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SET Token Delivery Using HTTP
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Abstract

This specification defines how a series of security event tokens (SETs) may be delivered to a previously registered receiver using HTTP POST over TLS initiated as a push to the receiver, or as a poll by the receiver. The specification also defines how delivery can be assured subject to the SET Token Receiver's need for assurance.

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1. Introduction and Overview

This specification defines how a stream of SETs (see [I-D.ietf-secevent-token]) can be transmitted to a previously registered Event Receiver using HTTP [RFC7231] over TLS. The specification defines a method to push SETs via HTTP POST and another method to poll for SETs using HTTP POST.

This specification defines two methods of SET delivery in what is known as Event Streams.

This specification does not define the method by which Event Streams are defined, provisioned, managed, monitored, and configured and is out of scope of this specification.

[[This work is TBD by the SECEVENTS WG]]

1.1. Notational Conventions

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.

For purposes of readability examples are not URL encoded. Implementers MUST percent encode URLs as described in Section 2.1 of [RFC3986] .

Throughout this documents all figures MAY contain spaces and extra line-wrapping for readability and space limitations. Similarly, some URI's contained within examples, have been shortened for space and readability reasons.

1.2. Definitions

This specification assumes terminology defined in the Security Event Token specification[I-D.ietf-secevent-token] .

The following definitions are defined for Security Event distribution:

Event Transmitter

A service provider that delivers SETs to other providers known as Event Receivers. An Event Transmitter is responsible for offering a service that allows the Event Receiver to check the Event Stream configuration and status known as the "Control Plane".

Event Receiver

A service provider that registers to receive SETs from an Event Transmitter and provides an endpoint to receive SETs via HTTP POST. Event Receivers can check current Event Stream configuration and status by accessing the Event Transmitters "Control Plane".

Event Stream

An Event Stream is a defined location, distribution method and whereby an Event Transmitter and Event Receiver exchange a pre-defined family of SETs. A Stream is assumed to have configuration data such as HTTP endpoints, timeouts, public key sets for signing and encryption, and Event Families.

Subject

The security subject around which a security event has occurred. For example, a security subject might per a user, a person, an email address, a service provider entity, an IP address, an OAuth Client, a mobile device, or any identifiable thing referenced in security and authorization systems.

Event

An Event is defined to be an event as represented by a security event token (SET). See [I-D.ietf-secevent-token].

NumericDate

A JSON numeric value representing the number of seconds from 1970-01-01T00:00:00Z UTC until the specified UTC date/time, ignoring leap seconds. This is equivalent to the IEEE Std 1003.1, 2013 Edition [POSIX.1] definition "Seconds Since the Epoch", in which each day is accounted for by exactly 86400 seconds, other than that non-integer values can be represented. See [RFC3339] for details regarding date/times in general and UTC in particular.

2. SET Event Stream Protocol

An Event Stream represents the communication channel over which a series of SETs are delivered to a configured Event Receiver.

2.1. Event Delivery Process

When an Event occurs, the Event Transmitter constructs a SET token [I-D.ietf-secevent-token] that describes the Event. The Event Transmitter determines the Event Streams over which the SET should be distributed to.

How SETs are defined and the process by which Events are identified for Event Receivers is out-of-scope of this specification.

When a SET is available for an Event Receiver, the Event Transmitter attempts to deliver the SET based on the Event Receiver's registered delivery mechanism:

- o The Event Transmitter uses an HTTP/1.1 POST to the Event Receiver endpoint to deliver the SET;

- o The Event Transmitter queues up the SET in a buffer so that an Event Receiver MAY poll for SETs using HTTP/1.1 POST.
- o Or, the Event Transmitter delivers the Event through a different method not defined by this specification.

Delivery of SETs MAY be delivered using one of two modes:

PUSH

In which SETs are delivered one at a time using HTTP POST requests by an Event Transmitter to an Event Receiver. The HTTP request body is a JSON Web Token [RFC7519] with a "Content-Type" header of "application/secevent+jwt" as defined in Section 2.2 and 6.2 of [I-D.ietf-secevent-token]. Upon receipt, the Event Receiver acknowledges receipt with a response with HTTP Status 202, as described below in Section 2.2.

POLLING Where multiple SETs are delivered in a JSON document [RFC7159] to an Event Receiver in response to an HTTP POST request to the Event Transmitter. Then in a following request, the Event Receiver acknowledges received SETs and MAY poll for more. In POLLING mode, all requests and responses are JSON documents and use a "Content-Type" of "application/json" as described in Section 2.3.

After successful (acknowledged) SET delivery, Event Transmitters SHOULD NOT be required to maintain or record SETs for recovery. Once a SET is acknowledged, the Event Receiver SHALL be responsible for retention and recovery.

Transmitted SETs SHOULD be self-validating (e.g. signed) if there is a requirement to verify they were issued by the Event Transmitter at a later date when de-coupled from the original delivery where authenticity could be checked via the HTTP or TLS mutual authentication.

Upon receiving a SET, the Event Receiver reads the SET and validates it. The Event Receiver MUST acknowledge receipt to the Event Transmitter, using the defined acknowledgement or error method depending on the method of transfer.

The Event Receiver SHALL NOT use the Event acknowledgement mechanism to report Event errors other than relating to the parsing and validation of the SET.

2.2. Push Delivery using HTTP

This method allows an Event Transmitter to use HTTP POST (Section 4.3.3 [RFC7231]) to deliver SETs to a previously registered web callback URI supplied by the Event Receiver as part of an Event Stream configuration process (not defined by this document).

The SET to be delivered MAY be signed and/or encrypted as defined in [I-D.ietf-secevent-token].

The Event Stream configuration defines a URI of an Event Receiver provided endpoint which accepts HTTP POST requests (e.g. "https://rp.example.com/Events").

The HTTP Content-Type (see Section 3.1.1.5 [RFC7231]) for the HTTP POST is "application/secevent+jwt" and SHALL consist of a single SET (see [I-D.ietf-secevent-token]). As per Section 5.3.2 [RFC7231], the expected media type ("Accept" header) response is "application/json".

To deliver an Event, the Event Transmitter generates an event delivery message and uses HTTP POST to the configured endpoint with the appropriate "Accept" and "Content-Type" headers.

```
POST /Events HTTP/1.1
```

```
Host: notify.examplerp.com
Accept: application/json
Authorization: Bearer h480djs93hd8
Content-Type: application/secevent+jwt
eyJhbGciOiJub251In0
```

```
.
eyJwdWJsaXNoZXJvcmkioiJodHRwczovL3NjaW0uZXhhbXBsZS5jb20iLCJmZWV
kVXJpcyI6WyJodHRwczovL2podWIuZXhhbXBsZS5jb20vRmVlZHMvOThkNTI0Nj
FmYTViYmM4Nzk1OTNiNzc1NCIsImh0dHBzOi8vamh1Yi5leGFtcGxlLmNvbS9GZ
WVkey81ZDc2MDQ1MTZiMWQwODY0MWQ3Njc2ZWU3Il10sInJlc291cmNlVXJpcyI6
WyJodHRwczovL3NjaW0uZXhhbXBsZS5jb20vVXNlcnMvNDRmNjE0MmRmOTZiZDZ
hYjYxZTclMjFkOSJdLCJldmVudFR5cGVzIjpbIkNSRUFURSJdLCJhdHRyaWJldG
VzIjpbImkIiwibmFtZSI6InVzZXJOYW1lIiwicGFzc3dvcmQiLCJlbWFpbiX
SwidmFsdWVzIjpb7ImVtYWlscyI6W3sidHlwZSI6IndvcmsiLCJ2YWxlZSI6Impk
b2VAZXhhbXBsZS5jb20ifV0sInBhc3N3b3JkIjoibm90NHUybm8iLCJlc2VyTmF
tZSI6Impkb2UiLCJpZCI6IjQ0ZjYxNDJkZjk2YmQ2YWI2MWU3NTIxZDkiLCJyYW
11Ijpb7ImdpdmVuTmFtZSI6IkpvaG4iLCJmYW1pbHl0YW11IjoiriRG91In19fQ
```

Figure 1: Example HTTP POST Request

Upon receipt of the request, the Event Receiver SHALL validate the JWT structure of the SET as defined in Section 7.2 [RFC7519]. The

Event Receiver SHALL also validate the SET information as described in Section 2 [I-D.ietf-secevent-token].

If the SET is determined to be valid, the Event Receiver SHALL "acknowledge" successful submission by responding with HTTP Status 202 as "Accepted" (see Section 6.3.3 [RFC7231]).

In order to maintain compatibility with other methods of transmission, the Event Receiver SHOULD NOT include an HTTP response body representation of the submitted SET or what the SET's pending status is when acknowledging success. In the case of an error (e.g. HTTP Status 400), the purpose of the HTTP response body is to indicate any SET parsing, validation, or cryptographic errors.

The following is a non-normative example of a successful receipt of a SET.

```
HTTP/1.1 202 Accepted
```

Figure 2: Example Successful Delivery Response

Note that the purpose of the "acknowledgement" response is to let the Event Transmitter know that a SET has been delivered and the information no longer needs to be retained by the Event Transmitter. Before acknowledgement, Event Receivers SHOULD ensure they have validated received SETs and retained them in a manner appropriate to information retention requirements appropriate to the SET event types signaled. The level and method of retention of SETs by Event Receivers is out-of-scope of this specification.

In the Event of a general HTTP error condition, the Event Receiver MAY respond with an appropriate HTTP Status code as defined in Section 6 [RFC7231].

When the Event Receiver detects an error parsing or validating a received SET (as defined by [I-D.ietf-secevent-token]), the Event Receiver SHALL indicate an HTTP Status 400 error with an error code as described in Section 2.4.

The following is an example non-normative error response.

```
HTTP/1.1 400 Bad Request
Content-Type: application/json

{
  "err": "dup",
  "description": "SET already received. Ignored."
}
```

Figure 3: Example HTTP Status 400 Response

2.3. Polling Delivery using HTTP

This method allows an Event Receiver to use HTTP POST (Section 4.3.3 [RFC7231]) to acknowledge SETs and to check for and receive zero or more SETs. Requests MAY be made at a periodic interval (short polling) or requests MAY wait pending availability of new SETs using long polling (see Section 2 [RFC6202]).

The delivery of SETs in this method is facilitated by HTTP POST requests initiated by the Event Receiver in which:

- o The Event Receiver makes a request for available SETs using an HTTP POST to a pre-arranged endpoint provided by the Event Transmitter. Or,
- o After validating previously received SETs, the Event Receiver initiates another poll request using HTTP POST that includes acknowledgement of previous SETs, and waits for the next batch of SETs.

The purpose of the "acknowledgement" is to inform the Event Transmitter that has successfully been delivered and attempts to re-deliver are no longer required. Before acknowledgement, Event Receivers SHOULD ensure received SETs have been validated and retained in a manner appropriate to the receiver's retention requirements. The level and method of retention of SETs by Event Receivers is out-of-scope of this specification.

2.3.1. Polling HTTP Request Attributes

When initiating a poll request, the Event Receiver constructs a JSON document that consists of polling request parameters and SET acknowledgement parameters in the form of JSON attributes.

The request payloads are delivered in one of two forms as described in Section 2.3.3 and Section 2.3.4

When making a request, the HTTP header "Content-Type" is set to "application/json".

The following JSON Attributes are used in a polling request:

Request Processing Parameters

maxEvents

an OPTIONAL JSON integer value indicating the maximum number of unacknowledged SETs that SHOULD be returned. If more than the maximum number of SETs are available, the oldest SETs available SHOULD be returned first. A value of "0" MAY be used by Event Receivers that would like to perform an acknowledge only request. This enables the Receiver to use separate HTTP requests for acknowledgement and reception of SETs. When zero returned events is requested, the value of the attribute "returnImmediately" SHALL be ignored as an immediate response is expected.

returnImmediately

An OPTIONAL JSON boolean value that indicates the Event Transmitter SHOULD return an immediate response even if no results are available (short polling). The default value is "false" indicates the request is to be treated as an HTTP Long Poll (see Section 2 [RFC6202]). The time out for the request is part of the Stream configuration which is out of scope of this specification.

SET Acknowledgment Parameters

ack

Which is an array of Strings that each correspond to the "jti" of a successfully received SET. If there are no outstanding SETs to acknowledge, the attribute MAY be omitted. When acknowledging a SET, the Event Transmitter is released from any obligation to retain the SET (e.g. for a future re-try to receive).

setErrs

A JSON Object that contains one or more nested JSON attributes that correspond to the "jti" of each invalid SET received. The value of each is a JSON object whose contents is an "err" attribute and "description" attribute whose value correspond to the errors described in Section 2.4.

2.3.2. Polling HTTP Response Attributes

In response to a poll request, the Event Transmitter checks for available SET events and responds with a JSON document containing the following JSON attributes:

sets

A JSON object that contains zero or more nested JSON attributes. Each nested attribute corresponds to the "jti" of a SET to be delivered and whose value is a JSON String containing the value of the encoded corresponding SET. If there are no outstanding SETs to be transmitted, the JSON object SHALL be empty.

moreAvailable

A JSON boolean value that indicates if more unacknowledged SETs are available to be returned.

When making a response, the HTTP header "Content-Type" is set to "application/json".

2.3.3. Poll Request

The Event Receiver performs an HTTP POST (see Section 4.3.4 [RFC7231]) to a pre-arranged polling endpoint URI to check for SETs that are available. Because the Event Receiver has no prior SETs to acknowledge, the "ack" and "errs" request parameters are omitted.

If after a period of time, negotiated between the Event Transmitter and Receiver, an Event Transmitter MAY re-issue SETs it has previously delivered. The Event Receiver SHOULD accept repeat SETs and acknowledge the SETs regardless of whether the Receiver believes it has already acknowledged the SETs previously. An Event Transmitter MAY limit the number of times it attempts to deliver a SET. Upon abandoning delivery of a SET, the Event Transmitter SHOULD have a method to notify the Event Receiver of the loss such as through a status service (not defined by this specification).

If the Event Receiver has received SETs from the Event Transmitter, the Event Receiver SHOULD parse and validate received SETs to meet its own requirements and SHOULD acknowledge receipt in a timely (e.g. minutes) fashion so that the Event Transmitter may mark the SETs as received. Event Receivers SHOULD acknowledge receipt before taking any local actions based on the SETs to avoid unnecessary delay in acknowledgement where possible.

Poll requests have three variations:

Poll Only

In which an Event Receiver asks for the next set of Events where no previous SET deliveries are acknowledged (such as in the initial poll request).

Acknowledge Only

In which an Event Receiver sets the "maxEvents" attribute to "0" along with "ack" and "err" attributes indicating the Event Receiver is acknowledging previously received SETs and does not want to receive any new SETs in response to the request.

Combined Acknowledge and Poll

In which an Event Receiver is both acknowledging previously received SETs using the "ack" and "err" attributes and will wait for the next group of SETs in the Event Transmitters response.

2.3.3.1. Poll Only Request

In the case where no SETs were received in a previous poll (see Figure 10), the Event Receiver simply polls without acknowledgement parameters ("sets" and "setErrs").

The following is an example request made by an Event Receiver that has no outstanding SETs to acknowledge and is polling for available SETs.

The following is a non-normative example poll request to the endpoint: "https://nofity.exampleidp.com/Events".

```
POST /Events HTTP/1.1

Host: notify.exampleidp.com
Authorization: Bearer h480djs93hd8
Accept: application/json

{
  "returnImmediately":true
}
```

Figure 4: Example Initial Poll Request

An Event Receiver MAY poll with no parameters at all by passing an empty JSON object.

The following is a non-normative example default poll request to the endpoint: "https://nofity.exampleidp.com/Events".

```
POST /Events HTTP/1.1

Host: notify.exampleidp.com
Authorization: Bearer h480djs93hd8
Accept: application/json

{}
```

Figure 5: Example Default Poll Request

2.3.3.2. Acknowledge Only Request

In this variation, the Event Receiver acknowledges previously received SETs and indicates it does not want to receive SETs in response by setting the "maxEvents" attribute to "0".

This variation is typically used when an Event Receiver needs to acknowledge received SETs independently (e.g. on separate threads) from the process of receiving SETs.

The following is a non-normative example poll with acknowledgement of SETs received (for example as shown in Figure 9).

```
POST /Events HTTP/1.1

Host: notify.exampleidp.com
Authorization: Bearer h480djs93hd8
Content-Type: application/json
Authorization: Bearer h480djs93hd8

{
  "ack":[
    "4d3559ec67504aaba65d40b0363faad8",
    "3d0c3cf797584bd193bd0fb1bd4e7d30"
  ],
  "maxEvents":0
}
```

Figure 6: Example Acknowledge Only request

2.3.3.3. Poll with Acknowledgement

This variation allows a receiver thread to simultaneously acknowledge previously received SETs and wait for the next group of SETs in a single request.

The following is a non-normative example poll with acknowledgement of SETs received in Figure 9.

```
POST /Events HTTP/1.1

Host: notify.exampleidp.com
Authorization: Bearer h480djs93hd8
Content-Type: application/json
Authorization: Bearer h480djs93hd8

{
  "ack":[
    "4d3559ec67504aaba65d40b0363faad8",
    "3d0c3cf797584bd193bd0fb1bd4e7d30"
  ],
  "returnImmediately":false
}
```

Figure 7: Example Poll With Acknowledgement and No Errors

In the above acknowledgement, the Event Receiver has acknowledged receipt of two SETs and has indicated it wants to wait until the next SET is available.

2.3.3.4. Poll with Acknowledgement and Errors

In the case where errors were detected in previously delivered SETs, the Event Receiver MAY use the "setErrs" attribute to indicate errors in the following poll request.

The following is a non-normative example of a response acknowledging 1 error and 1 receipt of two SETs received in Figure 9.

```
POST /Events HTTP/1.1

Host: notify.exampleidp.com
Authorization: Bearer h480djs93hd8
Content-Type: application/json
Authorization: Bearer h480djs93hd8

{
  "ack":["3d0c3cf797584bd193bd0fb1bd4e7d30"],
  "setErrs":{
    "4d3559ec67504aaba65d40b0363faad8":{
      "err":"jwtAud",
      "description":"The audience value was incorrect."
    }
  },
  "returnImmediately":true
}
```

Figure 8: Example Poll Acknowledgement With Error

2.3.4. Poll Response

In response to a poll request, the service provider MAY respond immediately if SETs are available to be delivered. If no SETs are available at the time of the request, the Event Transmitter SHALL delay responding until a SET is available unless the poll request parameter "returnImmediately" is "true".

As described in Section 2.3.2 a JSON document is returned containing a number of attributes including "sets" which SHALL contain zero or more SETs.

The following is a non-normative example response to the request shown Section 2.3.3 showing no new SETs or unacknowledged SETs are available.

```
HTTP/1.1 200 OK
Content-Type: application/json
Location: https://notify.exampleidp/Events
```

```
{
  "sets":{ }
}
```

Figure 10: Example No SETs Poll Response

Upon receiving the JSON document (e.g. as shown in Figure 9), the Event Receiver parses and verifies the received SETs and notifies the Event Transmitter via the next poll request to the Event Transmitter as described in Section 2.3.3.3 or Section 2.3.3.4.

2.4. Error Response Handling

If a SET is invalid, the following error codes are defined:

Err Value	Description
json	Invalid JSON object.
jwtParse	Invalid or unparsable JWT or JSON structure.
jwtHdr	In invalid JWT header was detected.
jwtCrypto	Unable to parse due to unsupported algorithm.
jws	Signature was not validated.
jwe	Unable to decrypt JWE encoded data.
jwtAud	Invalid audience value.
jwtIss	Issuer not recognized.
setType	An unexpected Event type was received.
setParse	Invalid structure was encountered such as an inability to parse or an incomplete set of Event claims.
setData	SET event claims incomplete or invalid.
dup	A duplicate SET was received and has been ignored.

Table 1: SET Errors

An error response SHALL include a JSON object which provides details about the error. The JSON object includes the JSON attributes:

```
err
```

A value which is a keyword that describes the error (see Table 1).

description

A human-readable text that provides additional diagnostic information.

When included as part of an HTTP Status 400 response, the above JSON is the HTTP response body (see Figure 3). When included as part of a batch of SETs, the above JSON is included as part of the "setErrs" attribute as defined in Section 2.3.2 and Section 2.3.3.4

3. Authentication and Authorization

The SET delivery methods described in this specification are based upon HTTP and depend on the use of TLS and/or standard HTTP authentication and authorization schemes as per [RFC7235]. For example, the following methodologies could be used among others:

TLS Client Authentication

Event delivery endpoints MAY request TLS mutual client authentication. See Section 7.3 [RFC5246].

Bearer Tokens

Bearer tokens [RFC6750] MAY be used when combined with TLS and a token framework such as OAuth 2.0 [RFC6749]. For security considerations regarding the use of bearer tokens in SET delivery see Section 4.4.1.

Basic Authentication

Usage of basic authentication should be avoided due to its use of a single factor that is based upon a relatively static, symmetric secret. Implementers SHOULD combine the use of basic authentication with other factors. The security considerations of HTTP BASIC, are well documented in [RFC7617] and SHOULD be considered along with using signed SETs (see SET Payload Authentication below).

SET Payload Authentication

In scenarios where SETs are signed and the delivery method is HTTP POST (see Section 2.2), Event Receivers MAY elect to use Basic Authentication or not to use HTTP or TLS based authentication at all. See Section 4.1 for considerations.

As per Section 4.1 of [RFC7235], a SET delivery endpoint SHALL indicate supported HTTP authentication schemes via the "WWW-Authenticate" header.

Because SET Delivery describes a simple function, authorization for the ability to pick-up or deliver SETs can be derived by considering the identity of the SET issuer, or via an authentication method above. This specification considers authentication as a feature to prevent denial-of-service attacks. Because SETs are not commands (see), Event Receivers are free to ignore SETs that are not of interest.

For illustrative purposes only, SET delivery examples show an OAuth2 bearer token value [RFC6750] in the authorization header. This is not intended to imply that bearer tokens are preferred. However, the use of bearer tokens in the specification does reflect common practice.

3.1. Use of Tokens as Authorizations

When using bearer tokens or proof-of-possession tokens that represent an authorization grant such as issued by OAuth (see [RFC6749]), implementers SHOULD consider the type of authorization granted, any authorized scopes (see Section 3.3 of [RFC6749]), and the security subject(s) that SHOULD be mapped from the authorization when considering local access control rules. Section 6 of the OAuth Assertions draft [RFC7521], documents common scenarios for authorization including:

- o Clients using an assertion to authenticate and/or act on behalf of itself;
- o Clients acting on behalf of a user; and,
- o A Client acting on behalf of an anonymous user (e.g., see next section).

When using OAuth authorization tokens, implementers MUST take into account the threats and countermeasures documented in the security considerations for the use of client authorizations (see Section 8 of [RFC7521]). When using other token formats or frameworks, implementers MUST take into account similar threats and countermeasures, especially those documented by the relevant specifications.

4. Security Considerations

4.1. Authentication Using Signed SETs

In scenarios where HTTP authorization or TLS mutual authentication are not used or are considered weak, JWS signed SETs SHOULD be used (see [RFC7515] and Security Considerations

[I-D.ietf-secevent-token]). This enables the Event Receiver to validate that the SET issuer is authorized to deliver SETs.

4.2. HTTP Considerations

SET delivery depends on the use of Hypertext Transfer Protocol and thus subject to the security considerations of HTTP Section 9 [RFC7230] and its related specifications.

As stated in Section 2.7.1 [RFC7230], an HTTP requestor **MUST NOT** generate the "userinfo" (i.e., username and password) component (and its "@" delimiter) when an "http" URI reference is generated with a message as they are now disallowed in HTTP.

4.3. TLS Support Considerations

SETs contain sensitive information that is considered PII (e.g. subject claims). Therefore, Event Transmitters and Event Receivers **MUST** require the use of a transport-layer security mechanism. Event delivery endpoints **MUST** support TLS 1.2 [RFC5246] and **MAY** support additional transport-layer mechanisms meeting its security requirements. When using TLS, the client **MUST** perform a TLS/SSL server certificate check, per [RFC6125]. Implementation security considerations for TLS can be found in "Recommendations for Secure Use of TLS and DTLS" [RFC7525].

4.4. Authorization Token Considerations

When using authorization tokens such as those issued by OAuth 2.0 [RFC6749], implementers **MUST** take into account threats and countermeasures documented in Section 8 of [RFC7521].

4.4.1. Bearer Token Considerations

Due to the possibility of interception, Bearer tokens **MUST** be exchanged using TLS.

Bearer tokens **MUST** have a limited lifetime that can be determined directly or indirectly (e.g., by checking with a validation service) by the service provider. By expiring tokens, clients are forced to obtain a new token (which usually involves re-authentication) for continued authorized access. For example, in OAuth2, a client **MAY** use OAuth token refresh to obtain a new bearer token after authenticating to an authorization server. See Section 6 of [RFC6749].

Implementations supporting OAuth bearer tokens need to factor in security considerations of this authorization method [RFC7521].

Since security is only as good as the weakest link, implementers also need to consider authentication choices coupled with OAuth bearer tokens. The security considerations of the default authentication method for OAuth bearer tokens, HTTP BASIC, are well documented in [RFC7617], therefore implementers are encouraged to prefer stronger authentication methods. Designating the specific methods of authentication and authorization are out-of-scope for the delivery of SET tokens, however this information is provided as a resource to implementers.

5. Privacy Considerations

If a SET needs to be retained for audit purposes, JWS MAY be used to provide verification of its authenticity.

Event Transmitters SHOULD attempt to specialize Event Streams so that the content is targeted to the specific business and protocol needs of subscribers.

When sharing personally identifiable information or information that is otherwise considered confidential to affected users, Event Transmitters and Receivers MUST have the appropriate legal agreements and user consent or terms of service in place.

The propagation of subject identifiers can be perceived as personally identifiable information. Where possible, Event Transmitters and Receivers SHOULD devise approaches that prevent propagation -- for example, the passing of a hash value that requires the subscriber to already know the subject.

6. IANA Considerations

There are no IANA considerations.

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Appendix A. Other Streaming Specifications

[[EDITORS NOTE: This section to be removed prior to publication]]

The following pub/sub, queuing, streaming systems were reviewed as possible solutions or as input to the current draft:

XMPP Events

The WG considered the XMPP events and its ability to provide a single messaging solution without the need for both polling and push modes. The feeling was the size and methodology of XMPP was too far apart from the current capabilities of the SECEVENTS community which focuses in on HTTP based service delivery and authorization.

Amazon Simple Notification Service

Simple Notification Service, is a pub/sub messaging product from AWS. SNS supports a variety of subscriber types: HTTP/HTTPS endpoints, AWS Lambda functions, email addresses (as JSON or plain text), phone numbers (via SMS), and AWS SQS standard queues. It doesn't directly support pull, but subscribers can get the pull model by creating an SQS queue and subscribing it to the topic. Note that this puts the cost of pull support back onto the subscriber, just as it is in the push model. It is not clear that one way is strictly better than the other; larger, sophisticated developers may be happy to own message persistence so they can have their own internal delivery guarantees. The long tail of OIDC clients may not care about that, or may fail to get it right. Regardless, I think we can learn something from the Delivery Policies supported by SNS, as well as the delivery controls that SQS offers (e.g. Visibility Timeout, Dead-Letter Queues). I'm not suggesting that we need all of these things in the spec, but they give an idea of what features people have found useful.

Other information:

- o API Reference:
<http://docs.aws.amazon.com/AWSSimpleQueueService/latest/APIReference/Welcome.html>
- o Visibility Timeouts:
<http://docs.aws.amazon.com/AWSSimpleQueueService/latest/SQSDeveloperGuide/sqs-visibility-timeout.html>

Apache Kafka

Apache Kafka is an Apache open source project based upon TCP for distributed streaming. It prescribes some interesting general purpose features that seem to extend far beyond the simpler streaming model SECEVENTs is after. A comment from MS has been that Kafka does an acknowledge with poll combination event which seems to be a performance advantage. See: <https://kafka.apache.org/intro>

Google Pub/Sub

Google Pub Sub system favours a model whereby polling and acknowledgement of events is done as separate endpoints as separate functions.

Information:

- o Cloud Overview - <https://cloud.google.com/pubsub/>
- o Subscriber Overview - <https://cloud.google.com/pubsub/docs/subscriber>
- o Subscriber Pull(poll) - <https://cloud.google.com/pubsub/docs/pull>

Appendix B. Acknowledgments

The editors would like to thanks the members of the SCIM WG which began discussions of provisioning events starting with: draft-hunt-scim-notify-00 in 2015.

The editor would like to thank the participants in the the SECEVENTS working group for their support of this specification.

Appendix C. Change Log

Draft 00 - PH - Based on draft-hunt-secevent.distribution with the following additions:

- o Removed Control Plane from specification
- o Added new HTTP Polling delivery method
- o Added general HTTP security considerations
- o Added authentication and authorization
- o Revised Verify Event to work with both types of delivery

Draft 01 - PH - Removed Verification section per feedback from IETF99.

Draft 02 - MS -

- o Minor editorial improvements
- o Removed Identity Provider / Relying Party Terminology
- o Changed boilerplate language according to RFC8174

This draft was based on draft-hunt-secevent.distribution revision history:

- o Draft 00 - PH - First Draft based on reduced version of draft-hunt-idevent-distribution
- o Draft 01 - PH -
 - * Reworked terminology to match new WG Transmitter/Receiver terms
 - * Reworked sections into Data Plane vs. Control Plane
 - * Removed method transmission registry in order to simplify the specification
 - * Made Create, Update operations optional for Control Plane (Read is MTI)
- o Draft 02 - PH
 - * Added iss metadata for Event Stream
 - * Changed to using JWKS_uri for issuer and receiver.
 - * Control Plane sections moved to draft-hunt-secevent-stream-mgmt

- * Added support for delivering multiple events using HTTP POST polling

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Security Event Token (SET)
draft-ietf-secevent-token-13

Abstract

This specification defines the Security Event Token (SET) data structure. A SET describes statements of fact from the perspective of an issuer about a subject. These statements of fact represent an event that occurred directly to or about a security subject, for example, a statement about the issuance or revocation of a token on behalf of a subject. This specification is intended to enable representing security- and identity-related events. A SET is a JSON Web Token (JWT), which can be optionally signed and/or encrypted. SETs can be distributed via protocols such as HTTP.

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1. Introduction and Overview

This specification defines an extensible Security Event Token (SET) data structure, which can be exchanged using protocols such as HTTP. The specification builds on the JSON Web Token (JWT) format [RFC7519] in order to provide a self-contained token that can be optionally signed using JSON Web Signature (JWS) [RFC7515] and/or encrypted using JSON Web Encryption (JWE) [RFC7516].

This specification profiles the use of JWT for the purpose of issuing Security Event Tokens (SETs). This specification defines a base format used by profiling specifications to define actual events and their meanings. This specification uses non-normative example events to demonstrate how events can be constructed.

This specification is scoped to security- and identity-related events. While Security Event Tokens may be used for other purposes, the specification only considers security and privacy concerns relevant to identity and personal information.

Security events are not commands issued between parties. A SET describes statements of fact from the perspective of an issuer about a subject (e.g., a web resource, token, IP address, the issuer itself). These statements of fact represent a logical event that occurred directly to or about a security subject, for example, a statement about the issuance or revocation of a token on behalf of a subject. A security subject may be permanent (e.g., a user account) or temporary (e.g., an HTTP session) in nature. A state change could describe a direct change of entity state, an implicit change of state, or other higher-level security statements such as:

- o The creation, modification, removal of a resource.
- o The resetting or suspension of an account.
- o The revocation of a security token prior to its expiry.
- o The logout of a user session. Or,
- o An indication that a user has been given control of an email identifier that was previously controlled by another user.

While subject state changes are often triggered by a user agent or security subsystem, the issuance and transmission of an event may occur asynchronously and in a back channel to the action that caused the change that generated the security event. Subsequently, a SET

recipient, having received a SET, validates and interprets the received SET and takes its own independent actions, if any. For example, having been informed of a personal identifier being associated with a different security subject (e.g., an email address is being used by someone else), the SET recipient may choose to ensure that the new user is not granted access to resources associated with the previous user. Or, the SET recipient may not have any relationship with the subject, and no action is taken.

While SET recipients will often take actions upon receiving SETs, security events cannot be assumed to be commands or requests. The intent of this specification is to define a syntax for statements of fact that SET recipients may interpret for their own purposes.

1.1. Notational Conventions

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.

For purposes of readability, examples are not URL encoded. Implementers MUST percent encode URLs as described in Section 2.1 of [RFC3986].

Throughout this document, all figures may contain spaces and extra line-wrapping for readability and space limitations. Similarly, some URIs contained within examples have been shortened for space and readability reasons.

1.2. Definitions

The following definitions are used with SETs:

Security Event Token (SET)

A SET is a JWT [RFC7519] conforming to this specification.

SET Issuer

A service provider that creates SETs to be sent to other service providers known as SET recipients.

SET Recipient

A SET recipient is an entity that receives SETs through some distribution method. A SET recipient is the same entity referred as a "recipient" in [RFC7519] or "receiver" in related specifications.

Subject

A SET describes an event or state change that has occurred to a subject. A subject might, for instance, be a principal (e.g., Section 4.1.2 of [RFC7519]), a web resource, an entity such as an IP address, or the issuer of the SET.

Event Identifier

A member name for an element of the JSON object that is the value of the "events" claim in a SET. This member name **MUST** be a URI.

Event Payload

A member value for an element of the JSON object that is the value of the "events" claim in a SET. This member value **MUST** be a JSON object.

Profiling Specification

A specification that profiles the SET data structure to define one or more specific event types and their associated claims and processing rules.

2. The Security Event Token (SET)

A SET is a JWT [RFC7519] data structure that represents one or more related aspects of a security event that occurred to a subject. The JWT Claims Set in a SET has the following structure:

- o The top-level claims in the JWT Claims Set are called the SET "envelope". Some of these claims are present in every SET; others will be specific to particular SET profiles or profile families. Claims in the envelope **SHOULD** be registered in the "JSON Web Token Claims" registry [IANA.JWT.Claims] or be Public Claims or Private Claims, as defined in [RFC7519].
- o Envelope claims that are profiled and defined in this specification are used to validate the SET and provide information about the event data included in the SET. The claim "events" contains the event identifiers and event-specific data expressed about the security subject. The envelope **MAY** include event-specific or profile-specific data. The "events" claim value **MUST** be a JSON object that contains at least one member.
- o Each member of the "events" JSON object is a name/value pair. The JSON member name is a URI string value, which is the event identifier, and the corresponding value is a JSON object known as the event "payload". The payload JSON object contains claims that pertain to that event identifier and need not be registered as JWT claims. These claims are defined by the profiling specification

that defines the event. An event with no payload claims SHALL be represented as the empty JSON object ("{}").

- o When multiple event identifiers are contained in a SET, they represent multiple aspects of the same state transition that occurred to the security subject. They are not intended to be used to aggregate distinct events about the same subject. Beyond this, the interpretation of SETs containing multiple event identifiers is out of scope for this specification; profiling specifications MAY define their own rules regarding their use of SETs containing multiple event identifiers, as described in Section 3. Possible uses of multiple values include, but are not limited to:
 - * Values to provide classification information (e.g., threat type or level).
 - * Additions to existing event representations.
 - * Values used to link potential series of events.
 - * Specific-purpose event URIs used between particular SET issuers and SET recipients.

2.1. Illustrative Examples

This section illustrates several possible uses of SETs through non-normative examples.

2.1.1. SCIM Example

The following example shows the JWT Claims Set for a hypothetical SCIM [RFC7644] password reset SET. Such a SET might be used by a receiver as a trigger to reset active user-agent sessions related to the identified user.

```
{
  "iss": "https://scim.example.com",
  "iat": 1458496025,
  "jti": "3d0c3cf797584bd193bd0fb1bd4e7d30",
  "aud": [
    "https://jhub.example.com/Feeds/98d52461fa5bbc879593b7754",
    "https://jhub.example.com/Feeds/5d7604516b1d08641d7676ee7"
  ],
  "sub": "https://scim.example.com/Users/44f6142df96bd6ab61e7521d9",
  "events": {
    "urn:ietf:params:scim:event:passwordReset":
      { "id": "44f6142df96bd6ab61e7521d9" },
    "https://example.com/scim/event/passwordResetExt":
      { "resetAttempts": 5 }
  }
}
```

Figure 1: Example SCIM Password Reset Event

The JWT Claims Set usage consists of:

- o The "events" claim specifying the hypothetical SCIM URN ("urn:ietf:params:scim:event:passwordReset") for a password reset, and a second value, "https://example.com/scim/event/passwordResetExt", that is used to provide additional event information such as the current count of resets.
- o The "iss" claim, denoting the SET issuer.
- o The "sub" claim, specifying the SCIM resource URI that was affected.
- o The "aud" claim, specifying the intended audiences for the event. (The syntax of the "aud" claim is defined in Section 4.1.3 of [RFC7519].)

The SET contains two event payloads:

- o The "id" claim represents SCIM's unique identifier for a subject.
- o The second payload identified by "https://example.com/scim/event/passwordResetExt") and the payload claim "resetAttempts" conveys the current count of reset attempts. In this example, while the count is a simple factual statement for the issuer, the meaning of the value (a count) is up to the receiver. As an example, such a value might be used by the receiver to infer increasing risk.

In this example, the SCIM event indicates that a password has been updated and the current password reset count is 5. Notice that the value for "resetAttempts" is in the event payload of an event used to convey this information.

2.1.2. Logout Example

Here is another example JWT Claims Set for a security event token, this one for a Logout Token:

```
{
  "iss": "https://server.example.com",
  "sub": "248289761001",
  "aud": "s6BhdRkqt3",
  "iat": 1471566154,
  "jti": "bWJq",
  "sid": "08a5019c-17e1-4977-8f42-65a12843ea02",
  "events": {
    "http://schemas.openid.net/event/backchannel-logout": {}
  }
}
```

Figure 2: Example OpenID Back-Channel Logout Event

Note that the above SET has an empty JSON object and uses the JWT claims "sub" and "sid" to identify the subject that was logged out. At the time of this writing, this example corresponds to the logout token defined in the OpenID Connect Back-Channel Logout 1.0 [OpenID.BackChannel] specification.

2.1.3. Consent Example

In the following example JWT Claims Set, a fictional medical service collects consent for medical actions and notifies other parties. The individual for whom consent is identified was originally authenticated via OpenID Connect. In this case, the issuer of the security event is an application rather than the OpenID provider:

```
{
  "iss": "https://my.med.example.org",
  "iat": 1458496025,
  "jti": "fb4e75b5411e4e19b6c0fe87950f7749",
  "aud": [
    "https://rp.example.com"
  ],
  "events": {
    "https://openid.net/heart/specs/consent.html": {
      "iss": "https://connect.example.com",
      "sub": "248289761001",
      "consentUri": [
        "https://terms.med.example.org/labdisclosure.html#Agree"
      ]
    }
  }
}
```

Figure 3: Example Consent Event

In the above example, the attribute "iss" contained within the payload for the event "https://openid.net/heart/specs/consent.html" refers to the issuer of the security subject ("sub") rather than the SET issuer "https://my.med.example.org". They are distinct from the top-level value of "iss", which always refers to the issuer of the event -- a medical consent service that is a relying party to the OpenID Provider.

2.1.4. RISC Example

The following example JWT Claims Set is for an account disabled event. This example was taken from a working draft of the RISC events specification, where RISC is the OpenID RISC (Risk and Incident Sharing and Coordination) working group [RISC]. The example is subject to change.

```
{
  "iss": "https://idp.example.com/",
  "jti": "756E69717565206964656E746966696572",
  "iat": 1508184845,
  "aud": "636C69656E745F6964",
  "events": {
    "http://schemas.openid.net/secevent/risc/event-type/\
account-disabled": {
      "subject": {
        "subject_type": "iss-sub",
        "iss": "https://idp.example.com/",
        "sub": "7375626A656374"
      },
      "reason": "hijacking",
      "cause-time": 1508012752
    }
  }
}
```

Figure 4: Example RISC Event

Notice that parameters to the event are included in the event payload, in this case, the "reason" and "cause-time" values. The subject of the event is identified using the "subject" payload value, which itself is a JSON object.

2.2. Core SET Claims

The following claims from [RFC7519] are profiled for use in SETs:

"iss" (Issuer) Claim

As defined by Section 4.1.1 of [RFC7519], this claim contains a string identifying the service provider publishing the SET (the issuer). In some cases, the issuer of the SET will not be the issuer associated with the security subject of the SET.

Therefore, implementers cannot assume that the issuers are the same unless the profiling specification specifies that they are for SETs conforming to that profile. This claim is REQUIRED.

"iat" (Issued At) Claim

As defined by Section 4.1.6 of [RFC7519], this claim contains a value representing when the SET was issued. This claim is REQUIRED.

"jti" (JWT ID) Claim

As defined by Section 4.1.7 of [RFC7519], this claim contains a unique identifier for the SET. The identifier MUST be unique within a particular event feed and MAY be used by clients to track whether a particular SET has already been received. This claim is REQUIRED.

"aud" (Audience) Claim

As defined by Section 4.1.3 of [RFC7519], this claim contains one or more audience identifiers for the SET. This claim is RECOMMENDED.

"sub" (Subject) Claim

As defined by Section 4.1.2 of [RFC7519], this claim contains a StringOrURI value representing the principal that is the subject of the SET. This is usually the entity whose "state" was changed. For example:

- * an IP Address was added to a black list;
- * a URI representing a user resource that was modified; or,
- * a token identifier (e.g. "jti") for a revoked token.

If used, the profiling specification MUST define the content and format semantics for the value. This claim is OPTIONAL, as the principal for any given profile may already be identified without the inclusion of a subject claim. Note that some SET profiles MAY choose to convey event subject information in the event payload (either using the "sub" member name or another name), particularly if the subject information is relative to issuer information that is also conveyed in the event payload, which may be the case for some identity SET profiles.

"exp" (Expiration Time) Claim

As defined by Section 4.1.4 of [RFC7519], this claim is the time after which the JWT MUST NOT be accepted for processing. In the context of a SET however, this notion does not typically apply, since a SET represents something that has already occurred and is historical in nature. Therefore, its use is NOT RECOMMENDED. (Also, see Section 4.1 for additional reasons not to use the "exp" claim in some SET use cases.)

The following new claims are defined by this specification:

"events" (Security Events) Claim

This claim contains a set of event statements that each provide information describing a single logical event that has occurred about a security subject (e.g., a state change to the subject). Multiple event identifiers with the same value **MUST NOT** be used. The "events" claim **MUST NOT** be used to express multiple independent logical events.

The value of the "events" claim is a JSON object whose members are name/value pairs whose names are URIs identifying the event statements being expressed. Event identifiers **SHOULD** be stable values (e.g., a permanent URL for an event specification). For each name present, the corresponding value **MUST** be a JSON object. The JSON object **MAY** be an empty object ("{}"), or it **MAY** be a JSON object containing data described by the profiling specification.

"txn" (Transaction Identifier) Claim

An **OPTIONAL** string value that represents a unique transaction identifier. In cases in which multiple related JWTs are issued, the transaction identifier claim can be used to correlate these related JWTs. Note that this claim can be used in JWTs that are SETs and also in JWTs using non-SET profiles.

"toe" (Time of Event) Claim

A value that represents the date and time at which the event occurred. This value is a NumericDate (see Section 2 of [RFC7519]). By omitting this claim, the issuer indicates that they are not sharing an event time with the recipient. (Note that in some use cases, the represented time might be approximate; statements about the accuracy of this field **MAY** be made by profiling specifications.) This claim is **OPTIONAL**.

2.3. Explicit Typing of SETs

This specification registers the "application/secevent+jwt" media type, which can be used to indicate that the content is a SET. SETs **MAY** include this media type in the "typ" header parameter of the JWT representing the SET to explicitly declare that the JWT is a SET. This **MUST** be included if the SET could be used in an application context in which it could be confused with other kinds of JWTs.

Per the definition of "typ" in Section 4.1.9 of [RFC7515], it is **RECOMMENDED** that the "application/" prefix be omitted. Therefore, the "typ" value used **SHOULD** be "secevent+jwt".

2.4. Security Event Token Construction

This section describes how to construct a SET.

The following is an example JWT Claims Set for a hypothetical SCIM SET (which has been formatted for readability):

```
{
  "iss": "https://scim.example.com",
  "iat": 1458496404,
  "jti": "4d3559ec67504aaba65d40b0363faad8",
  "aud": [
    "https://scim.example.com/Feeds/98d52461fa5bbc879593b7754",
    "https://scim.example.com/Feeds/5d7604516b1d08641d7676ee7"
  ],
  "events": {
    "urn:ietf:params:scim:event:create": {
      "ref":
        "https://scim.example.com/Users/44f6142df96bd6ab61e7521d9",
      "attributes": ["id", "name", "userName", "password", "emails"]
    }
  }
}
```

Figure 5: Example Event Claims

The JSON Claims Set is encoded per [RFC7519].

In this example, the SCIM SET claims are encoded in an unsecured JWT. The JOSE Header for this example is:

```
{"typ":"secevent+jwt","alg":"none"}
```

Base64url encoding (see Section 2 of [RFC7515]) of the octets of the UTF-8 [RFC3629] representation of the JOSE Header yields:

```
eyJ0eXAiOiJzZW5ldmVudCtqd3QiLCJhbGciOiJub251In0
```


Top-Level Claims

Claims and values placed at the JWT Claims Set. Examples are claims defined by the JWT specification (see [RFC7519]), the SET specification, and by the profiling specification.

Event Payload

The JSON data structure contents and format, containing event-specific information, if any (see Section 1.2).

Semantics

Defining the semantics of the SET contents for SETs utilizing the profile is equally important. Possibly most important is defining the procedures used to validate the SET issuer and to obtain the keys controlled by the issuer that were used for cryptographic operations used in the JWT representing the SET. For instance, some profiles may define an algorithm for retrieving the SET issuer's keys that uses the "iss" claim value as its input. Likewise, if the profile allows (or requires) that the JWT be unsecured, the means by which the integrity of the JWT is ensured MUST be specified.

Subject Identification

Profiling specifications MUST define how the event subject is identified in the SET, as well as how to differentiate between the event subject's issuer and the SET issuer, if applicable. It is NOT RECOMMENDED for profiling specifications to use the "sub" claim in cases in which the subject is not globally unique and has a different issuer from the SET itself.

Validation

Profiling specifications MUST clearly specify the steps that a recipient of a SET utilizing that profile MUST perform to validate that the SET is both syntactically and semantically valid.

Among the syntax and semantics of SETs that a profiling specification may define is whether the value of the "events" claim may contain multiple members, and what processing instructions are employed in the single- and multiple-valued cases for SETs conforming to that profile. Many valid choices are possible. For instance, some profiles might allow multiple event identifiers to be present and specify that any that are not understood by recipients be ignored, thus enabling extensibility. Other profiles might allow multiple event identifiers to be present but require that all be understood if the SET is to be accepted. Some profiles might require that only a single value be present. All such choices are within the scope of profiling specifications to define.

4. Preventing Confusion between SETs and other JWTs

Because [RFC7519] states that "all claims that are not understood by implementations MUST be ignored", there is a consideration that a SET might be confused with another kind of JWT from the same issuer. Unless this confusion is prevented, this might enable an attacker who possesses a SET to use it in a context in which another kind of JWT is expected, or vice-versa. This section presents concrete techniques for preventing confusion between SETs and several other specific kinds of JWTs, as well as generic techniques for preventing possible confusion between SETs and other kinds of JWTs.

4.1. Distinguishing SETs from ID Tokens

A SET might be confused with ID Token [OpenID.Core] if a SET is mistakenly or maliciously used in a context requiring an ID Token. If a SET could otherwise be interpreted as a valid ID Token (because it includes the required claims for an ID Token and valid issuer and audience claim values for an ID Token) then that SET profile MUST require that the "exp" claim not be present in the SET. Because "exp" is a required claim in ID Tokens, valid ID Token implementations will reject such a SET if presented as if it were an ID Token.

Excluding "exp" from SETs that could otherwise be confused with ID Tokens is actually defense in depth. In any OpenID Connect contexts in which an attacker could attempt to substitute a SET for an ID Token, the SET would actually already be rejected as an ID Token because it would not contain the correct "nonce" claim value for the ID Token to be accepted in contexts for which substitution is possible.

Note that the use of explicit typing, as described in Section 2.3, will not achieve disambiguation between ID Tokens and SETs, as the ID Token validation rules do not use the "typ" header parameter value.

4.2. Distinguishing SETs from Access Tokens

OAuth 2.0 [RFC6749] defines access tokens as being opaque. Nonetheless, some implementations implement access tokens as JWTs. Because the structure of these JWTs is implementation-specific, ensuring that a SET cannot be confused with such an access token is therefore likewise, in general, implementation specific. Nonetheless, it is recommended that SET profiles employ the following strategies to prevent possible substitutions of SETs for access tokens in contexts in which that might be possible:

- o Prohibit use of the "exp" claim, as is done to prevent ID Token confusion.
- o Where possible, use a separate "aud" claim value to distinguish between the SET recipient and the protected resource that is the audience of an access token.
- o Modify access token validation systems to check for the presence of the "events" claim as a means to detect security event tokens. This is particularly useful if the same endpoint may receive both types of tokens.
- o Employ explicit typing, as described in Section 2.3, and modify access token validation systems to use the "typ" header parameter value.

4.3. Distinguishing SETs from other kinds of JWTs

JWTs are now being used in application areas beyond the identity applications in which they first appeared. For instance, the "Session Initiation Protocol (SIP) Via Header Field Parameter to Indicate Received Realm" [RFC8055] and "Personal Assertion Token (PASSporT)" [RFC8225] specifications both define JWT profiles that use mostly or completely different sets of claims than are used by ID Tokens. If it would otherwise be possible for an attacker to substitute a SET for one of these (or other) kinds of JWTs, then the SET profile must be defined in such a way that any substituted SET will result in its rejection when validated as the intended kind of JWT.

The most direct way to prevent confusion is to employ explicit typing, as described in Section 2.3, and modify applicable token validation systems to use the "typ" header parameter value. This approach can be employed for new systems but may not be applicable to existing systems.

Another way to ensure that a SET is not confused with another kind of JWT is to have the JWT validation logic reject JWTs containing an "events" claim unless the JWT is intended to be a SET. This approach can be employed for new systems but may not be applicable to existing systems. Validating that the JWT has an "events" claim will be effective in preventing attackers from passing other kinds of JWTs off as SETs.

For many use cases, the simplest way to prevent substitution is requiring that the SET not include claims that are required for the kind of JWT that might be the target of an attack. For example, for

[RFC8055], the "sip_callid" claim could be omitted and for [RFC8225], the "orig" claim could be omitted.

In many contexts, simple measures such as these will accomplish the task, should confusion otherwise even be possible. Note that this topic is being explored in a more general fashion in JSON Web Token Best Current Practices [I-D.ietf-oauth-jwt-bcp]. The proposed best practices in that draft may also be applicable for particular SET profiles and use cases.

5. Security Considerations

5.1. Confidentiality and Integrity

SETs may contain sensitive information. Therefore, methods for distribution of events SHOULD require the use of a transport-layer security mechanism when distributing events. Parties MUST support TLS 1.2 [RFC5246] or a higher version and MAY support additional transport-layer mechanisms meeting its security requirements. When using TLS, the client MUST perform a TLS server certificate check, per [RFC6125]. Implementation security considerations for TLS can be found in "Recommendations for Secure Use of TLS and DTLS" [RFC7525].

Security events distributed through third parties or that carry personally identifiable information MUST be encrypted using JWE [RFC7516] or secured for confidentiality by other means.

Unless integrity of the JWT is ensured by other means, it MUST be signed using JWS [RFC7515] by an issuer that is trusted to do so for the use case so that the SET can be authenticated and validated by the SET recipient.

5.2. Delivery

This specification does not define a delivery mechanism for SETs. In addition to confidentiality and integrity (discussed above), implementers and profiling specifications must consider the consequences of delivery mechanisms that are not secure and/or not assured. For example, while a SET may be end-to-end secured using JWE encrypted SETs, without (mutual) TLS, there is no assurance that the correct endpoint received the SET and that it could be successfully processed.

5.3. Sequencing

This specification defines no means of ordering multiple SETs in a sequence. Depending on the type and nature of the events represented by SETs, order may or may not matter. For example, in provisioning,

event order is critical -- an object cannot be modified before it is created. In other SET types, such as a token revocation, the order of SETs for revoked tokens does not matter. If, however, the event conveys a logged in or logged out status for a user subject, then order becomes important.

Profiling specifications and implementers SHOULD take caution when using timestamps such as "iat" to define order. Distributed systems will have some amount of clock skew. Thus, time by itself will not guarantee order.

Specifications profiling SET SHOULD define a mechanism for detecting order or sequence of events when the order matters. For example, the "txn" claim could contain an ordered value (e.g., a counter) that the issuer includes, although just as for timestamps, ensuring such ordering can be difficult in distributed systems.

5.4. Timing Issues

When SETs are delivered asynchronously and/or out-of-band with respect to the original action that incurred the security event, it is important to consider that a SET might be delivered to a SET recipient in advance of or behind the process that caused the event. For example, a user having been required to log out and then log back in again, may cause a "token revoked" SET to be issued, typically causing the receiver to reset all active sessions at the receiver that are related to that user. If revocation SET arrives at the same time as the user agent re-logs in, timing could cause problems by erroneously treating the new user session as logged out. Profiling specifications SHOULD be careful to consider both SET expression and timing issues. For example, it might be more appropriate to revoke a specific session or identity token rather than a general logout statement about a "user". Alternatively, profiling specifications could use timestamps that allow new sessions to be started immediately after a stated logout event time.

5.5. Preventing Confusion

Also, see Section 4 above for both additional security considerations and normative text on preventing SETs from being confused with other kinds of JWTs.

6. Privacy Considerations

If a SET needs to be retained for audit purposes, the signature can be used to provide verification of its authenticity.

SET issuers SHOULD attempt to specialize SETs so that their content is targeted to the specific business and protocol needs of the intended SET recipients.

When sharing personally identifiable information or information that is otherwise considered confidential to affected users, SET issuers and recipients should have the appropriate legal agreements and user consent and/or terms of service in place.

The propagation of subject identifiers can be perceived as personally identifiable information. Where possible, SET issuers and recipients SHOULD devise approaches that prevent propagation -- for example, the passing of a salted hash value that requires the SET recipient to know the subject.

In some cases, it may be possible for a SET recipient to correlate different events and thereby gain information about a subject that the SET issuer did not intend to share. For example, a SET recipient might be able to use "iat" values or highly precise "toe" values to determine that two otherwise un-relatable events actually relate to the same real-world event. The union of information from both events could allow a SET recipient to de-anonymize data or recognize that unrelated identifiers relate to the same individual. SET issuers SHOULD take steps to minimize the chance of event correlation, when such correlation would constitute a privacy violation. For instance, they could use approximate values for the "toe" claim or arbitrarily delay SET issuance, where such delay can be tolerated.

7. IANA Considerations

7.1. JSON Web Token Claims Registration

This specification registers the "events", "toe", and "txn" claims in the IANA "JSON Web Token Claims" registry [IANA.JWT.Claims] established by [RFC7519].

7.1.1. Registry Contents

- o Claim Name: "events"
- o Claim Description: Security Events
- o Change Controller: IESG
- o Specification Document(s): Section 2.2 of [[this specification]]

- o Claim Name: "toe"
- o Claim Description: Time of Event
- o Change Controller: IESG
- o Specification Document(s): Section 2.2 of [[this specification]]

- o Claim Name: "txn"
- o Claim Description: Transaction Identifier
- o Change Controller: IESG
- o Specification Document(s): Section 2.2 of [[this specification]]

7.2. Structured Syntax Suffix Registration

This section registers the "+jwt" structured syntax suffix [RFC6838] in the "Structured Syntax Suffix" registry [IANA.StructuredSuffix] in the manner described in [RFC6838], which can be used to indicate that the media type is encoded as a JWT.

7.2.1. Registry Contents

- o Name: JSON Web Token (JWT)
- o +suffix: +jwt
- o References: Section 3 of [RFC7519]
- o Encoding considerations: binary; JWT values are encoded as a series of base64url-encoded values (some of which may be the empty string) separated by period ('.') characters.
- o Interoperability considerations: n/a
- o Fragment identifier considerations:
The syntax and semantics of fragment identifiers specified for +jwt SHOULD be as specified for "application/jwt". (At publication of this document, there is no fragment identification syntax defined for "application/jwt".)

The syntax and semantics for fragment identifiers for a specific "xxx/yyy+jwt" SHOULD be processed as follows:

For cases defined in +jwt, where the fragment identifier resolves per the +jwt rules, then process as specified in +jwt.

For cases defined in +jwt, where the fragment identifier does not resolve per the +jwt rules, then process as specified in "xxx/yyy+jwt".

For cases not defined in +jwt, then process as specified in "xxx/yyy+jwt".

- o Security considerations: See Section 11 of [RFC7519].
- o Contact:
Michael B. Jones, mbj@microsoft.com
- o Author/Change controller:
Security Events Working Group.
The IESG has change control over this registration.

7.3. Media Type Registration

7.3.1. Registry Contents

This section registers the "application/secevent+jwt" media type [RFC2046] in the "Media Types" registry [IANA.MediaTypes] in the manner described in [RFC6838], which can be used to indicate that the content is a SET.

- o Type name: application
- o Subtype name: secevent+jwt
- o Required parameters: n/a
- o Optional parameters: n/a
- o Encoding considerations: binary; A SET is a JWT; JWT values are encoded as a series of base64url-encoded values (some of which may be the empty string) separated by period ('.') characters.
- o Security considerations: See Section 5 of [[this specification]]
- o Interoperability considerations: n/a
- o Published specification: Section 2.3 of [[this specification]]
- o Applications that use this media type: Applications that exchange SETs
- o Fragment identifier considerations: n/a
- o Additional information:

Magic number(s): n/a
File extension(s): n/a
Macintosh file type code(s): n/a

- o Person & email address to contact for further information:
Michael B. Jones, mbj@microsoft.com
- o Intended usage: COMMON
- o Restrictions on usage: none
- o Author: Michael B. Jones, mbj@microsoft.com
- o Change controller: IESG
- o Provisional registration? No

8. References

8.1. Normative References

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Appendix A. Acknowledgments

The editors would like to thank the members of the IETF SCIM working group, which began discussions of provisioning events starting with draft-hunt-scim-notify-00 in 2015. The editors would like to thank the participants in the IETF id-event mailing list, the Security Events working group, and related working groups for their contributions to this specification. The specification incorporates suggestions made by many people, including Annabelle Backman, John Bradley, Alissa Cooper, Ned Freed, Dick Hardt, Russ Housley, Benjamin Kaduk, Mirja Kuehlewind, Mark Lizar, Alexey Melnikov, Andrew Nash, Eric Rescorla, Adam Roach, Justin Richer, Nat Sakimura, Marius Scurtescu, Yaron Sheffer, and Martin Vigoureux.

Appendix B. Change Log

[[to be removed by the RFC Editor before publication as an RFC]]

From the original draft-hunt-idevent-token:

Draft 01 - PH - Renamed eventUris to events

Draft 00 - PH - First Draft

Draft 01 - PH - Fixed some alignment issues with JWT. Remove event type attribute.

Draft 02 - PH - Renamed to Security Events, removed questions, clarified examples and intro text, and added security and privacy section.

Draft 03 - PH

General edit corrections from Sarah Squire

Changed "event" term to "SET"

Corrected author organization for William Denniss to Google

Changed definition of SET to be 2 parts, an envelope and 1 or more payloads.

Clarified that the intent is to express a single event with optional extensions only.

- mbj - Registered "events" claim, and proof-reading corrections.

Draft 04 - PH -

- o Re-added the "sub" claim with clarifications that any SET type may use it.
- o Added additional clarification on the use of envelope vs. payload attributes
- o Added security consideration for event timing.
- o Switched use of "attribute" to "claim" for consistency.
- o Revised examples to put "sub" claim back in the top level.
- o Added clarification that SETs typically do not use "exp".
- o Added security consideration for distinguishing Access Tokens and SETs.

Draft 05 - PH - Fixed find/replace error that resulted in claim being spelled claimc

Draft 06 - PH -

- o Corrected typos
- o New txn claim
- o New security considerations Sequencing and Timing Issues

Draft 07 -

- o PH - Moved payload objects to be values of event URI attributes, per discussion.
- o mbj - Applied terminology consistency and grammar cleanups.

Draft 08 - PH -

- o Added clarification to status of examples

- o Changed from primary vs. extension to state that multiple events may be expressed, some of which may or may not be considered extensions of others (which is for the subscriber or profiling specifications to determine).

- o Other editorial changes suggested by Yaron
From draft-ietf-secevent-token:

Draft 00 - PH - First WG Draft based on draft-hunt-idevent-token

Draft 01 - PH - Changes as follows:

- o Changed terminology away from pub-sub to transmitter/receiver based on WG feedback
- o Cleaned up/removed some text about extensions (now only used as example)
- o Clarify purpose of spec vs. future profiling specs that define actual events

Draft 02 - Changes are as follows:

- o mbj - Added the Requirements for SET Profiles section.
- o mbj - Expanded the Security Considerations section to describe how to prevent confusion of SETs with ID Tokens, access tokens, and other kinds of JWTs.
- o mbj - Registered the "application/secevent+jwt" media type and defined how to use it for explicit typing of SETs.
- o mbj - Clarified the misleading statement that used to say that a SET conveys a single security event.
- o mbj - Added a note explicitly acknowledging that some SET profiles may choose to convey event subject information in the event payload.
- o PH - Corrected encoded claim example on page 10.
- o mbj - Applied grammar corrections.

Draft 03 - Changes are as follows:

- o pjh - Corrected old "subscriber" to "Event Receiver". Added clarification in definition that Event Receiver is the same as JWT recipient.

- o pjh - Added definition for "toe" (and IANA registration).
- o pjh - Removed "nbf" claim.
- o pjh - Figure 3, moved "sub" to the events payload next to "iss".
- o pjh - Clarified the use of "nonce" in contexts where substitution is possible.
- o mbj - Addressed WGLC comments by Nat Sakimura.
- o mbj - Addressed WGLC comments by Annabelle Backman.
- o mbj - Addressed WGLC comments by Marius Scurtescu.

Draft 04 - mbj - Changes were as follows:

- o Clarified that all "events" values must represent aspects of the same state change that occurred to the subject -- not an aggregation of unrelated events about the subject.
- o Removed ambiguities about the roles of multiple "events" values and the responsibilities of profiling specifications for defining how and when they are used.
- o Corrected places where the term JWT was used when what was actually being discussed was the JWT Claims Set.
- o Addressed terminology inconsistencies. In particular, standardized on using the term "issuer" to align with JWT terminology and the "iss" claim. Previously the term "transmitter" was sometimes used and "issuer" was sometimes used. Likewise, standardized on using the term "recipient" instead of "receiver" for the same reasons.
- o Added a RISC event example, courtesy of Marius Scurtescu.
- o Applied wording clarifications suggested by Annabelle Backman and Yaron Sheffer.
- o Applied numerous grammar, syntax, and formatting corrections.

Draft 05 - mbj - Changes were as follows:

- o Simplified the definitions of the "iat" and "toe" claims in ways suggested by Annabelle Backman.
- o Added privacy considerations text suggested by Annabelle Backman.

- o Updated the RISC event example, courtesy of Marius Scurtescu.
- o Reordered the claim definitions to place the required claims first.
- o Changed to using the RFC 8174 boilerplate instead of the RFC 2119 boilerplate.

Draft 06 - mbj - Changes were as follows:

- o Changed "when the event was issued" to "when the SET was issued" in the "iat" description, as suggested by Annabelle Backman.
- o Applied editorial improvements that improve the consistency of the specification that were suggested by Annabelle Backman, Marius Scurtescu, and Yaron Sheffer.

Draft 07 - PH - Text refinement to Section 3 proposed by Annabelle Backman post WGLC

Draft 08 - mbj - Changes were as follows:

- o Incorporated wording improvements resulting from Russ Housley's SecDir comments.
- o Acknowledged individuals who made significant contributions.

Draft 09 - pjh/mbj - Changes addressing AD review comments by Benjamin Kaduk

Draft 10 - pjh/mbj - Changes were as follows:

- o Incorporated wording improvements resulting from Russ Housley's additional SecDir comments.
- o Registered +jwt structured syntax suffix.

Draft 11 - pjh/mbj - Incorporated feedback from Security Area Director Eric Rescorla and IANA Designated Expert Ned Freed.

- o Clarified "iss" claim language about the SET issuer versus the security subject issuer.
- o Changed a "SHOULD" to a "MUST" in the "sub" claim description to be consistent with the Requirements for SET Profiles section.
- o Described the use of the "events" claim to prevent attackers from passing off other kinds of JWTs as SETs.

- o Stated that SETs are to be signed by an issuer that is trusted to do so for the use case.
- o Added quotes in the phrase ' "token revoked" SET to be issued' in the Timing Issues section.
- o Added section number references to the media type and media type suffix registrations.
- o Changed the encodings of the media type and media type suffix registrations to binary (since no line breaks are allowed).
- o Replaced a "TBD" in the media type registration with descriptive text.
- o Acknowledged Eric Rescorla and Ned Freed.

Draft 12 - pjh/mbj - Incorporated feedback from Adam Roach, Alexey Melnikov, and Alissa Cooper.

- o Removed unused references to RFC 7009 and RFC 7517.
- o Corrected name of RFC 8055 in Section 4.3 to "Session Initiation Protocol (SIP) Via Header Field Parameter to Indicate Received Realm".
- o Added normative references for base64url and UTF-8.
- o Section 5.1 - Changed SHOULD to MUST in "personally identifiable information MUST be encrypted using JWE [RFC7516] or ...".
- o Section 5.2 - Changed "MUST consider" to "must consider".

Draft 13 - ph - Added edit from Martin Vigoureaux regarding a non-normative "MAY" in Section 1.1. Updated acknowledgements.

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