Abstract

The U2F Javascript API consists of two calls - one to register a U2F token with a relying party (i.e., cause the U2F token to generate a new key pair, and to introduce the new public key to the relying party), and one to sign an identity assertion (i.e., exercise a previously-registered key pair).

Status of This Document

This section describes the status of this document at the time of its publication. Other documents may supersede this document. A list of current FIDO Alliance publications and the latest revision of this technical report can be found in the FIDO Alliance specifications index at https://www.fidoalliance.org/specifications/.

This document was published by the FIDO Alliance as a Proposed Standard. If you wish to make comments regarding this document, please Contact Us. All comments are welcome.

Implementation of certain elements of this Specification may require licenses under third party intellectual property rights, including without limitation, patent rights. The FIDO Alliance, Inc. and its Members and any other contributors to the Specification are not, and shall not be held, responsible in any manner for identifying or failing to identify any or all such third party intellectual property rights.

THIS FIDO ALLIANCE SPECIFICATION IS PROVIDED "AS IS" AND WITHOUT ANY WARRANTY OF ANY KIND, INCLUDING, WITHOUT LIMITATION, ANY EXPRESS OR IMPLIED WARRANTY OF NON-INFRINGEMENT, MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE.

This document has been reviewed by FIDO Alliance Members and is endorsed as a Proposed Standard. It is a stable document and may be used as reference material or cited from another document. FIDO Alliance's role in making the Recommendation is to draw attention to the specification and to promote its widespread deployment.

Table of Contents

1. Notation
   1.1 Key Words
2. Introduction
3. API Levels
   3.1 Low-level MessagePort API
      3.1.1 Dictionary U2fRequest Members
      3.1.2 Dictionary U2fResponse Members
      3.1.3 Dictionary Error Members
   3.2 High-level Javascript API
      3.2.1 Methods
4. U2F transports
5. U2F operations
   5.1 Registration
      5.1.1 Dictionary RegisterRequest Members
      5.1.2 Dictionary RegisterResponse Members
      5.1.3 Dictionary RegisterRequest Members
      5.1.4 Dictionary SignResponse Members
   5.2 Generating signed identity assertions
      5.2.1 Dictionary U2fSignRequest Members
      5.2.2 Dictionary SignResponse Members
   5.3 Error codes
      5.3.1 Constants
1. Notation

Type names, attribute names and element names are written as code.

String literals are enclosed in "", e.g. "UAF-TLV".

In formulas we use "|" to denote byte wise concatenation operations.

DOM APIs are described using the ECMAScript [ECMA-262] bindings for WebIDL [WebIDL].

U2F specific terminology used in this document is defined in [FIDOGlossary].

1.1 Key Words

The key words "must", "must not", "required", "shall", "shall not", "should", "should not", "recommended", "may", and "optional" in this document are to be interpreted as described in [RFC2119].

Below we explain some of the terms used in this document:

<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>websafe-base64 encoding</td>
<td>This is the &quot;Base 64 Encoding with URL and Filename Safe Alphabet&quot; from Section 5 in [RFC4648] without padding.</td>
</tr>
<tr>
<td>stringified javascript object</td>
<td>This is the JSON object (i.e., a string starting with &quot;{&quot; and ending with &quot;}&quot;) whose keys are the property names of the javascript object, and whose values are the corresponding property values. Only &quot;data objects&quot; can be stringified, i.e., only objects whose property names and values are supported in JSON.</td>
</tr>
</tbody>
</table>

2. Introduction

Note: Reading the 'FIDO U2F Overview' (see [U2FOverview] in bibliography) is recommended as a background for this document.

A Relying Party (RP) consumes identity assertions from U2F tokens. The RP's web pages communicate with the U2F tokens on the client through a Javascript API. The RP also needs to perform some verification steps on the server side (see below). How the data obtained by the RP's Javascript is transferred to the RP's server is out of scope of this document. We instead describe the Javascript API used by the RP.

3. API Levels

The U2F API may be exposed to web pages on two levels. On the required lower level, RPs interact with the FIDO client through a MessagePort [WEBMESSAGING] object. The low-level MessagePort API defines the message formats for messages sent and received on the port, for the two operations supported by the API. This specification does not describe how such a port is made available to RP web pages, as this is (for now) implementation and browser dependent.

For convenience, the FIDO client may also expose a high-level Javascript API built on top of the MessagePort API. This API consists of functions corresponding to the different requests that can be made to the FIDO client. These functions respond to the RP asynchronously by invoking a callback.

Why two API levels? The messaging API requires only that pages obtain a MessagePort instance to the FIDO client, i.e. no code needs to be injected to JavaScript context of the RP's pages. This allows RPs to keep full control over the JS running in their pages. The JS API is offered as a convenient abstraction of the messaging API, and is useful for RP developers to quickly integrate U2F into their websites.

3.1 Low-level MessagePort API

RP web pages communicate with the FIDO client over an instance of the HTML5 MessagePort interface. Client implementations may choose how this instance is made available to web pages.

Responses from the FIDO client should be U2fResponse dictionaries:

```webidl

dictionary U2fResponse {
  DOMString? requestId;
  DOMString? appid;
  unsigned long? timeoutSeconds;
}
```

3.1.1 Dictionary U2fRequest Members

```webidl

dictionary U2fRequest {
  DOMString type;
  DOMString? appId;
  unsigned long? timeoutSeconds;
  unsigned long? requestId;
}
```

Subtypes of U2fRequest for register and sign requests are defined below in their respective sections. If timeoutSeconds is omitted, timeout behavior is unspecified. If requestId is present, the FIDO client must include its value the corresponding Response dictionary under the same key.

Responses from the FIDO client to the RP webpage should be U2fResponse dictionaries:
### 3.1.2 Dictionary U2fResponse Members

- **type** of type DOMString
  The response type, either "u2f_register_response" or "u2f_sign_response"

- **responseData** of type (Error or RegisterResponse or SignResponse)
  The response data, see 5. U2F operations

- **requestId** of type unsigned long, nullable
  The requestId value of the corresponding request, if present. Otherwise omitted.

Errors are indicated by an Error dictionary sent as the response data. An error dictionary can be identified by checking for its non-zero integer errorCode key. RegisterResponse and SignResponse do not define this key. An error object may optionally contain a string errorMessage with further description of the error.

### 3.1.3 Dictionary Error Members

- **errorCode** of type ErrorCode
  An error code from the ErrorCode enumeration.

- **errorMessage** of type DOMString, nullable
  A description of the error.

### 3.2 High-level Javascript API

A FIDO client may provide a JavaScript convenience API that abstracts the lower-level MessagePort API. Implementations may choose how to make such an API available to RP web pages. If such an API is provided, it should provide a namespace object u2f of the following interface.

#### 3.2.1 Methods

**register**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Type</th>
<th>Nullable</th>
<th>Optional</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>appId</td>
<td>DOMString</td>
<td>X</td>
<td>X</td>
<td>An application id for the request.</td>
</tr>
<tr>
<td>registerRequests</td>
<td>sequence&lt;RegisterRequest&gt;</td>
<td>X</td>
<td>X</td>
<td>Register requests, one for each U2F protocol version accepted by RP</td>
</tr>
<tr>
<td>registeredKeys</td>
<td>sequence&lt;RegisteredKey&gt;</td>
<td>X</td>
<td>X</td>
<td>Identifiers for already registered tokens</td>
</tr>
<tr>
<td>callback</td>
<td>function(RegisterResponse or Error)</td>
<td>X</td>
<td>X</td>
<td>Response handler</td>
</tr>
<tr>
<td>opt_timeoutSeconds</td>
<td>unsigned long</td>
<td>✓</td>
<td>✓</td>
<td>Timeout in seconds, for the FIDO client's handling of the request.</td>
</tr>
</tbody>
</table>

**sign**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Type</th>
<th>Nullable</th>
<th>Optional</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>appId</td>
<td>DOMString</td>
<td>X</td>
<td>X</td>
<td>An application id for the request.</td>
</tr>
<tr>
<td>challenge</td>
<td>DOMString</td>
<td>X</td>
<td>X</td>
<td>The websafe-base64-encoded challenge.</td>
</tr>
<tr>
<td>registeredKeys</td>
<td>sequence&lt;RegisteredKey&gt;</td>
<td>X</td>
<td>X</td>
<td>Sign requests, one for each registered token</td>
</tr>
<tr>
<td>callback</td>
<td>function(SignResponse or Error)</td>
<td>X</td>
<td>X</td>
<td>Response handler</td>
</tr>
<tr>
<td>opt_timeoutSeconds</td>
<td>unsigned long</td>
<td>✓</td>
<td>✓</td>
<td>Timeout in seconds, for the FIDO client's handling of the request.</td>
</tr>
</tbody>
</table>

The JavaScript API must invoke the provided callbacks with either response objects, or an error object. An error can be detected by testing for a non-zero errorCode key.

#### EXAMPLE 1

```javascript
u2f.sign(reqs, function(response) {  
  if (response.errorCode) {  
    // response is an Error  
  } else {  
    // response is a SignResponse  
    ....  
  }  
});
```
4. U2F transports

A U2F token may support one or more of the low-level transport mechanisms. In order to improve user experience, the RP may indicate to the client which transports a particular key handle uses. It does so through the use of the `Transport` enumeration:

```webidl
enum Transport {
    "bt",
    "ble",
    "nfc",
    "usb"
};
```

<table>
<thead>
<tr>
<th>Enumeration description</th>
</tr>
</thead>
<tbody>
<tr>
<td>bt</td>
</tr>
<tr>
<td>ble</td>
</tr>
<tr>
<td>nfc</td>
</tr>
<tr>
<td>usb</td>
</tr>
</tbody>
</table>

For convenience, all the transports supported by a token may be referred to by:

```webidl
typedef sequence<Transport> Transports;
```

Throughout this specification, the identifier `Transports` is used to refer to the `sequence<Transport>` type.

5. U2F operations

Regardless of the API level used, the U2F client must support the two operations of registering a token, and generating a signed assertion. This section describes the interface to each operation, their corresponding request and response dictionaries and possible error codes.

5.1 Registration

To register a U2F token for a user account at the RP, the RP must:

- decide which U2F protocol version(s) of device it wants to register,
- pick an appropriate application id for the registration request,
- generate a random challenge, and
- store all private information associated with the registration (expiration times, user ids, etc.)

The RP may choose an application id for the registration request. If none is chosen, the RP’s web origin is used as the application id. The new key pair that the U2F token generates will be associated with this application id. (For application id details see [FIDOAppIDAndFacets] in bibliography).

For each version it is willing to register, it then prepares a `RegisterRequest` dictionary as follows:

```webidl
dictionary RegisterRequest {
    DOMString version;
    DOMString challenge;
};
```

5.1.1 Dictionary `RegisterRequest` Members

- **version** of type `DOMString`  
  The version of the protocol that the to-be-registered token must speak. E.g. "U2F_V2".

- **challenge** of type `DOMString`  
  The websafe-base64-encoded challenge.

Additionally, the RP should prepare a `RegisteredKey` for each U2F token that is already registered for the current user as follows:

```webidl
dictionary RegisteredKey {
    DOMString version;
    DOMString keyHandle;
    Transports? transports;
    DOMString? appId;
};
```

5.1.2 Dictionary `RegisteredKey` Members

- **version** of type `DOMString`  
  Version of the protocol that the to-be-registered U2F token must speak. E.g. "U2F_V2"

- **keyHandle** of type `DOMString`  
  The registered keyHandle to use for signing, as returned by the U2F token during registration.

- **transports** of type `Transports`, nullable  
  The transport(s) this token supports, if known by the RP.

- **appId** of type `DOMString`, nullable  
  The application id that the RP would like to assert for this key handle, if it’s distinct from the application id for the overall request. (Ordinarily this will be omitted.)

The RP delivers a registration request to the FIDO client either via the low-level MessagePort API, or by invoking the high-level JavaScript API. Using the low-level MessagePort API, the RP would construct a message of the `U2FRegisterRequest` type:
5.1.3 Dictionary U2fRegisterRequest Members

- `type` of type DOMString, defaulting to 'u2f_register_request'
- `registerRequests` of type sequence<RegisterRequest>
- `registeredKeys` of type sequence<RegisteredKey>

An array of RegisteredKeys representing the U2F tokens registered to this user.

Example 2

```javascript
// Low-level API
var port = (obtain U2F MessagePort in a browser specific manner);
port.addEventListener('message', responseHandler);
port.postMessage({
  'type': 'u2f_register_request',
  'appId': <Application Id>,
  'registerRequests': [<RegisterRequest instance>, ...],
  'registeredKeys': [RegisteredKey for known token 1>, ...],
  'timeoutSeconds': 30,
  'requestId': <unique integer> // optional
});
```

Using the high-level API, the values are passed as parameters:

Example 3

```javascript
// High-level API
u2f.register(<Application id>, [
  <RegisterRequest instance>, ...],
  [RegisteredKey for known token 1>, ...],
  registerResponseHandler);
```

The FIDO client should treat the order of RegisterRequest dictionaries in the first parameter as a prioritized list. That is, if multiple tokens are present that support more than one version provided by the RP, the version that appears first should be selected. Note that this means multiple RegisterRequests with the same version are redundant, since the first one will always be selected.

Note also that the responseHandler in the low-level API receives a Response object, while the registerResponseHandler in the high-level API receives the Error or registerResponse objects directly.

The FIDO client will create the raw registration messages from this data (see [U2FRawMsgs] in bibliography), and attempt to perform a registration operation with a U2F token. The registration request message is then used to register a U2F token that is not already registered (if such a token is present).

Note that as part of creating the registration request message, the FIDO client will create a Client Data object (see [U2FRawMsgs]). This Client Data object will be returned to the caller as part of the registration response (see below).

If the registration is successful, the FIDO client returns (via the message port, or the JS API callback) a RegisterResponse dictionary as follows.

```javascript
dictionary RegisterResponse {
  DOMString version;
  DOMString registrationData;
  DOMString clientData;
}
```

5.1.4 Dictionary RegisterResponse Members

- `version` of type DOMString
  The version of the protocol that the registered token speaks. E.g. "U2F_V2".
- `registrationData` of type DOMString
  The raw registration response websafe-base64
- `clientData` of type DOMString
  The client data created by the FIDO client, websafe-base64 encoded.

For the contents of these fields, refer to [U2FRawMsgs] (see bibliography).

Backward compatibility with U2F 1.0 API

For backward compatibility with the U2F 1.0 API, the RP may prepare a SignRequest in lieu of a RegisteredKey for each U2F token that is already registered for the current user. See JavaScript API 1.0 for the specification of SignRequest.

Similarly, U2F clients may implement backward compatibility with version 1.0 by accepting a signRequests key in lieu of registeredKeys.

5.2 Generating signed identity assertions

To obtain an identity assertion from a locally-attached U2F token, the RP must

- generate a random challenge, and
- prepare a RegisteredKey object for each U2F token that the user has currently registered with the RP.

The RP delivers a sign request to the FIDO client either via the low-level MessagePort API, or by invoking the high-level JavaScript API. Using the low-level MessagePort API, the RP would construct a message of the U2fSignRequest type:

```javascript
dictionary U2fSignRequest { U2fRequest {
  DOMString requestId;
  DOMString timeoutSeconds;
  RegisteredKeys registeredKeys;
}}
```
5.2.1 Dictionary U2fSignRequest Members

- **type** of type DOMString, defaulting to 'u2f_sign_request'
- **challenge** of type DOMString
  The websafe-base64-encoded challenge.
- **registeredKeys** of type sequence<RegisteredKey>
  An array of RegisteredKeys representing the U2F tokens registered to this user.

In response to a sign request, the FIDO client should perform the following steps:

- Verify the application identity of the caller.
- Using the provided challenge, create a client data object.
- Using the client data, the application id, and the key handle, create a raw authentication request message (see [U2FRawMsgs] in bibliography) and send it to the U2F token.

When the RP provides the **transports** value for any **RegisteredKey**, the client may treat that value has a hint about which transports to prefer for the key handle. The client may also use the transports as a hint about user interface, if the client presents any. Irrespective of whether the RP sets any **transports** value for any **RegisteredKey**, the client should send each key handle over all transports supported by the client.

Eventually the FIDO client must respond (via the MessageChannel or the provided callback). In the case of an error, an **Error** dictionary is returned. In case of success, a **SignResponse** is returned.

5.2.2 Dictionary SignResponse Members

- **keyHandle** of type DOMString
  The keyHandle of the RegisteredKey that was processed.
- **signatureData** of type DOMString
  The raw response from U2F device, websafe-base64 encoded.
- **clientData** of type DOMString
  The client data created by the FIDO client, websafe-base64 encoded.

If there are multiple U2F tokens that responded to the authentication request, the FIDO client will pick one of the responses and pass it to the caller.

5.3 Error codes

When an **Error** object is returned, its **errorCode** field is set to a non-negative integer indicating the general error that occurred, from the following enumeration.

5.3.1 Constants

- **OK** of type short
  Success. Not used in errors but reserved
- **OTHER_ERROR** of type short
  An error otherwise not enumerated here
- **BAD_REQUEST** of type short
  The request cannot be processed
- **CONFIGURATION_UNSUPPORTED** of type short
  Client configuration is not supported
The presented device is not eligible for this request. For a registration request this may mean that the token is already registered, and for a sign request it may mean the token does not know the presented key handle.

Timeout reached before request could be satisfied

Backward compatibility with U2F 1.0 API

For backward compatibility with the U2F 1.0 API, the RP may prepare a `signInRequest` in lieu of a `RegisteredKey` for each U2F token that is already registered for the current user. See JavaScript API 1.0 for the specification of `signInRequest`.

Similarly, U2F clients may implement backward compatibility with version 1.0 by accepting a `signRequests` key in lieu of `registeredKeys`.

A. References

A.1 Normative references

[ECMA-262]  

[FIDOAppIDAndFacets]  
D. Balfanz, B. Hill, R. Lindemann, D. Baghdasaryan, FIDO AppID and Facets v1.0. FIDO Alliance Proposed Standard. URLs:  
HTML: fido-appid-and-facets-v1.1-id-20150902.html  

[FIDOGlossary]  
R. Lindemann, D. Baghdasaryan, B. Hill, J. Hodges, FIDO Technical Glossary. FIDO Alliance Proposed Standard. URLs:  
HTML: fido-glossary-v1.1-id-20150902.html  
PDF: fido-glossary-v1.1-id-20150902.pdf

[RFC2119]  

[RFC4648]  

[U2FRawMsgs]  

[WEBMESSAGING]  
Ian Hickson, HTML5 Web Messaging. 19 May 2015. W3C Recommendation. URL: https://www.w3.org/TR/webmessaging/

[WebIDL]  
Cameron McCormack, Boris Zbarsky, WebIDL Level 1. 15 September 2016. W3C Proposed Recommendation. URL: https://www.w3.org/TR/WebIDL-1/

A.2 Informative references

[U2FOverview]  