in binary format encoding. The token hash has no relation to other possibly used token identifiers, such as the "cti" (CWT ID) claim of CBOR Web Tokens (CWTs) [RFC8392].

- Token Revocation List (TRL): a collection of token hashes, in which the corresponding Access Tokens have been revoked but are not expired yet.

- TRL resource: a resource on the Authorization Server, with a TRL as its representation.

- TRL endpoint: an endpoint at the Authorization Server associated to the TRL resource. The default name of the TRL endpoint in a url-path is '/revoke/trl'. Implementations are not required to use this name, and can define their own instead.

- Registered device: a device registered at the Authorization Server, i.e. as a Client, or a Resource Server, or both. A registered device acts as caller of the TRL endpoint.

- Administrator: entity authorized to get full access to the TRL at the Authorization Server, and acting as caller of the TRL endpoint. An administrator is not necessarily a registered device as defined above, i.e. a Client requesting Access Tokens or a Resource Server consuming Access Tokens. How the administrator authorization is established and verified is out of the scope of this specification.

- Pertaining Access Token:

  * With reference to an administrator, an Access Token issued by the Authorization Server.

  * With reference to a registered device, an Access Token intended to be owned by that device. An Access Token pertains to a Client if the Authorization Server has issued the Access Token and provided it to that Client. An Access Token pertains to a Resource Server if the Authorization Server has issued the Access Token to be consumed by that Resource Server.

2. Protocol Overview

This protocol defines how a CoAP-based Authorization Server informs Clients and Resource Servers, i.e. registered devices, about revoked Access Tokens. How the relationship between the registered device and the Authorization Server is established is out of the scope of this specification.

At a high level, the steps of this protocol are as follows.

- Upon startup, the Authorization Server creates a TRL resource. At any point in time, the TRL resource represents the list of all revoked Access Tokens issued by the Authorization Server that are yet not expired.

- When a device registers at the Authorization Server, it receives the url-path to the TRL resource.

  After the registration procedure is finished, the registered device sends an Observation Request to that TRL resource as described in [RFC7641], i.e. a GET request with an Observe option set to 0 (register). Upon receiving the request, the Authorization Server adds the registered device to the list of observers of the TRL resource.

At any time, the registered device can send a GET request to the TRL endpoint. When doing so, it can request for: the current list of pertaining revoked Access Tokens (see Section 5.1); or the most recent TRL updates occurred over the list of pertaining revoked Access Tokens (see Section 5.2). In either case, the registered devices may especially rely on an Observation Request.

- When an Access Token is revoked, the Authorization Server adds the corresponding token hash to the TRL. Also, when a revoked Access Token eventually expires, the Authorization Server removes the corresponding token hash from the TRL.

  In either case, after updating the TRL, the Authorization Server sends Observe Notifications as per [RFC7641]. That is, one Observe Notification is sent to each registered device the Access Token pertains to, and specifies the current updated list of token hashes in the portion of the TRL pertaining to that device.

  Further Observe Notifications may be sent, consistently with ongoing additional observations of the TRL resource.

- An administrator can observe and access the TRL like a registered device, while getting the full updated representation of the TRL.

Figure 1 shows a high-level overview of the service provided by this protocol. In particular, it shows the Observe Notifications sent by the Authorization Server to one administrator and four registered devices, upon revocation of the issued Access Tokens t1, t2 and t3, with token hash th1, th2 and th3, respectively. Each dotted line associated to a pair of registered devices indicates the Access Token that they both own.

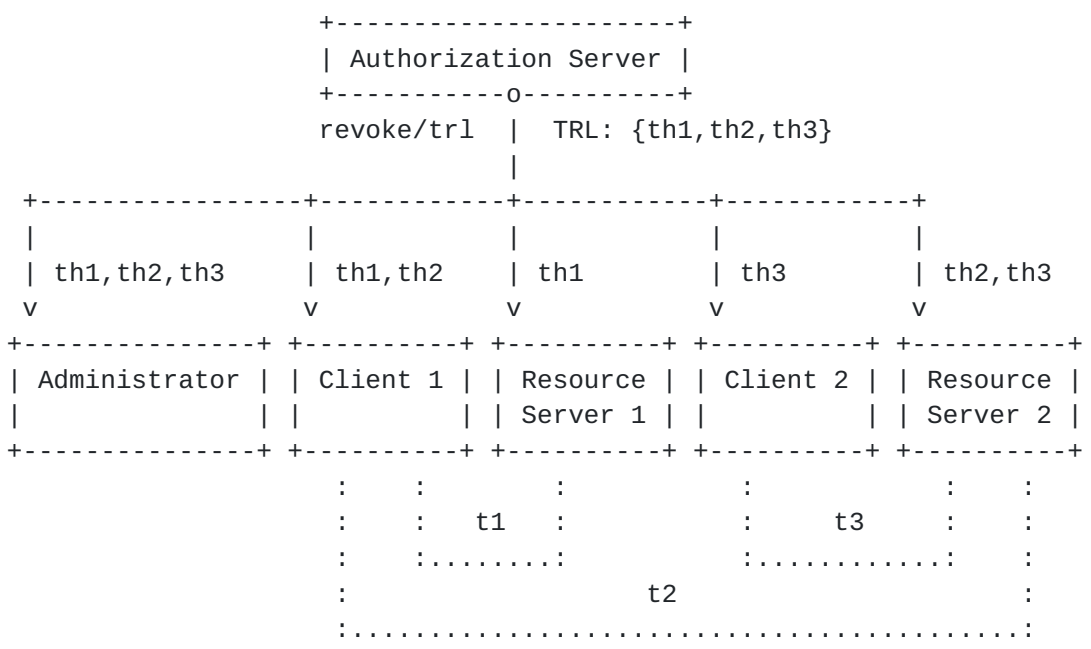


Figure 1: Protocol Overview

Section 8 provides examples of the protocol flow and message exchange between the Authorization Server and a registered device.

3. Token Hash

The token hash of an Access Token is computed as follows.

1. The Authorization Server defines ENCODED_TOKEN, as the content of the 'access_token' parameter in the Authorization Server response (see Section 5.8.2 of [I-D.ietf-ace-oauth-authz]), where the Access Token was included and returned to the requesting Client.

   Note that the content of the 'access_token' parameter is either:

   * A CBOR byte string, if the Access Token was transported using CBOR. With reference to the example in Figure 2, and assuming the string's length in bytes to be 119 (i.e., 0x77 in hexadecimal), then ENCODED_TOKEN takes the bytes {0x58 0x77 0xd0 0x83 0x44 0xa1 ...}, i.e. the raw content of the parameter 'access_token'.

   * A text string, if the Access Token was transported using JSON. With reference to the example in Figure 3, ENCODED_TOKEN takes "2YotnFZFEjr1zCsicMWpAA", i.e. the raw content of the parameter 'access_token'.

2. The Authorization Server defines HASH_INPUT as follows.

   * If CBOR was used to transport the Access Token (as a CWT or JWT), HASH_INPUT takes the same value of ENCODED_TOKEN.

   * If JSON was used to transport the Access Token (as a CWT or JWT), HASH_INPUT takes the serialization of ENCODED_TOKEN.

     In either case, HASH_INPUT results in the binary representation of the content of the 'access_token' parameter from the Authorization Server response.

3. The Authorization Server generates a hash value of HASH_INPUT as per Section 6 of [RFC6920]. The resulting output in binary format is used as the token hash. Note that the used binary format embeds the identifier of the used hash function, in the first byte of the computed token hash.

   The specifically used hash function MUST be collision-resistant on byte-strings, and MUST be selected from the "Named Information Hash Algorithm" Registry [Named.Information.Hash.Algorithm].

   The Authorization Server specifies the used hash function to registered devices during their registration procedure (see Section 6).

```
2.01 Created
Content-Format: application/ace+cbor
Max-Age: 85800
Payload:
{
   access_token : h'd08344a1...'
   (remainder of the Access Token omitted for brevity)
   token_type : pop,
   expires_in : 86400,
   profile    : coap_dtls,
   (remainder of the response omitted for brevity)
}
```

Figure 2: Example of Authorization Server response using CBOR

```
HTTP/1.1 200 OK
Content-Type: application/json
Cache-Control: no-store
Pragma: no-cache
Payload:
{
   "access_token" : "2YotnFZFEjr1zCsicMWpAA"
   (remainder of the Access Token omitted for brevity)
   "token_type" : "pop",
   "expires_in" : 86400,
   "profile"    : "coap_dtls",
   (remainder of the response omitted for brevity)
}
```

Figure 3: Example of Authorization Server response using JSON

4. The TRL Resource

Upon startup, the Authorization Server creates a single TRL resource, encoded as a CBOR array.

Each element of the array is a CBOR byte string, with value the token hash of an Access Token. The order of the token hashes in the CBOR array is irrelevant, and the CBOR array MUST be treated as a set in which the order has no significant meaning.

The TRL is initialized as empty, i.e. the initial content of the TRL resource representation MUST be an empty CBOR array.

4.1. Update of the TRL Resource

The Authorization Server updates the TRL in the following two cases.

- When a non-expired Access Token is revoked, the token hash of the Access Token is added to the TRL resource representation. That is, a CBOR byte string with the token hash as its value is added to the CBOR array used as TRL resource representation.

- When a revoked Access Token expires, the token hash of the Access Token is removed from the TRL resource representation. That is, the CBOR byte string with the token hash as its value is removed from the CBOR array used as TRL resource representation.

5. The TRL Endpoint

Consistent with Section 6.5 of [I-D.ietf-ace-oauth-authz], all communications between a caller of the TRL endpoint and the Authorization Server MUST be encrypted, as well as integrity and

replay protected. Furthermore, responses from the Authorization Server to the caller MUST be bound to the caller's request.

The Authorization Server MUST implement measures to prevent access to the TRL endpoint by entities other than registered devices and authorized administrators.

The TRL endpoint supports only the GET method, and allows two types of query of the TRL.

- Full query: the Authorization Server returns the token hashes of the revoked Access Tokens currently in the TRL and pertaining to the requester. The Authorization Server MUST support this type of query. The processing of a full query and the related response format are defined in Section 5.1.

- Diff query: the Authorization Server returns a list of diff entries. Each diff entry is related to one of the most recent updates, in the portion of the TRL pertaining to the requester. The Authorization Server MAY support this type of query.

  The entry associated to one of such updates contains a list of token hashes, such that: i) the corresponding revoked Access Tokens pertain to the requester; and ii) they were added to or removed from the TRL at that update. The processing of a diff query and the related response format are defined in Section 5.2.

The TRL endpoint allows the following query parameter in a GET request.

- 'diff': if included, it indicates to perform a diff query of the TRL. Its value MUST be either:

  * the integer 0, indicating that a (notification) response should include as many diff entries as the Authorization Server can provide in the response; or

  * a positive integer greater than 0, indicating the maximum number of diff entries that a (notification) response should include.

5.1. Full Query of the TRL

In order to produce a (notification) response to a GET request asking for a full query of the TRL, the Authorization Server performs the following actions.

1. From the current TRL resource representation, the Authorization Server builds a set HASHES, such that:

   * If the requester is a registered device, HASHES specifies the token hashes of the Access Tokens pertaining to that registered device. The Authorization Server can use the authenticated identity of the registered device to perform the necessary filtering on the TRL resource representation.

   * If the requester is an administrator, HASHES specifies all the token hashes in the current TRL resource representation.

2. The Authorization Server sends a 2.05 (Content) Response to the requester, with a CBOR array as payload. Each element of the array specifies one of the token hashes from the set HASHES, encoded as a CBOR byte string.

   The order of the token hashes in the CBOR array is irrelevant, i.e. the CBOR array MUST be treated as a set in which the order has no significant meaning.

5.2. Diff Query of the TRL

In order to produce a (notification) response to a GET request asking for a diff query of the TRL, the Authorization Server performs the following actions.

1. The Authorization Server defines the positive integer NUM. If the value N specified in the query parameter 'diff' of the GET request is equal to 0 or greater than a pre-defined positive integer N_MAX, then NUM takes the value of N_MAX. Otherwise, NUM takes N.

2. The Authorization Server prepares U = min(NUM, SIZE) diff entries, where SIZE <= N_MAX is the number of TRL updates pertaining to the requester and currently stored at the Authorization Server. That is, the diff entries are related to the U most recent TRL updates pertaining to the requester. In particular, the first entry refers to the most recent of such updates, the second entry refers to the second from last of such updates, and so on.

   Each diff entry is a CBOR array 'diff-entry', which includes the following two elements.

   * The first element is a CBOR array 'removed'. Each element of the array is a CBOR byte string, with value the token hash of an Access Token such that: it pertained to the requester; and

it was removed from the TRL during the update associated to the diff entry.

* The second element is a CBOR array 'added'. Each element of the array is a CBOR byte string, with value the token hash of an Access Token such that: it pertains to the requester; and it was added to the TRL during the update associated to the diff entry.

The order of the token hashes in the CBOR arrays 'removed' and 'added' is irrelevant. That is, the CBOR arrays 'removed' and 'added' MUST be treated as a set in which the order of elements has no significant meaning.

3. The Authorization Server prepares a 2.05 (Content) Response for the requester, with a CBOR array 'diff' of U elements as payload. Each element of the CBOR array 'diff' specifies one of the CBOR arrays 'diff-entry' prepared at point 2 as diff entries.

   Within the CBOR array 'diff', the CBOR arrays 'diff-entry' MUST be sorted to reflect the corresponding updates to the TRL in reverse chronological order. That is, the first 'diff-entry' element of 'diff' relates to the most recent update to the portion of the TRL pertaining to the requester.

The CDDL definition [RFC8610] of the CBOR array 'diff' formatted as in the response from the Authorization Server is provided below.

```
token-hash = bytes
trl-patch = [* token-hash]
diff-entry = [removed: trl-patch, added: trl-patch]
diff = [* diff-entry]
```

Figure 4: CDDL definition of the response payload following a Diff Query request to the TRL endpoint

If the Authorization Server supports diff queries:

- The Authorization Server MUST return a 4.00 (Bad Request) response in case the 'diff' parameter specifies a value other than 0 or than a positive integer.

- The Authorization Server MUST keep track of N_MAX most recent updates to the portion of the TRL that pertains to each caller of the TRL endpoint. The particular method to achieve this is implementation-specific.

- When SIZE is equal to N_MAX, and a new TRL update occurs as pertaining to a registered device, the Authorization Server MUST first delete the oldest stored update for that device, before storing this latest update as the most recent one for that device.

- The Authorization Server SHOULD provide registered devices and administrators with the value of N_MAX, upon their registration (see Section 6).

If the Authorization Server does not support diff queries, it proceeds as when processing a full query (see Section 5.1).

Appendix A discusses how the diff query of the TRL is in fact a usage example of the Series Transfer Pattern defined in [I-D.bormann-t2trg-stp].

Appendix B discusses how the diff query of the TRL can be further improved by using the "Cursor" pattern defined in Section 3.3 of [I-D.bormann-t2trg-stp].

6. Upon Registration

During the registration process at the Authorization Server, an administrator or a registered device receives the following information as part of the registration response.

- The url-path to the TRL endpoint at the Authorization Server.

- The hash function used to compute token hashes. This is specified as an integer or a text string, taking value from the "ID" or "Hash Name String" column of the "Named Information Hash Algorithm" Registry [Named.Information.Hash.Algorithm], respectively.

- Optionally, a positive integer N_MAX, if the Authorization Server supports diff queries of the TRL resource (see Section 5.2).

After the registration procedure is finished, the administrator or registered device performs a GET request to the TRL resource, including the CoAP Observe option set to 0 (register), in order to start an observation of the TRL resource at the Authorization Server, as per Section 3.1 of [RFC7641]. The GET request can express the wish for a full query (see Section 5.1) or a diff query (see Section 5.2) of the TRL.

In case the request is successfully processed, The Authorization Server replies using the CoAP response code 2.05 (Content) and including the CoAP Observe option in the response. The payload of

the response is formatted as defined in Section 5.1 or in Section 5.2, in case the GET request was for a full query or a diff query of the TRL, respectively.

Further details about the registration process at the Authorization Server are out of scope for this specification. Note that the registration process is also out of the scope of the ACE framework for Authentication and Authorization (see Section 5.5 of [I-D.ietf-ace-oauth-authz]).

7. Notification of Revoked Tokens

When the TRL is updated (see Section 4.1), the Authorization Server sends Observe Notifications to every observer of the TRL resource. Observe Notifications are sent as per Section 4.2 of [RFC7641].

The payload of each Observe Notification is formatted as defined in Section 5.1 or in Section 5.2, in case the original Observation Request was for a full query or a diff query of the TRL, respectively.

Furthermore, an administrator or a registered device can send additional GET requests to the TRL endpoint at any time, in order to retrieve the token hashes of the pertaining revoked Access Tokens. When doing so, the caller of the TRL endpoint can perform a full query (see Section 5.1) or a diff query (see Section 5.2).

8. Interaction Examples

This section provides examples of interactions between a Resource Server RS as registered device and an Authorization Server AS. The Authorization Server supports both full query and diff query of the TRL, as defined in Section 5.1 and Section 5.2, respectively.

The details of the registration process are omitted, but it is assumed that the Resource Server sends an unspecified payload to the Authorization Server, which replies with a 2.01 (Created) response.

The payload of the registration response is a CBOR map, which includes the following entries:

- a "trl" parameter, specifying the path of the TRL resource;
- a "trl_hash" parameter, specifying the hash function used to computed token hashes as defined in Section 3;
- an "n_max" parameter, specifying the value of N_MAX, i.e. the maximum number of TRL updates pertaining to each registered device

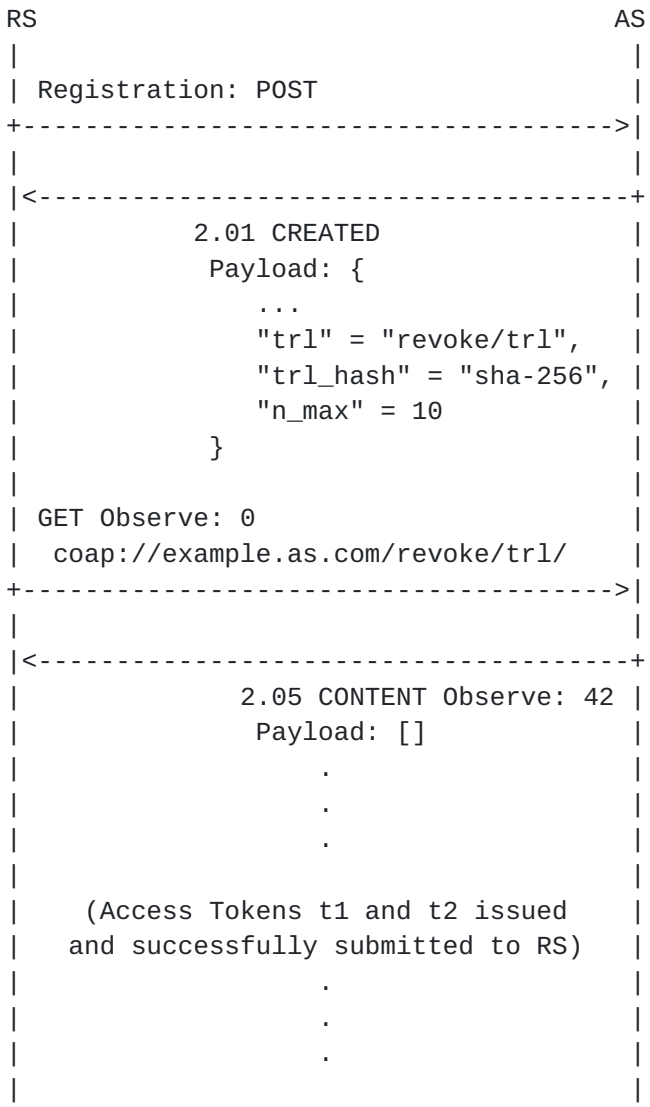
that the Authorization Server retains for that device (see Section 5.2);

- possible further parameters related to the registration process.

Furthermore, 'h(x)' refers to the hash function used to compute the token hashes, as defined in Section 3 of this specification and according to [RFC6920]. Assuming the usage of CWTs transported in CBOR, 'bstr.h(t1)' and 'bstr.h(t2)' denote the byte-string representations of the token hashes for the Access Tokens t1 and t2, respectively.

8.1. Full Query with Observation

Figure 5 shows an example interaction considering a CoAP observation and a full query of the TRL.



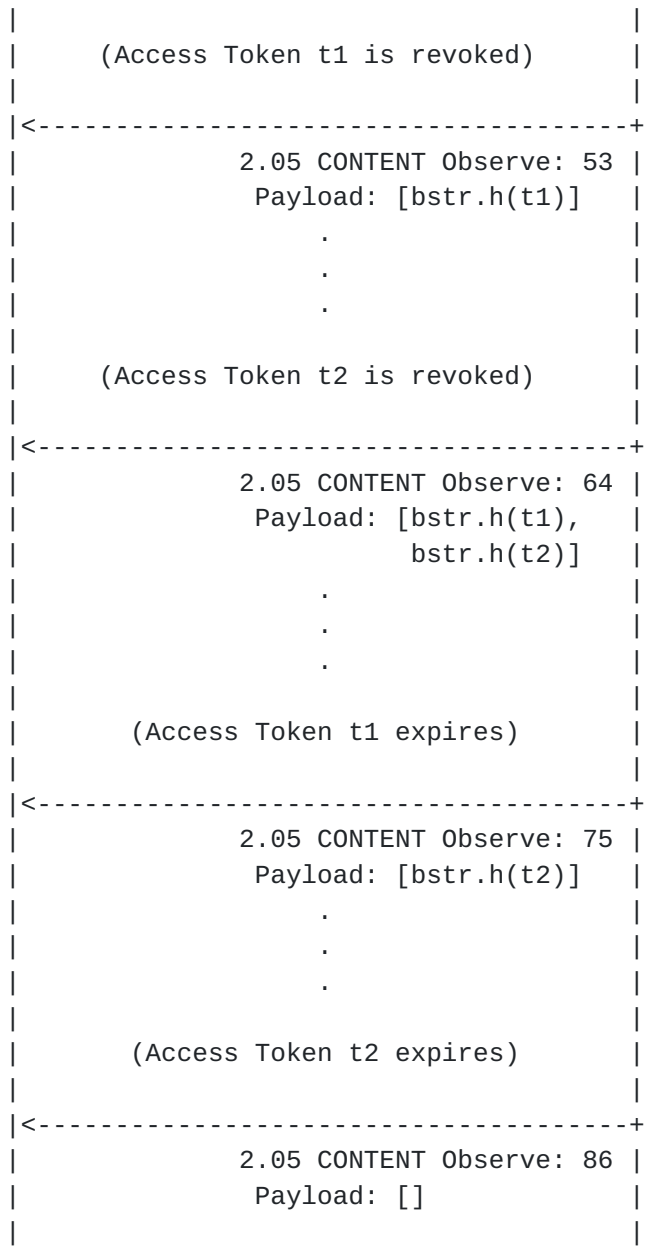
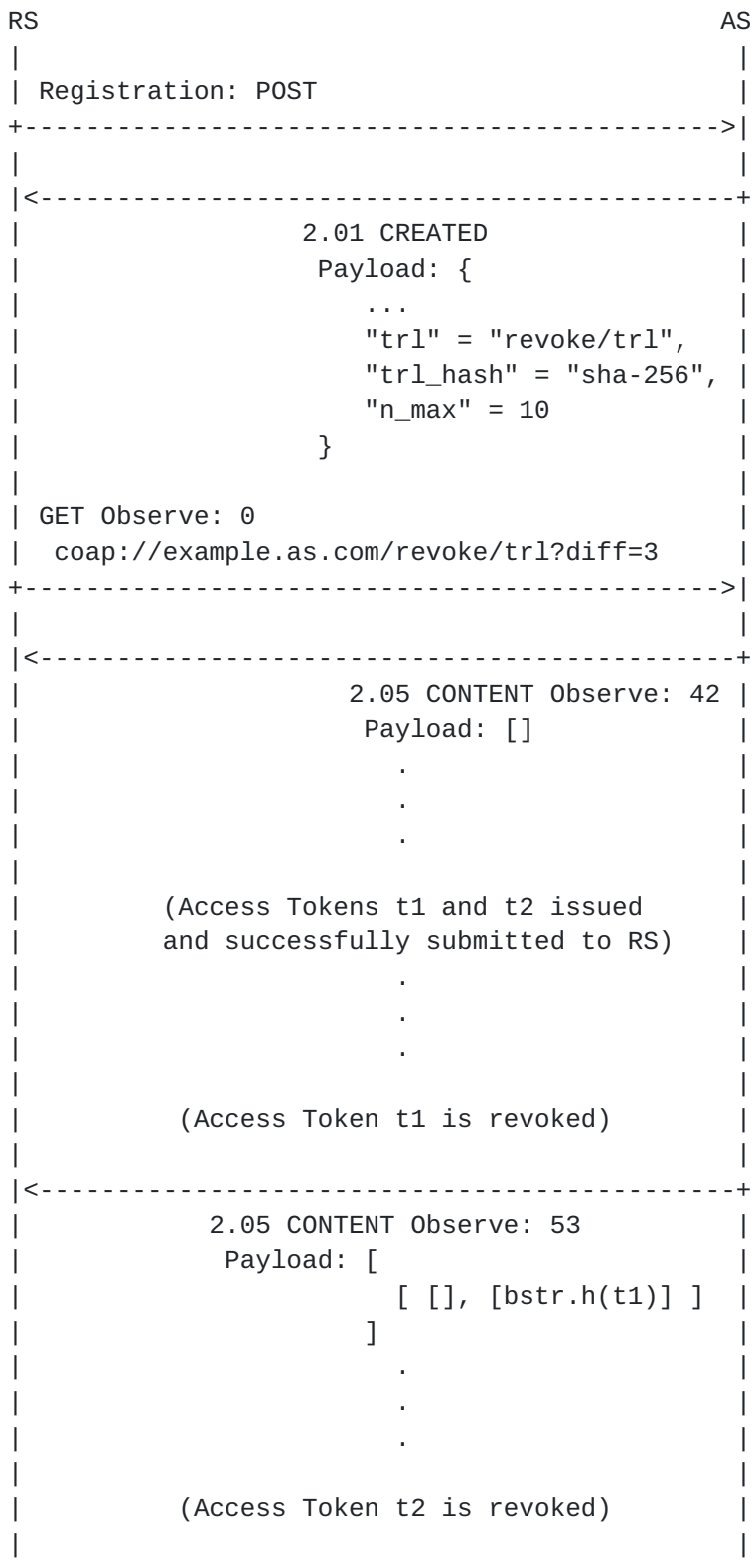


Figure 5: Interaction for Full Query with Observation

8.2. Diff Query with Observation

Figure 6 shows an example interaction considering a CoAP observation and a diff query of the TRL.

The Resource Server indicates N=3 as value of the query parameter "diff", i.e. as the maximum number of diff entries to be specified in a response from the Authorization Server.


RS
AS
Registration: POST
2.01 CREATED
Payload: {
...
"trl" = "revoke/trl",
"trl_hash" = "sha-256",
"n_max" = 10
}
GET Observe: 0
coap://example.as.com/revoke/trl?diff=3
2.05 CONTENT Observe: 42
Payload: []
(Access Tokens t1 and t2 issued
and successfully submitted to RS)
(Access Token t1 is revoked)
2.05 CONTENT Observe: 53
Payload: [
[[], [bstr.h(t1)]]
]
(Access Token t2 is revoked)

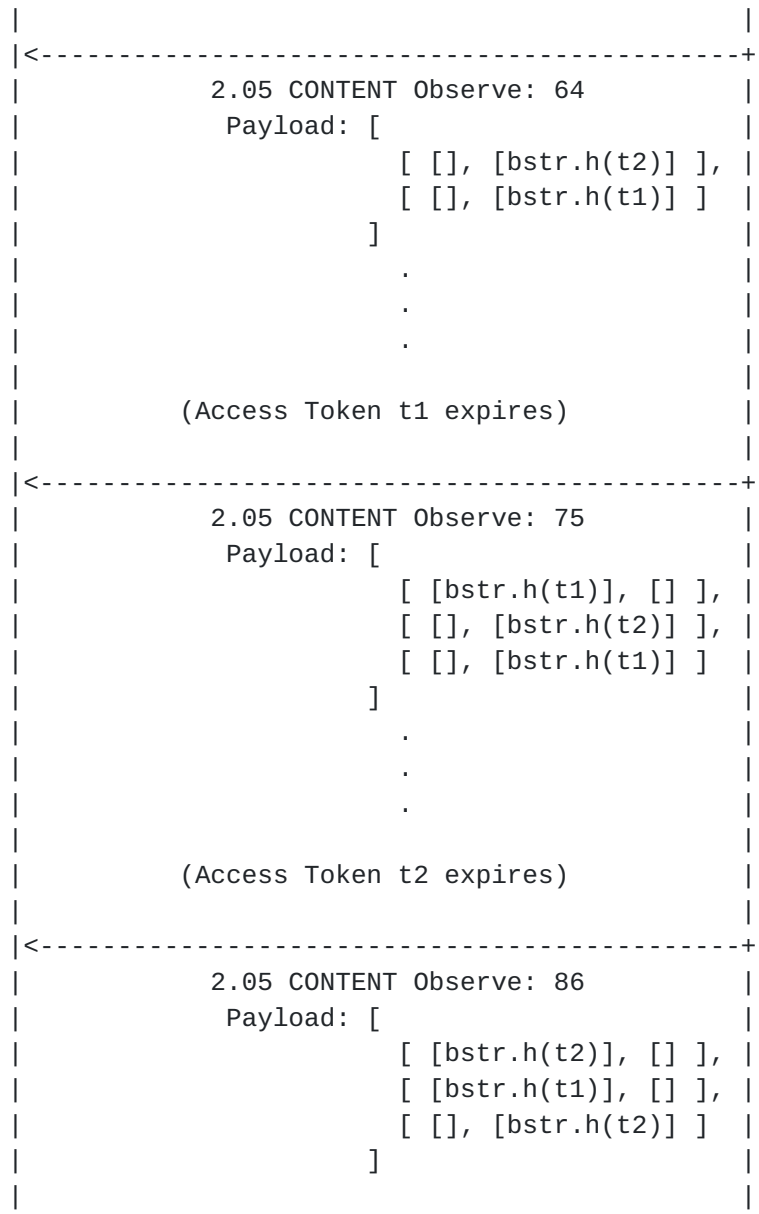


Figure 6: Interaction for Diff Query with Observation

8.3. Full Query with Observation and Additional Diff Query

Figure 7 shows an example interaction considering a CoAP observation and a full query of the TRL.

The example also considers one of the notifications from the Authorization Server to get lost in transmission, and thus not reaching the Resource Server.

When this happens, and after a waiting time defined by the application has elapsed, the Resource Server sends a GET request with

no observation to the Authorization Server, to perform a diff query of the TRL. The Resource Server indicates N=8 as value of the query parameter "diff", i.e. as the maximum number of diff entries to be specified in a response from the Authorization Server.

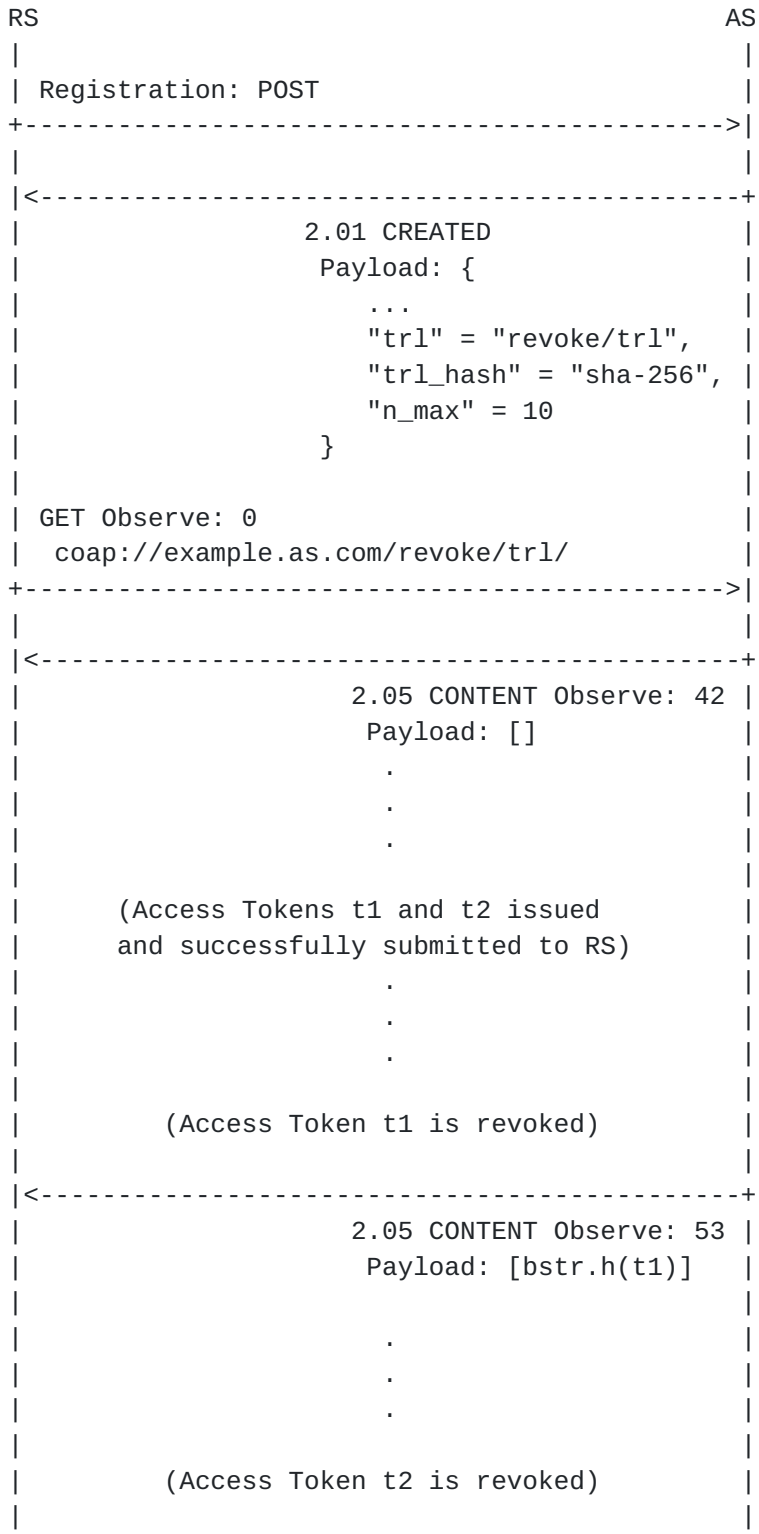


Figure 7: Interaction for Full Query with Observation and Diff Query

9. Security Considerations

Security considerations are inherited from the ACE framework for Authentication and Authorization [I-D.ietf-ace-oauth-authz], from [RFC8392] as to the usage of CWTs, from [RFC7519] as to the usage of JWTs, from [RFC7641] as to the usage of CoAP Observe, and from [RFC6920] with regards to resource naming through hashes. The following considerations also apply.

The Authorization Server MUST ensure that each registered device can access and retrieve only its pertaining portion of the TRL. To this end, the Authorization Server can perform the required filtering based on the authenticated identity of the registered device, i.e., a (non-public) identifier that the Authorization Server can securely relate to the registered device and the secure association they use to communicate.

Disclosing any information about revoked Access Tokens to entities other than the intended registered devices may result in privacy concerns. Therefore, the Authorization Server MUST ensure that, other than registered devices accessing their own pertaining portion of the TRL, only authorized and authenticated administrators can retrieve the full TRL. To this end, the Authorization Server may rely on an access control list or similar.

If a registered device has many non-expired Access Tokens associated to itself that are revoked, the pertaining portion of the TRL could grow to a size bigger than what the registered device is prepared to handle upon reception, especially if relying on a full query of the TRL resource (see Section 5.1). This could be exploited by attackers to negatively affect the behavior of a registered device. Short expiration times could help reduce the size of a TRL, but an Authorization Server SHOULD take measures to limit this size.

Most of the communication about revoked Access Tokens presented in this specification relies on CoAP Observe Notifications sent from the Authorization Server to a registered device. The suppression of those notifications by an external attacker that has access to the network would prevent registered devices from ever knowing that their pertaining Access Tokens have been revoked. To avoid this, a registered device SHOULD NOT rely solely on the CoAP Observe notifications. In particular, a registered device SHOULD also regularly poll the Authorization Server for the most current information about revoked Access Tokens, by sending GET requests to the TRL endpoint according to an application policy.

10. IANA Considerations

This document has the following actions for IANA.

10.1. Media Type Registrations

This specification registers the 'application/ace-trl+cbor' media type for messages of the protocols defined in this document encoded in CBOR. This registration follows the procedures specified in [RFC6838].

Type name: application

Subtype name: ace-trl+cbor

Required parameters: N/A

Optional parameters: N/A

Encoding considerations: Must be encoded as CBOR map containing the protocol parameters defined in [this document].

Security considerations: See Section 9 of this document.

Interoperability considerations: N/A

Published specification: [this document]

Applications that use this media type: The type is used by Authorization Servers, Clients and Resource Servers that support the notification of revoked Access Tokens, according to a Token Revocation List maintained by the Authorization Server as specified in [this document].

Fragment identifier considerations: N/A

Additional information: N/A

Person & email address to contact for further information: <iesg@ietf.org>

Intended usage: COMMON

Restrictions on usage: None

Author: Marco Tiloca <marco.tiloca@ri.se.com>

Change controller: IESG

10.2. CoAP Content-Formats Registry

This specification registers the following entry to the "CoAP Content-Formats" registry, within the "CoRE Parameters" registry:

Media Type: application/ace-trl+cbor

Encoding: -

ID: TBD

Reference: [this document]

10.3. Token Revocation List Registry

This specification establishes the "Token Revocation List" IANA Registry. The Registry has been created to use the "Expert Review" registration procedure [RFC8126]. Expert review guidelines are provided in Section 10.4. It should be noted that, in addition to the expert review, some portions of the Registry require a specification, potentially a Standards Track RFC, to be supplied as well.

The columns of this Registry are:

- Name: This is a descriptive name that enables easier reference to the item. The name MUST be unique. It is not used in the encoding.

- CBOR Key: This is the value used as CBOR key of the item. These values MUST be unique. The value can be a positive integer or a negative integer. Different ranges of values use different registration policies [RFC8126]. Integer values from -256 to 255 are designated as Standards Action. Integer values from -65536 to -257 and from 256 to 65535 are designated as Specification Required. Integer values greater than 65535 are designated as Expert Review. Integer values less than -65536 are marked as Private Use.

- CBOR Type: This contains the CBOR type of the item, or a pointer to the registry that defines its type, when that depends on another item.

- Reference: This contains a pointer to the public specification for the item.

This Registry has been initially populated by the values in Appendix B.4.4. The Reference column for all of these entries refers to this document.

10.4. Expert Review Instructions

The IANA registry established in this document is defined as expert review. This section gives some general guidelines for what the experts should be looking for, but they are being designated as experts for a reason so they should be given substantial latitude.

Expert reviewers should take into consideration the following points:

- Point squatting should be discouraged. Reviewers are encouraged to get sufficient information for registration requests to ensure that the usage is not going to duplicate one that is already registered and that the point is likely to be used in deployments. The zones tagged as private use are intended for testing purposes and closed environments, code points in other ranges should not be assigned for testing.

- Specifications are required for the standards track range of point assignment. Specifications should exist for specification required ranges, but early assignment before a specification is available is considered to be permissible. Specifications are needed for the first-come, first-serve range if they are expected to be used outside of closed environments in an interoperable way. When specifications are not provided, the description provided needs to have sufficient information to identify what the point is being used for.

- Experts should take into account the expected usage of fields when approving point assignment. The fact that there is a range for standards track documents does not mean that a standards track document cannot have points assigned outside of that range. The length of the encoded value should be weighed against how many code points of that length are left, the size of device it will be used on, and the number of code points left that encode to that size.

11. References

11.1. Normative References

[I-D.ietf-ace-oauth-authz]
Seitz, L., Selander, G., Wahlstroem, E., Erdtman, S., and H. Tschofenig, "Authentication and Authorization for Constrained Environments (ACE) using the OAuth 2.0 Framework (ACE-OAuth)", draft-ietf-ace-oauth-authz-37 (work in progress), February 2021.

[Named.Information.Hash.Algorithm]
IANA, "Named Information Hash Algorithm", <https://www.iana.org/assignments/named-information/named-information.xhtml>.

[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/info/rfc2119>.

[RFC6749] Hardt, D., Ed., "The OAuth 2.0 Authorization Framework", RFC 6749, DOI 10.17487/RFC6749, October 2012, <https://www.rfc-editor.org/info/rfc6749>.

[RFC6838] Freed, N., Klensin, J., and T. Hansen, "Media Type Specifications and Registration Procedures", BCP 13, RFC 6838, DOI 10.17487/RFC6838, January 2013, <https://www.rfc-editor.org/info/rfc6838>.

[RFC6920] Farrell, S., Kutscher, D., Dannewitz, C., Ohlman, B., Keranen, A., and P. Hallam-Baker, "Naming Things with Hashes", RFC 6920, DOI 10.17487/RFC6920, April 2013, <https://www.rfc-editor.org/info/rfc6920>.

[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/info/rfc7252>.

[RFC7519] Jones, M., Bradley, J., and N. Sakimura, "JSON Web Token (JWT)", RFC 7519, DOI 10.17487/RFC7519, May 2015, <https://www.rfc-editor.org/info/rfc7519>.

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

[RFC8126] Cotton, M., Leiba, B., and T. Narten, "Guidelines for Writing an IANA Considerations Section in RFCs", BCP 26, RFC 8126, DOI 10.17487/RFC8126, June 2017, <https://www.rfc-editor.org/info/rfc8126>.

[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/info/rfc8174>.

[RFC8259] Bray, T., Ed., "The JavaScript Object Notation (JSON) Data Interchange Format", STD 90, RFC 8259, DOI 10.17487/RFC8259, December 2017, <https://www.rfc-editor.org/info/rfc8259>.

[RFC8392] Jones, M., Wahlstroem, E., Erdtman, S., and H. Tschofenig, "CBOR Web Token (CWT)", RFC 8392, DOI 10.17487/RFC8392, May 2018, <https://www.rfc-editor.org/info/rfc8392>.

[RFC8610] Birkholz, H., Vigano, C., and C. Bormann, "Concise Data Definition Language (CDDL): A Notational Convention to Express Concise Binary Object Representation (CBOR) and JSON Data Structures", RFC 8610, DOI 10.17487/RFC8610, June 2019, <https://www.rfc-editor.org/info/rfc8610>.

[RFC8949] Bormann, C. and P. Hoffman, "Concise Binary Object Representation (CBOR)", STD 94, RFC 8949, DOI 10.17487/RFC8949, December 2020, <https://www.rfc-editor.org/info/rfc8949>.

11.2. Informative References

[I-D.bormann-t2trg-stp] Bormann, C. and K. Hartke, "The Series Transfer Pattern (STP)", draft-bormann-t2trg-stp-03 (work in progress), April 2020.

[RFC7009] Lodderstedt, T., Ed., Dronia, S., and M. Scurtescu, "OAuth 2.0 Token Revocation", RFC 7009, DOI 10.17487/RFC7009, August 2013, <https://www.rfc-editor.org/info/rfc7009>.

Appendix A. Usage of the Series Transfer Pattern

This section discusses how the diff query of the TRL defined in Section 5.2 is a usage example of the Series Transfer Pattern defined in [I-D.bormann-t2trg-stp].

A diff query enables the transfer of a series of TRL updates, with the Authorization Server specifying U <= N_MAX diff entries as the U

most recent updates to the portion of the TRL pertaining to a registered device.

For each registered device, the Authorization Server maintains an update collection of maximum N_MAX items. Each time the TRL changes, the Authorization Server performs the following operations for each registered device.

1. The Authorization Server considers the portion of the TRL pertaining to that registered device. If the TRL portion is not affected by this TRL update, the Authorization Server stops the processing for that registered device.

2. Otherwise, the Authorization Server creates two sets 'trl_patch' of token hashes, i.e. one "removed" set and one "added" set, as related to this TRL update.

3. The Authorization Server fills the two sets with the token hashes of the removed and added Access Tokens, respectively, from/to the TRL portion from step 1.

4. The Authorization Server creates a new series item including the two sets from step 3, and adds the series item to the update collection associated to the registered device.

When responding to a diff query request from a registered device (see Section 5.2), 'diff' is a subset of the collection associated to the requester, where each 'diff_entry' record is a series item from that collection. Note that 'diff' specifies the whole current collection when the value of U is equal to SIZE, i.e. the current number of series items in the collection.

The value N of the 'diff' query parameter in the diff query request allows the requester and the Authorization Server to trade the amount of provided information with the latency of the information transfer.

Since the collection associated to each registered device includes up to N_MAX series item, the Authorization Server deletes the oldest series item when a new one is generated and added to the end of the collection, due to a new TRL update pertaining to that registered device. This addresses the question "When can the server decide to no longer retain older items?" in Section 3.2 of [I-D.bormann-t2trg-stp].

Appendix B. Usage of the "Cursor" Pattern

Building on Appendix A, this section describes how the diff query of the TRL defined in Section 5.2 can be further improved by using the "Cursor" pattern of the Series Transfer Pattern (see Section 3.3 of [I-D.bormann-t2trg-stp]).

This has two benefits. First, the Authorization Server can avoid excessively big latencies when several diff entries have to be transferred, by delivering one adjacent subset at the time, in different diff query responses. Second, a requester can retrieve diff entries associated to TRL updates that, even if not the most recent ones, occurred after a TRL update indicated as checkpoint.

To this end, each series item in an update collection is also associated with an unsigned integer 'index', with value the absolute counter of series items added to that collection minus 1. That is, the first series item added to a collection has 'index' with value 0. Then, the values of 'index' are used as cursor information.

Furthermore, the Authorization Server defines an unsigned integer MAX_DIFF_BATCH <= N_MAX, specifying the maximum number of diff entries to be included in a single diff query response. If supporting diff queries, the Authorization Server SHOULD provide registered devices and administrators with the value of MAX_DIFF_BATCH, upon their registration (see Section 6).

Finally, the full query and diff query exchanges defined in Section 5.1 and Section 5.2 are extended as follows.

In particular, successul responses from the TRL endpoint MUST use the Content-Format "application/ace-trl+cbor" defined in Section 10.2 of this specification.

B.1. Full Query Request

No changes apply to what defined in Section 5.1.

B.2. Full Query Response

When sending a 2.05 (Content) response to a full query request (see Appendix B.1), the response payload includes a CBOR map with the following fields, whose CBOR labels are defined in Appendix B.4.4.

- 'trl': this field MUST include a CBOR array of token hashes. The CBOR array is populated and formatted as defined in Section 5.1.

- 'cursor': this field MUST include either the CBOR simple value Null or a CBOR unsigned integer.

  The CBOR simple value Null MUST be used to indicate that there are currently no TRL updates pertinent to the requester, i.e. the update collection for that requester is empty. This is the case from when the requester registers at the Authorization Server until a first update pertaining that requester occurs to the TRL.

  Otherwise, the field MUST include a CBOR unsigned integer, encoding the 'index' value of the last series item in the collection, as corresponding to the most recent update pertaining to the requester occurred to the TRL.

B.3. Diff Query Request

In addition to the query parameter 'diff' (see Section 5.2), the requester can specify a query parameter 'cursor', with value an unsigned integer.

B.4. Diff Query Response

The Authorization Server composes a response to a diff query request (see Appendix B.3) as follows, depending on the parameters specified in the request and on the current status of the update collection for the requester.

B.4.1. Empty Collection

If the collection associated to the requester has no elements, the Authorization Server returns a 2.05 (Content) diff query response.

The response payload includes a CBOR map with the following fields, whose CBOR labels are defined in Appendix B.4.4.

- 'diff': this field MUST include an empty CBOR array.

- 'cursor': this field MUST include the CBOR simple value Null.

- 'more': this fields MUST include the CBOR simple value False.

B.4.2. Cursor Not Specified in the Diff Query Request

If the update collection associated to the requester is not empty and the diff query request does not include the query parameter 'cursor', the Authorization Server returns a 2.05 (Content) diff query response.

The response payload includes a CBOR map with the following fields, whose CBOR labels are defined in Appendix B.4.4.

- 'diff': this field MUST include a CBOR array, containing L = min(U, MAX_DIFF_BATCH) diff entries. In particular, the CBOR array is populated as follows.

  * If U <= MAX_DIFF_BATCH, these diff entries are the last series items in the collection associated to the requester, corresponding to the L most recent TRL updates pertaining to the requester.

  * If U > MAX_DIFF_BATCH, these diff entries are the eldest of the last L series items in the collection associated to the requester, as corresponding to the first L of the U most recent TRL updates pertaining to the requester.

  The 'diff' CBOR array as well as the individual diff entries have the same format specified in Figure 4 and used for the reponse payload defined in Section 5.2.

- 'cursor': this field MUST include a CBOR unsigned integer. This takes the 'index' value of the series element of the collection included as first diff entry in the 'diff' CBOR array. That is, it takes the 'index' value of the series item in the collection corresponding to the most recent update pertaining to the requester and returned in this diff query response.

  Note that 'cursor' takes the same 'index' value of the last series item in the collection when U <= MAX_DIFF_BATCH.

- 'more': this field MUST include the CBOR simple value False if U <= MAX_DIFF_BATCH, or the CBOR simple value True otherwise.

  If 'more' has value True, the requester can send a follow-up diff query request including the query parameter 'cursor', with the same value of the 'cursor' field included in this diff query response. This would result in the Authorization Server transfering the following subset of series items as diff entries, i.e. resuming from where interrupted in the previous transfer.

B.4.3. Cursor Specified in the Diff Query Request

If the update collection associated to the requester is not empty and the diff query request includes the query parameter 'cursor' with value P, the Authorization Server proceeds as follows.

- The Authorization Server MUST return a 4.00 (Bad Request) response in case the 'cursor' parameter specifies a value other than 0 or than a positive integer.

- If no series item X with 'index' having value P is found in the collection associated to the requester, then that item has been previously removed from the history of updates for that requester (see Appendix A). In this case, the Authorization Server returns a 2.05 (Content) diff query response.

  The response payload includes a CBOR map with the following fields, whose CBOR labels are defined in Appendix B.4.4.

  * 'diff': this field MUST include an empty CBOR array.

  * 'cursor': this field MUST include the CBOR simple value Null.

  * 'more': this field MUST include the CBOR simple value True.

  With the combination ('cursor', 'more') = (Null, True), the Authorization Server is signaling that the update collection is in fact not empty, but that some series items have been lost due to their removal, including the item with 'index' value P that the requester wished to use as checkpoint.

  When receiving this diff query response, the requester should send a new full query request to the Authorization Server, in order to fully retrieve the current pertaining portion of the TRL.

- If the series item X with 'index' having value P is found in the collection associated to the requester, the Authorization Server returns a 2.05 (Content) diff query response.

  The response payload includes a CBOR map with the following fields, whose CBOR labels are defined in Appendix B.4.4.

  * 'diff': this field MUST include a CBOR array, containing L = min(SUB_U, MAX_DIFF_BATCH) diff entries, where SUB_U = min(NUM, SUB_SIZE), and SUB_SIZE is the number of series items in the collection following the series item X.

    That is, these are the L updates pertaining to the requester that immediately follow the series item X indicated as checkpoint. In particular, the CBOR array is populated as follows.

    + If SUB_U <= MAX_DIFF_BATCH, these diff entries are the last series items in the collection associated to the requester,

corresponding to the L most recent TRL updates pertaining to the requester.

+ If SUB_U > MAX_DIFF_BATCH, these diff entries are the eldest of the last L series items in the collection associated to the requester, corresponding to the first L of the SUB_U most recent TRL updates pertaining to the requester.

The 'diff' CBOR array as well as the individual diff entries have the same format specified in Figure 4 and used for the reponse payload defined in Section 5.2.

* 'cursor': this field MUST include a CBOR unsigned integer. In particular:

+ If L is equal to 0, i.e. the series item X is the last one in the collection, 'cursor' takes the same 'index' value of the last series item in the collection.

+ If L is different than 0, 'cursor' takes the 'index' value of the series element of the collection included as first diff entry in the 'diff' CBOR array. That is, it takes the 'index' value of the series item in the collection corresponding to the most recent update pertaining to the requester and returned in this diff query response.

Note that 'cursor' takes the same 'index' value of the last series item in the collection when SUB_U <= MAX_DIFF_BATCH.

* 'more': this field MUST include the CBOR simple value False if SUB_U <= MAX_DIFF_BATCH, or the CBOR simple value True otherwise.

If 'more' has value True, the requester can send a follow-up diff query request including the query parameter 'cursor', with the same value of the 'cursor' field specified in this diff query response. This would result in the Authorization Server transfering the following subset of series items as diff entries, i.e. resuming from where interrupted in the previous transfer.

B.4.4. TRL Parameters

This specification defines a number of fields used in the response to a diff query request to the TRL endpoint relying on the "Cursor" pattern, as defined in Appendix B.

The table below summarizes them, and specifies the CBOR key to use instead of the full descriptive name. Note that the Content-Format "application/ace-trl+cbor" defined in Section 10.2 of this specification MUST be used when these fields are transported.

Name	CBOR Key	CBOR Type	Reference
trl	TBD	array	[This Document]
cursor	TBD	simple value null / unsigned integer	[This Document]
diff	TBD	array	[This Document]
more	TBD	simple value True or False	[This Document]

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