



## FIDO Metadata Statements

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The English version of this specification is the only normative version. Non-normative [translations](#) may also be available.

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### Abstract

FIDO authenticators may have many different form factors, characteristics and capabilities. This document defines a standard means to describe the relevant pieces of information about an authenticator in order to interoperate with it, or to make risk-based policy decisions about transactions involving a particular authenticator.

### Status of This Document

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## 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-ED].

Following [WebIDL-ED], dictionary members are optional unless they are explicitly marked as required.

WebIDL dictionary members **must not** have a value of null.

Unless otherwise specified, if a WebIDL dictionary member is DOMString, it **must not** be empty.

Unless otherwise specified, if a WebIDL dictionary member is a List, it **must not** be an empty list.

All diagrams, examples, notes in this specification are non-normative.

### NOTE

Note: Certain dictionary members need to be present in order to comply with FIDO requirements. Such members are marked in the WebIDL definitions found in this document, as **required**. The keyword **required** has been introduced by [WebIDL-ED], which is a work-in-progress. If you are using a WebIDL parser which implements [WebIDL], then you may remove the keyword **required** from your WebIDL and use other means to ensure those fields are present.

### 1.1 Conformance

As well as sections marked as non-normative, all authoring guidelines, diagrams, examples, and notes in this specification are non-normative. Everything else in this specification is normative.

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

## 2. Overview

*This section is non-normative.*

The FIDO family of protocols enable simpler and more secure online authentication utilizing a wide variety of different devices in a competitive marketplace. Much of the complexity behind this variety is hidden from Relying Party applications, but in order to accomplish the goals of FIDO, Relying Parties must have some means of discovering and verifying various characteristics of authenticators. Relying Parties can learn a subset of verifiable information for authenticators certified by the FIDO Alliance with an Authenticator Metadata statement. The URL to access that Metadata statement is provided by the Metadata TOC file accessible through the Metadata Service [FIDOMetadataService].

For definitions of terms, please refer to the FIDO Glossary [FIDOGlossary].

## 2.1 Scope

This document describes the format of and information contained in *Authenticator Metadata* statements. For a definitive list of possible values for the various types of information, refer to the FIDO Registry of Predefined Values [FIDORegistry].

The description of the processes and methods by which authenticator metadata statements are distributed and the methods how these statements can be verified are described in the Metadata Service Specification [FIDOMetadataService].

## 2.2 Audience

The intended audience for this document includes:

- FIDO authenticator vendors who wish to produce metadata statements for their products.
- FIDO server implementers who need to consume metadata statements to verify characteristics of authenticators and attestation statements, make proper algorithm choices for protocol messages, create policy statements or tailor various other modes of operation to authenticator-specific characteristics.
- FIDO relying parties who wish to
  - create custom policy statements about which authenticators they will accept
  - risk score authenticators based on their characteristics
  - verify attested authenticator IDs for cross-referencing with third party metadata

## 2.3 Architecture

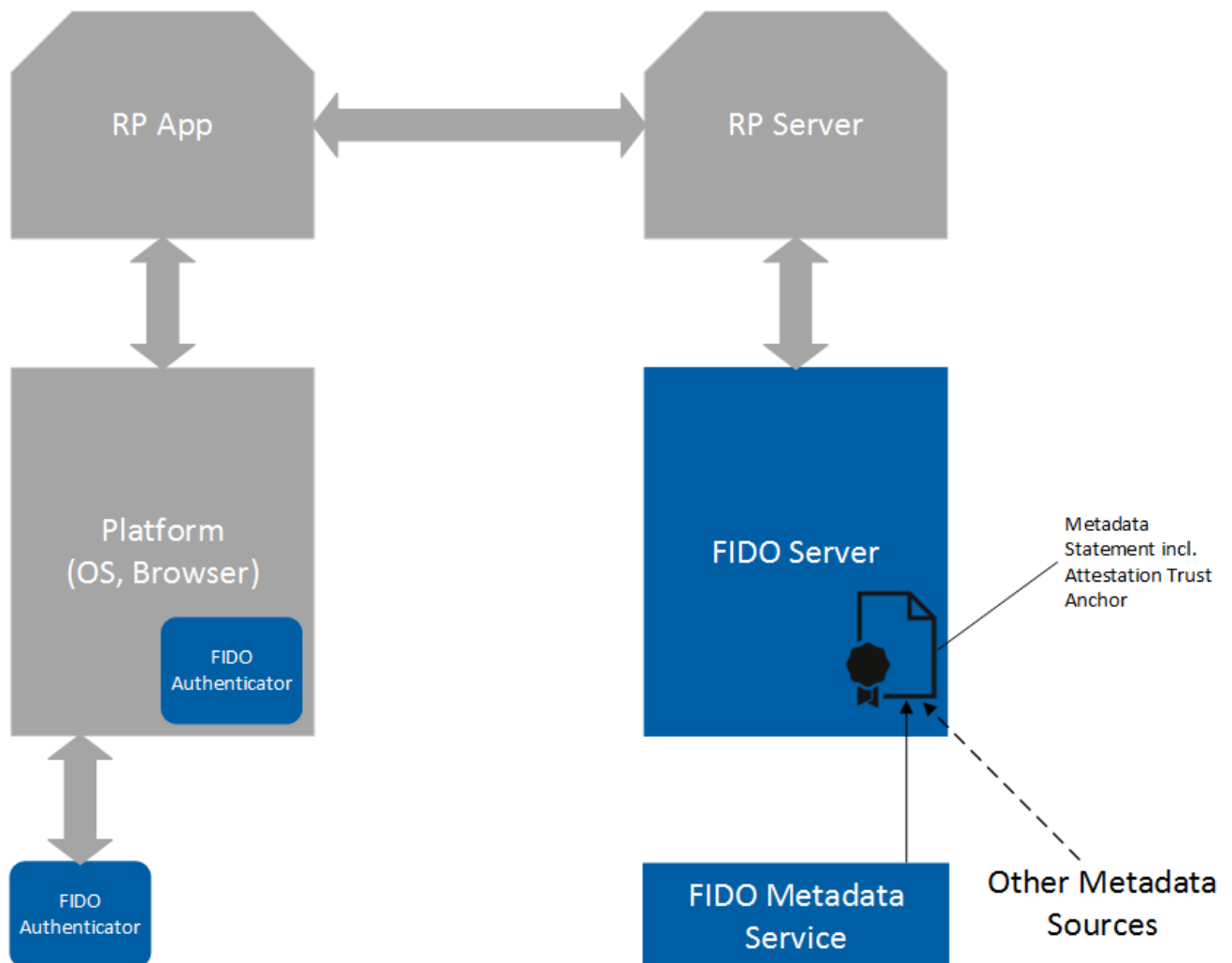


Fig. 1 The FIDO Architecture

*Authenticator metadata statements* are used directly by the FIDO server at a relying party, but the information contained in the authoritative statement is used in several other places. How a server obtains these metadata statements is described in

[[FIDOMetadataService](#)].

The workflow around an authenticator metadata statement is as follows:

1. The authenticator vendor produces a metadata statement describing the characteristics of an authenticator.
2. The metadata statement is submitted to the FIDO Alliance as part of the FIDO certification process. The FIDO Alliance distributes the metadata as described in [[FIDOMetadataService](#)].
3. A FIDO relying party configures its registration policy to allow authenticators matching certain characteristics to be registered.
4. The FIDO server sends a registration challenge message. This message can contain such policy statement.
5. Depending on the FIDO protocol being used, either the relying party application or the FIDO UAF Client receives the policy statement as part of the challenge message and processes it. It queries available authenticators for their self-reported characteristics and (with the user's input) selects an authenticator that matches the policy, to be registered.
6. The client processes and sends a registration response message to the server. This message contains a reference to the authenticator model and, optionally, a signature made with the private key corresponding to the public key in the authenticator's attestation certificate.
7. The FIDO Server looks up the metadata statement for the particular authenticator model. If the metadata statement lists an attestation certificate(s), it verifies that an attestation signature is present, and made with the private key corresponding to either (a) one of the certificates listed in this metadata statement or (b) corresponding to the public key in a certificate that *chains* to one of the issuer certificates listed in the authenticator's metadata statement.
8. The FIDO Server next verifies that the authenticator meets the originally supplied registration policy based on its authoritative metadata statement. This prevents the registration of unexpected authenticator models.
9. *Optionally*, a FIDO Server may, with input from the Relying Party, assign a risk or trust score to the authenticator, based on its metadata, including elements not selected for by the stated policy.
10. *Optionally*, a FIDO Server may cross-reference the attested authenticator model with other metadata databases published by third parties. Such third-party metadata might, for example, inform the FIDO Server if an authenticator has achieved certifications relevant to certain markets or industry verticals, or whether it meets application-specific regulatory requirements.

## 3. Types

*This section is normative.*

### 3.1 CodeAccuracyDescriptor dictionary

The `CodeAccuracyDescriptor` describes the relevant accuracy/complexity aspects of passcode user verification methods.

#### NOTE

One example of such a method is the use of 4 digit PIN codes for mobile phone SIM card unlock.

We are using the numeral system `base` (radix) and `minLen`, instead of the number of potential combinations since there is sufficient evidence [[iPhonePasscodes](#)] [[MoreTopWorstPasswords](#)] that users don't select their code evenly distributed at random. So software might take into account the various probability distributions for different bases. This essentially means that in practice, passcodes are not as secure as they could be if randomly chosen.

#### WebIDL

```
dictionary CodeAccuracyDescriptor {  
  required unsigned short base;  
  required unsigned short minLength;  
  unsigned short maxRetries;  
  unsigned short blockSlowdown;  
};
```

#### 3.1.1 Dictionary `CodeAccuracyDescriptor` Members

`base` of type `required unsigned short`

The numeric system base (radix) of the code, e.g. 10 in the case of decimal digits.

`minLength` of type `required unsigned short`

The minimum number of digits of the given base required for that code, e.g. 4 in the case of 4 digits.

`maxRetries` of type `unsigned short`

Maximum number of false attempts before the authenticator will block this method (at least for some time). 0 means it will never block.

`blockSlowdown` of type `unsigned short`

Enforced minimum number of seconds wait time after blocking (e.g. due to forced reboot or similar). 0 means this user verification method will be blocked, either permanently or until an alternative user verification method succeeded. All alternative user verification methods **must** be specified appropriately in `userVerificationDetails`.

### 3.2 BiometricAccuracyDescriptor dictionary

The `BiometricAccuracyDescriptor` describes relevant accuracy/complexity aspects in the case of a biometric user verification method.

#### NOTE

The *False Acceptance Rate* (FAR) and *False Rejection Rate* (FRR) values typically are interdependent via the *Receiver Operator Characteristic* (ROC) curve.

The *False Artefact Acceptance Rate* (FAAR) value reflects the capability of detecting presentation attacks, such as the detection of rubber finger presentation.

The FAR, FRR, and FAAR values given here **must** reflect the actual configuration of the authenticators (as opposed to being theoretical best case values).

At least one of the values **must** be set. If the vendor doesn't want to specify such values, then `VerificationMethodDescriptor.baDesc` **MUST** be omitted.

#### NOTE

Typical fingerprint sensor characteristics can be found in Google [Android 6.0 Compatibility Definition](#) and Apple [iOS Security Guide](#).

### WebIDL

```
dictionary BiometricAccuracyDescriptor {  
    double FAR;  
    double FRR;  
    double EER;  
    double FAAR;  
    unsigned short maxReferenceDataSets;  
    unsigned short maxRetries;  
    unsigned short blockSlowdown;  
};
```

### 3.2.1 Dictionary `BiometricAccuracyDescriptor` Members

#### **FAR** of type `double`

The false acceptance rate [ISO19795-1] for a single reference data set, i.e. the percentage of non-matching data sets that are accepted as valid ones. For example a FAR of 0.002% would be encoded as 0.00002.

#### NOTE

The resulting FAR when all reference data sets are used is `maxReferenceDataSets * FAR`.

The false acceptance rate is relevant for the security. Lower false acceptance rates mean better security.

Only the live captured subjects are covered by this value - not the presentation of artefacts.

#### **FRR** of type `double`

The false rejection rate for a single reference data set, i.e. the percentage of presented valid data sets that lead to a (false) non-acceptance. For example a FRR of 10% would be encoded as 0.1.

#### NOTE

The false rejection rate is relevant for the convenience. Lower false acceptance rates mean better convenience.

#### **EER** of type `double`

The equal error rate for a single reference data set.

#### **FAAR** of type `double`

The false artefact acceptance rate [ISO30107-1], i.e. the percentage of artefacts that are incorrectly accepted by the system. For example a FAAR of 0.1% would be encoded as 0.001.

#### NOTE

The false artefact acceptance rate is relevant for the security of the system. Lower false artefact acceptance rates imply better security.

**maxReferenceDataSets** of type `unsigned short`

Maximum number of alternative reference data sets, e.g. 3 if the user is allowed to enroll 3 different fingers to a fingerprint based authenticator.

**maxRetries** of type **unsigned short**

Maximum number of false attempts before the authenticator will block this method (at least for some time). 0 means it will never block.

**blockSlowdown** of type **unsigned short**

Enforced minimum number of seconds wait time after blocking (e.g. due to forced reboot or similar). 0 means that this user verification method will be blocked either permanently or until an alternative user verification method succeeded. All alternative user verification methods **must** be specified appropriately in the metadata in **userVerificationDetails**.

### 3.3 PatternAccuracyDescriptor dictionary

The **PatternAccuracyDescriptor** describes relevant accuracy/complexity aspects in the case that a pattern is used as the user verification method.

#### NOTE

One example of such a pattern is the 3x3 dot matrix as used in Android [[AndroidUnlockPattern](#)] screen unlock. The **minComplexity** would be 1624 in that case, based on the user choosing a 4-digit PIN, the minimum allowed for this mechanism.

#### WebIDL

```
dictionary PatternAccuracyDescriptor {  
  required unsigned long minComplexity;  
  unsigned short maxRetries;  
  unsigned short blockSlowdown;  
};
```

#### 3.3.1 Dictionary **PatternAccuracyDescriptor** Members

**minComplexity** of type **required unsigned long**

Number of possible patterns (having the minimum length) out of which exactly one would be the right one, i.e. 1/probability in the case of equal distribution.

**maxRetries** of type **unsigned short**

Maximum number of false attempts before the authenticator will block authentication using this method (at least temporarily). 0 means it will never block.

**blockSlowdown** of type **unsigned short**

Enforced minimum number of seconds wait time after blocking (due to forced reboot or similar mechanism). 0 means this user verification method will be blocked, either permanently or until an alternative user verification method method succeeded. All alternative user verification methods **must** be specified appropriately in the metadata under **userVerificationDetails**.

### 3.4 VerificationMethodDescriptor dictionary

A descriptor for a specific *base user verification method* as implemented by the authenticator.

A base user verification method must be chosen from the list of those described in [[FIDORegistry](#)]

#### NOTE

In reality, several of the methods described above might be combined. For example, a fingerprint based user verification can be combined with an alternative password.

The specification of the related AccuracyDescriptor is optional, but recommended.

#### WebIDL

```
dictionary VerificationMethodDescriptor {  
  required unsigned long userVerification;  
  CodeAccuracyDescriptor caDesc;  
  BiometricAccuracyDescriptor baDesc;  
  PatternAccuracyDescriptor paDesc;  
};
```

#### 3.4.1 Dictionary **VerificationMethodDescriptor** Members

**userVerification** of type **required unsigned long**

a *single* **USER\_VERIFY** constant (see [[FIDORegistry](#)]), **not a bit flag combination**. This value **must** be non-zero.

**caDesc** of type *CodeAccuracyDescriptor*

May optionally be used in the case of method `USER_VERIFY_PASSCODE`.

**baDesc** of type *BiometricAccuracyDescriptor*

May optionally be used in the case of method `USER_VERIFY_FINGERPRINT`, `USER_VERIFY_VOICEPRINT`, `USER_VERIFY_FACEPRINT`, `USER_VERIFY_EYEPRINT`, or `USER_VERIFY_HANDPRINT`.

**paDesc** of type *PatternAccuracyDescriptor*

May optionally be used in case of method `USER_VERIFY_PATTERN`.

### 3.5 verificationMethodANDCombinations typedef

#### WebIDL

```
typedef VerificationMethodDescriptor[] VerificationMethodANDCombinations;
```

`VerificationMethodANDCombinations` **must** be non-empty. It is a list containing the base user verification methods which must be passed as part of a successful user verification.

This list will contain only a single entry if using a single user verification method is sufficient.

If this list contains multiple entries, then all of the listed user verification methods **must** be passed as part of the user verification process.

### 3.6 rgbPaletteEntry dictionary

The `rgbPaletteEntry` is an RGB three-sample tuple palette entry

#### WebIDL

```
dictionary rgbPaletteEntry {  
  required unsigned short r;  
  required unsigned short g;  
  required unsigned short b;  
};
```

#### 3.6.1 Dictionary `rgbPaletteEntry` Members

**r** of type `required unsigned short`  
Red channel sample value

**g** of type `required unsigned short`  
Green channel sample value

**b** of type `required unsigned short`  
Blue channel sample value

### 3.7 DisplayPNGCharacteristicsDescriptor dictionary

The `DisplayPNGCharacteristicsDescriptor` describes a PNG image characteristics as defined in the PNG [\[PNG\]](#) spec for IHDR (image header) and PLTE (palette table)

#### WebIDL

```
dictionary DisplayPNGCharacteristicsDescriptor {  
  required unsigned long width;  
  required unsigned long height;  
  required octet bitDepth;  
  required octet colorType;  
  required octet compression;  
  required octet filter;  
  required octet interlace;  
  rgbPaletteEntry[] plte;  
};
```

#### 3.7.1 Dictionary `DisplayPNGCharacteristicsDescriptor` Members

**width** of type `required unsigned long`  
image width

**height** of type `required unsigned long`  
image height

**bitDepth** of type `required octet`  
Bit depth - bits per sample or per palette index.

**colorType** of type `required octet`  
Color type defines the PNG image type.

**compression** of type **required octet**

Compression method used to compress the image data.

**filter** of type **required octet**

Filter method is the preprocessing method applied to the image data before compression.

**interlace** of type **required octet**

Interlace method is the transmission order of the image data.

**plte** of type array of *rgbPaletteEntry*

1 to 256 palette entries

### 3.8 EcdaaTrustAnchor dictionary

In the case of ECDAAs attestation, the ECDAAs-Issuer's trust anchor **must** be specified in this field.

#### WebIDL

```
dictionary EcdaaTrustAnchor {
  required DOMString X;
  required DOMString Y;
  required DOMString c;
  required DOMString sx;
  required DOMString sy;
  required DOMString G1Curve;
};
```

#### 3.8.1 Dictionary **EcdaaTrustAnchor** Members

**x** of type **required DOMString**

base64url encoding of the result of ECPoint2ToB of the ECPoint2 $X = P_2^x X = P_2^x$ . See [FIDOEcdaaAlgorithm] for the definition of ECPoint2ToB.

**y** of type **required DOMString**

base64url encoding of the result of ECPoint2ToB of the ECPoint2 $Y = P_2^y Y = P_2^y$ . See [FIDOEcdaaAlgorithm] for the definition of ECPoint2ToB.

**c** of type **required DOMString**

base64url encoding of the result of BigIntegerToB( $c$ ). See section "Issuer Specific ECDAAs Parameters" in [FIDOEcdaaAlgorithm] for an explanation of  $c$ . See [FIDOEcdaaAlgorithm] for the definition of BigIntegerToB.

**sx** of type **required DOMString**

base64url encoding of the result of BigIntegerToB( $s_{Xsx}$ ). See section "Issuer Specific ECDAAs Parameters" in [FIDOEcdaaAlgorithm] for an explanation of  $s_{Xsx}$ . See [FIDOEcdaaAlgorithm] for the definition of BigIntegerToB.

**sy** of type **required DOMString**

base64url encoding of the result of BigIntegerToB( $s_{Ysy}$ ). See section "Issuer Specific ECDAAs Parameters" in [FIDOEcdaaAlgorithm] for an explanation of  $s_{Ysy}$ . See [FIDOEcdaaAlgorithm] for the definition of BigIntegerToB.

**G1Curve** of type **required DOMString**

Name of the Barreto-Naehrig elliptic curve for G1. "BN\_P256", "BN\_P638", "BN\_ISOP256", and "BN\_ISOP512" are supported. See section "Supported Curves for ECDAAs" in [FIDOEcdaaAlgorithm] for details.

#### NOTE

Whenever a party uses this trust anchor for the first time, it must first verify that it was correctly generated by verifying  $s$ ,  $s_x$ ,  $s_y$ ,  $s_x$ ,  $s_y$ . See [FIDOEcdaaAlgorithm] for details.

### 3.9 ExtensionDescriptor dictionary

This descriptor contains an extension supported by the authenticator.

#### WebIDL

```
dictionary ExtensionDescriptor {
  required DOMString id;
  DOMString data;
  required boolean fail_if_unknown;
};
```

#### 3.9.1 Dictionary **ExtensionDescriptor** Members

**id** of type **required DOMString**



Identifies the extension.

**data** of type [DOMString](#)

Contains arbitrary data further describing the extension and/or data needed to correctly process the extension.

This field **may** be missing or it **may** be empty.

**fail\_if\_unknown** of type [required boolean](#)

Indicates whether unknown extensions must be ignored (**false**) or must lead to an error (**true**) when the extension is to be processed by the FIDO Server, FIDO Client, ASM, or FIDO Authenticator.

- A value of **false** indicates that unknown extensions **must** be ignored
- A value of **true** indicates that unknown extensions **must** result in an error.

## 4. Metadata Keys

*This section is normative.*

### WebIDL

```
dictionary MetadataStatement {  
  AAID  
  AAGUID  
  DOMString[]  
  required DOMString  
  required unsigned short  
  DOMString  
  required Version[]  
  required DOMString  
  required unsigned short  
  required unsigned short  
  required unsigned short[]  
  required VerificationMethodANDCombinations[]  
  required unsigned short  
  boolean  
  boolean  
  required unsigned short  
  required unsigned long  
  required boolean  
  required unsigned short  
  DOMString  
  DisplayPNGCharacteristicsDescriptor[]  
  required DOMString[]  
  EcdaaTrustAnchor[]  
  DOMString  
  ExtensionDescriptor  
};
```

```
aaid;  
aaguid;  
attestationCertificateKeyIdentifiers;  
description;  
authenticatorVersion;  
protocolFamily;  
upv;  
assertionScheme;  
authenticationAlgorithm;  
publicKeyAlgAndEncoding;  
attestationTypes;  
userVerificationDetails;  
keyProtection;  
isKeyRestricted;  
isFreshUserVerificationRequired;  
matcherProtection;  
attachmentHint;  
isSecondFactorOnly;  
tcDisplay;  
tcDisplayContentType;  
tcDisplayPNGCharacteristics;  
attestationRootCertificates;  
ecdaaTrustAnchors;  
icon;  
supportedExtensions[];
```

### 4.1 Dictionary **MetadataStatement** Members

**aaid** of type [AAID](#)

The Authenticator Attestation ID. See [\[UAFProtocol\]](#) for the definition of the AAID structure. This field **must** be set if the authenticator implements FIDO UAF.

#### NOTE

FIDO UAF Authenticators support AAID, but they don't support AAGUID.

**aaguid** of type [AAGUID](#)

The Authenticator Attestation GUID. See [\[FIDOKeyAttestation\]](#) for the definition of the AAGUID structure. This field **must** be set if the authenticator implements FIDO 2.

#### NOTE

FIDO 2 Authenticators support AAGUID, but they don't support AAID.

**attestationCertificateKeyIdentifiers** of type array of [DOMString](#)

A list of the attestation certificate public key identifiers encoded as hex string. This value **must** be calculated according to method 1 for computing the keyIdentifier as defined in [\[RFC5280\]](#) section 4.2.1.2. The hex string **must not** contain any non-hex characters (e.g. spaces). All hex letters **must** be lower case. This field **must** be set if neither **aaid** nor **aaguid** are set. Setting this field implies that the attestation certificate(s) are dedicated to a single authenticator model.

All attestationCertificateKeyIdentifier values should be unique within the scope of the Metadata Service.

#### NOTE

FIDO U2F Authenticators typically do not support AAID nor AAGUID, but they use attestation certificates dedicated to a single authenticator model.

**description** of type [required DOMString](#)

A human-readable short description of the authenticator.

**NOTE**

This description should help an administrator configuring authenticator policies. This description might deviate from the description returned by the ASM for that authenticator.

This description should contain the public authenticator trade name and the publicly known vendor name.

**authenticatorVersion** of type [required unsigned short](#)

Earliest (i.e. lowest) trustworthy [authenticatorVersion](#) meeting the requirements specified in this metadata statement.

Adding new [StatusReport](#) entries with status [UPDATE\\_AVAILABLE](#) to the metadata [TOC](#) object [[FIDOMetadataService](#)] **must** also change this [authenticatorVersion](#) if the update fixes severe security issues, e.g. the ones reported by preceding [StatusReport](#) entries with status code [USER\\_VERIFICATION\\_BYPASS](#), [ATTESTATION\\_KEY\\_COMPROMISE](#), [USER\\_KEY\\_REMOTE\\_COMPROMISE](#), [USER\\_KEY\\_PHYSICAL\\_COMPROMISE](#), [REVOKED](#).

It is **recommended** to assume increased risk if this version is higher (newer) than the firmware version present in an authenticator. For example, if a [StatusReport](#) entry with status [USER\\_VERIFICATION\\_BYPASS](#) or [USER\\_KEY\\_REMOTE\\_COMPROMISE](#) precedes the [UPDATE\\_AVAILABLE](#) entry, than any firmware version lower (older) than the one specified in the metadata statement is assumed to be vulnerable.

**protocolFamily** of type [DOMString](#)

The FIDO protocol family. The values "uaf", "u2f", and "fido2" are supported. If this field is missing, the assumed protocol family is "uaf". Metadata Statements for U2F authenticators **must** set the value of protocolFamily to "u2f" and FIDO 2.0 Authenticators implementations **must** set the value of protocolFamily to "fido2".

**upv** of type array of [required Version](#)

The FIDO unified protocol version(s) (related to the specific protocol family) supported by this authenticator. See [[UAFProtocol](#)] for the definition of the [Version](#) structure.

**assertionScheme** of type [required DOMString](#)

The assertion scheme supported by the authenticator. Must be set to one of the enumerated strings defined in the FIDO UAF Registry of Predefined Values [[UAFRegistry](#)] or to "FIDOv2" in the case of the FIDO 2 assertion scheme.

**authenticationAlgorithm** of type [required unsigned short](#)

The authentication algorithm supported by the authenticator. Must be set to one of the [ALG\\_](#) constants defined in the FIDO Registry of Predefined Values [[FIDORegistry](#)]. This value **must** be non-zero.

**publicKeyAlgAndEncoding** of type [required unsigned short](#)

The public key format used by the authenticator during registration operations. Must be set to one of the [ALG\\_KEY](#) constants defined in the FIDO Registry of Predefined Values [[FIDORegistry](#)]. Because this information is not present in APIs related to authenticator discovery or policy, a FIDO server **must** be prepared to accept and process any and all key representations defined for any public key algorithm it supports. This value **must** be non-zero.

**attestationTypes** of type array of [required unsigned short](#)

The supported attestation type(s). (e.g. [TAG\\_ATTESTATION\\_BASIC\\_FULL](#)) See Registry for more information [[UAFRegistry](#)].

**userVerificationDetails** of type array of [required VerificationMethodANDCombinations](#)

A list of *alternative* VerificationMethodANDCombinations. Each of these entries is one alternative user verification method. Each of these alternative user verification methods might itself be an "AND" combination of multiple modalities.

All effectively available alternative user verification methods **must** be properly specified here. A user verification method is considered effectively available if this method can be used to either:

- enroll new verification reference data to one of the user verification methods
- or
- unlock the UAuth key directly after successful user verification

**keyProtection** of type [required unsigned short](#)

A 16-bit number representing the bit fields defined by the [KEY\\_PROTECTION](#) constants in the FIDO Registry of Predefined Values [[FIDORegistry](#)].

This value **must** be non-zero.

**NOTE**

The keyProtection specified here denotes the effective security of the attestation key and Uauth private key and the effective trustworthiness of the attested attributes in the "sign assertion". Effective security means that key extraction or injecting malicious attested attributes is only possible if the specified protection method is compromised. For example, if keyProtection=TEE is stated, it shall be impossible to extract the attestation key or the Uauth private key or to inject any malicious attested attributes *without breaking the TEE*.

#### **isKeyRestricted** of type **boolean**

This entry is set to **true**, if the Uauth private key is restricted by the *authenticator* to only sign valid FIDO signature assertions.

This entry is set to **false**, if the authenticator doesn't restrict the Uauth key to only sign valid FIDO signature assertions. In this case, the calling application could potentially get any hash value signed by the authenticator.

If this field is missing, the assumed value is isKeyRestricted=**true**

#### **NOTE**

Note that only in the case of isKeyRestricted=**true**, the FIDO server can trust a signature counter or transaction text to have been correctly processed/controlled by the authenticator.

#### **isFreshUserVerificationRequired** of type **boolean**

This entry is set to **true**, if Uauth key usage *always* requires a fresh user verification.

If this field is missing, the assumed value is isFreshUserVerificationRequired=**true**.

This entry is set to **false**, if the Uauth key can be used without requiring a fresh user verification, e.g. without any additional user interaction, if the user was verified a (potentially configurable) caching time ago.

In the case of isFreshUserVerificationRequired=**false**, the FIDO server **must** verify the registration response and/or authentication response and verify that the (maximum) caching time (sometimes also called "authTimeout") is acceptable.

This entry solely refers to the user verification. In the case of transaction confirmation, the authenticator **must** always ask the user to authorize the specific transaction.

#### **NOTE**

Note that in the case of isFreshUserVerificationRequired=**false**, the calling App could trigger use of the key without user involvement. In this case it is the responsibility of the App to ask for user consent.

#### **matcherProtection** of type **required unsigned short**

A 16-bit number representing the bit fields defined by the **MATCHER\_PROTECTION** constants in the FIDO Registry of Predefined Values [**FIDORegistry**].

This value **must** be non-zero.

#### **NOTE**

If multiple matchers are implemented, then this value must reflect the *weakest* implementation of all matchers.

The matcherProtection specified here denotes the effective security of the FIDO authenticator's user verification. This means that a false positive user verification implies breach of the stated method. For example, if matcherProtection=TEE is stated, it shall be impossible to trigger use of the Uauth private key when bypassing the user verification *without breaking the TEE*.

#### **attachmentHint** of type **required unsigned long**

A 32-bit number representing the bit fields defined by the **ATTACHMENT\_HINT** constants in the FIDO Registry of Predefined Values [**FIDORegistry**].

#### **NOTE**

The connection state and topology of an authenticator may be transient and cannot be relied on as authoritative by a relying party, but the metadata field should have all the bit flags set for the topologies possible for the authenticator. For example, an authenticator instantiated as a single-purpose hardware token that can communicate over bluetooth should set **ATTACHMENT\_HINT\_EXTERNAL** but not **ATTACHMENT\_HINT\_INTERNAL**.

**isSecondFactorOnly** of type **required boolean**

Indicates if the authenticator is designed to be used only as a second factor, i.e. requiring some other authentication method as a first factor (e.g. username+password).

**tcDisplay** of type **required unsigned short**

A 16-bit number representing a combination of the bit flags defined by the **TRANSACTION\_CONFIRMATION\_DISPLAY** constants in the FIDO Registry of Predefined Values [**FIDORegistry**].

This value **must** be 0, if transaction confirmation is not supported by the authenticator.

#### NOTE

The tcDisplay specified here denotes the effective security of the authenticator's transaction confirmation display. This means that only a breach of the stated method allows an attacker to inject transaction text to be included in the signature assertion which hasn't been displayed and confirmed by the user.

**tcDisplayContentType** of type **DOMString**

Supported MIME content type [**RFC2049**] for the transaction confirmation display, such as **text/plain** or **image/png**.

This value **must** be present if transaction confirmation is supported, i.e. **tcDisplay** is non-zero.

**tcDisplayPNGCharacteristics** of type array of **DisplayPNGCharacteristicsDescriptor**

A list of *alternative* DisplayPNGCharacteristicsDescriptor. Each of these entries is one alternative of supported image characteristics for displaying a PNG image.

This list **must** be present if PNG-image based transaction confirmation is supported, i.e. **tcDisplay** is non-zero and **tcDisplayContentType** is **image/png**.

**attestationRootCertificates** of type array of **required DOMString**

Each element of this array represents a PKIX [**RFC5280**] trust root X.509 certificate that is valid for this authenticator model. Multiple certificates might be used for different batches of the same model. The array does not represent a certificate chain, but only the trust anchor of that chain.

Each array element is a base64-encoded (section 4 of [**RFC4648**]), DER-encoded [**ITU-X690-2008**] PKIX certificate value. Each element **must** be dedicated for authenticator attestation.

#### NOTE

A certificate listed here is a trust root. It might be the actual certificate presented by the authenticator, or it might be an issuing authority certificate from the vendor that the actual certificate in the authenticator chains to.

In the case of "uaf" protocol family, the attestation certificate itself and the ordered certificate chain are included in the registration assertion (see [**UAFAuthnrCommands**]).

Either

1. the manufacturer attestation root certificate
- or
2. the root certificate dedicated to a specific authenticator model

**must** be specified.

In the case (1), the root certificate might cover multiple authenticator models. In this case, it must be possible to uniquely derive the authenticator model from the Attestation Certificate. When using AAID or AAGUID, this can be achieved by either specifying the AAID or AAGUID in the attestation certificate using the extension id-fido-gen-ce-aaid { 1 3 6 1 4 1 45724 1 1 1 } or id-fido-gen-ce-aaguid { 1 3 6 1 4 1 45724 1 1 4 } or - when neither AAID nor AAGUID are defined - by using the **attestationCertificateKeyIdentifier** method.

In the case (2) this is not required as the root certificate only covers a single authenticator model.

When supporting surrogate basic attestation only (see [**UAFProtocol**], section "Surrogate Basic Attestation"), no attestation root certificate is required/used. So this array **must** be empty in that case.

**ecdaaTrustAnchors** of type array of **EcdaaTrustAnchor**

A list of trust anchors used for ECDAA attestation. This entry **must** be present if and only if attestationType includes TAG\_ATTESTATION\_ECDAA. The entries in **attestationRootCertificates** have no relevance for ECDAA attestation. Each ecdaaTrustAnchor **must** be dedicated to a single authenticator model (e.g as identified by its AAID/AAGUID).

**icon** of type **DOMString**

A **data:** url [**RFC2397**] encoded PNG [**PNG**] icon for the Authenticator.

**supportedExtensions[]** of type **ExtensionDescriptor**

List of extensions supported by the authenticator.

## 5. Metadata Statement Format

This section is non-normative.

### NORMATIVE

A FIDO Authenticator Metadata Statement is a document containing a JSON encoded [dictionary MetadataStatement](#).

### 5.1 UAF Example

Example of the metadata statement for an UAF authenticator with:

- authenticatorVersion 2.
- Fingerprint based user verification allowing up to 5 registered fingers, with false acceptance rate of 0.002% and rate limiting attempts for 30 seconds after 5 false trials.
- Authenticator is embedded with the FIDO User device.
- The authentication keys are protected by TEE and are restricted to sign valid FIDO sign assertions only.
- The (fingerprint) matcher is implemented in TEE.
- The Transaction Confirmation Display is implemented in a TEE.
- The Transaction Confirmation Display supports display of "image/png" objects only.
- Display has a width of 320 and a height of 480 pixel. A bit depth of 16 bits per pixel offering True Color (=Color Type 2). The zlib compression method (0). It doesn't support filtering (i.e. filter type of=0) and no interlacing support (interlace method=0).
- The Authenticator can act as first factor or as second factor, i.e. isSecondFactorOnly = false.
- It supports the "UAFV1TLV" assertion scheme.
- It uses the [ALG\\_SIGN\\_SECP256R1\\_ECDSA\\_SHA256\\_RAW](#) authentication algorithm.
- It uses the [ALG\\_KEY\\_ECC\\_X962\\_RAW](#) public key format (0x100=256 decimal).
- It only implements the [TAG\\_ATTESTATION\\_BASIC\\_FULL](#) method (0x3E07=15879 decimal).
- It implements UAF protocol version (upv) 1.0 and 1.1.

### EXAMPLE 1: MetadataStatement for UAF Authenticator

```
{ "aaid": "1234#5678",  
  "description": "FIDO Alliance Sample UAF Authenticator",  
  "authenticatorVersion": 2,  
  "upv": [ { "major": 1, "minor": 0 }, { "major": 1, "minor": 1 } ],  
  "assertionScheme": "UAFV1TLV",  
  "authenticationAlgorithm": 1,  
  "publicKeyAlgAndEncoding": 256,  
  "attestationTypes": [15879],  
  "userVerificationDetails": [ [ { "userVerification": 2, "baDesc":  
    { "FAR": 0.00002, "maxRetries": 5, "blockSlowdown": 30, "maxReferenceDataSets": 5 } } ] ],  
  "keyProtection": 6,  
  "isKeyRestricted": true,  
  "matcherProtection": 2,  
  "attachmentHint": 1,  
  "isSecondFactorOnly": "false",  
  "tcDisplay": 5,  
  "tcDisplayContentType": "image/png",  
  "tcDisplayPNGCharacteristics": [ { "width": 320, "height": 480, "bitDepth": 16,  
    "colorType": 2, "compression": 0, "filter": "0", "interlace": 0 } ],  
  "attestationRootCertificates": [  
    "MIICPTCAeOgAnIBAGIJA0ueXvU3Oy2wMAoGCCqGSM49BAMCMHsxIDAeBgNVBAMM  
    F1NhbXBsZSBDbHRlc3Rhdlg0bWVibSb290MRyWfAYDQKDA1GSURPIEFsbGlhbml  
    MREwDwYDQQLDahVQUYgVFdHLEDSMBAGALUEBwwJUGFsbYBBbHRRvMQswCQYDQQI  
    DAJDQTElMAKGA1UEBhMCVVMwHhcNMTQwNjE4MzMyMzYwMTQwNjE4MzMyMzYwMT  
    WjB7MSAwHgYDVOQDDBdTbTbTbTbTbTbTbTbTbTbTbTbTbTbTbTbTbTbTbTbTbTb  
    RkLEtYBbBbGxpYw5jZTEpMA8GA1UECwwiVUFVGFJFRXRYwxEjAQBqNVBAcMVBhbG8g  
    QWx0b2ELMAKGA1UECwA0EzAjBgNVBAYTAU1VTMTkEwYwYwYwYwYwYwYwYwYwYw  
    zj0DAQcDQgAEH8hv2D0HXA59/BmpQ7RzehL/FMGzFdlQBq9vAUOpz3ajnuQ94PR7  
    aMzH33nUSBr8fHYDrqOBb58pxGgHJRYx/6NQME4wHQYDVR0OBByEFPoHA3CLhxFb  
    COIt7zE4w8hk5EJ/MB8GALUdIwQYMBAAFPoHA3CLhxFbCOIt7zE4w8hk5EJ/MaWg  
    ALUdEwQFMAMBAF8wCgYIKoZIzj0EAwIDSAAwRQIhAJ06QXSxT9ihIbEKYKIjsPkrI  
    vLlGtfsbDSu7ErJfzr4AiBqoYcZf0+zI55aQeAHjIzA9Xm63rruAXBz9ps9z2XN  
    lQ=="],  
  "icon": "data:image/png;base64,  
iVBORw0KGgoAAANSUHEUGAAAAE8AAAAvCAYAAACiwJfCAAAAAAXNSR0IArs4c6QAAAARnQUBAACx  
jvw8YQUAAAAAJcEnZcwAADsMAAA7DAcdvqQAAAahSURBVGHd7Zr5bxRlGMf9KzTB8AM/YEHE2W7p  
QzCWWKbclSpHAT1ELARE7kNECCA3FkWKOCKKSCFISkbcgVCDWGNESdAYidwgggJBiRiMhFc/4wy8  
884zu9NdlngTfZJP2n3no++88933fveBBx+PqCzJkTUVvBbLMPUDWvBTImpcCSzVxLdCdX9R05Sk19  
bb5atf599fg+/erA541q47aPlLLva9SIyVNUi8Ii8d5kGTsi30NFv7ai9n7QZPMwbdys2erU2XMq  
Udy8+ZcaNmGimE8yXN3RUD3a18nF0fUlovZ+0CtzWpd2Vj+e0mlbEyy6Dx4i5pUMGwveo506q227  
dtuWBiufr6wPv0FPNLhow1751Nm21LvPH3rVtWjFz66Lfgl8tX7FR19YFSXsmSseb9ceOGbYk7  
MNUCGPg8ZsbMe9rfQUaav/JMX9sqdzDCSvp0kZhmTz9x7bLhCMnThb16eJ+mvfQq8yaUZQNG64i  
XZ+0/kq6uoZF00tatzdWkfxnrQ99Bj91R5OIFnk54jN0mkUiqlO3XDW+Ml+98mKB6tW7rWpZcPc+  
0zq4tLrYlUc86E6eGdjTmubVpcusearfgIYGRk6brhZVr/JChzool7550jedLEXopWcApi2ZUghu  
7JLvrVsQU81zZkz0PeemMRyVvuQsX7PbiDQY5JvZonftK+1VY8H9utx530h0ob+jmRYqj6ouaYvEe  
nW/Wlyjpb8cwbM682tPwqW1R4tj/2SH13IRJYL4moZvXpiSqDr7dXtQHxa/PK3/+BWSK1dTgHu6V  
8tQJ3bwfKwPfrU0Q50s1r3levm8zZcql7+BBaw7K81EK5qzkYearK9A8p7P3GzDK+nd3DQow+6UC  
8SVN821uv38im7NtaXtVlCvq6Rgw4pkSmbdi3bu2De7YfaBBxcqfvqPrUfQNTQ221fdUVVT68rT  
JKF5DnSmUjgdqg4mSS9pmsfDJR3G6ToH0iW9aV7LWLHYXKL1TDt0LTAtkYIaamp1QjVv++uyGUxv  
dJ0DNVXSm+blqRxp184ddfX1Lp10/d69tsod0vs5hGre9xu8o+fpLR1cGhNTD6Z57C9KMWXefJd0  
Z94bb9oqd1RoNS7qITtZhimqivb03g0Ddvyk3WQBhZtK35YKND0nc803acS6FDZFGkaXLEJp5  
rdrlIBgp89eJcsm7Tvs0rkjGfn4b0kPoZn3UJUioRnz22yP1fmvUx+05gSqebVlm+zSuYnvHq7T  
WbdLiVvljplLlop6CLXP+2qtvgLlL/1vimISdMBgzSoFZyu6Tqd+jzXgsPaV9BCqee/NjYk6v6Lk  
9cwiuC/STtflHDpM3b592y7h3Thx5ozK69HlpYwUawaqS5cv26q7ceb8efVYArEpi3iF8zj1knsW
```

```
ZXHMMnCjY0Ogalo7UQfSCM3qQOr2H/XFP7ssXx45Y191ByeCep4moZoH+1fG3xD4tT7x8kwyj8nw
b9ev26V0B6d+7H4zKvudAH537FjgyzOHdJnHEuzmXq/WjxObvNMbv7nhywsX2aVsWtC8+48aLeap
E7p5wKzi0A2AQRV5nvR4E+uJc+b61kApqInxBgmd/4V5QP/mt18HDC7sRHfTmeu5lmhV0rn/ALX2
32bqd4BFnDx7VilcWS2uff0IbB47qexxmUj9QutYjupd3tYD6abWBBMrh+apNboKrnF1+ugCa4ri
XGfWMPptViavhU3YMOAAnuUb/R07L0yOSeOadE88ApsXFGff30ynhlJgM51CU6vN9EzgnpvHBFUy
iVraePiwJ53DF5ZTznomENg85kNud2oJi2Wpr4OmmkfN4x4zHfiVFc8Dv8NzuhNqOidilGvA6DGU
eZw078AAQn6ciEk6+rw5VcvjvqNDYPOoIUWaKShrxAuXLLkH4aYuGFMYDc10WF5Ta31hPJOfcUhr
U/J1INi6c6e1rYdBpo6++Yfjx61lGNfRm4MD5rJl3j3FoGhNjDSBNarYUgMLyMsZKpb7tXpoHfPs8
h3Wp1LzNfNk54XxClWDGUmYzXyefh6z/cKtVm4EBxa9VQGDzYr3LrUMRjHEKkk7zaFKYQA2hGQU1
z+85NFwPXDkz3vx10GqxQ6BzeNboBk5n8k4nebRh+klhWfxfTF0D1EyWU55nv+dgQqKaxzuCdEOi
sh102NQ8ah0mXr12La3m0f9wik9+wLNTMY/86MPo8yi310fxtM6PWogG9+DzUkYna56mSZt5WWSy
5qVAlrWUyJqXAlnzkaial/gHSD7RkTyihogAAAABJRU5ErkJggg=="
}
```

Example of an *User Verification Methods* entry for an authenticator with:

- Fingerprint based user verification method, with:
  - the ability for the user to enroll up to 5 fingers (reference data sets) with
    - a false acceptance rate of 1 in 50000 (0.002%) per finger. This results in a FAR of 0.01% (0.0001).
    - The fingerprint verification will be blocked after 5 unsuccessful attempts.
- A PIN code with a minimum length of 4 decimal digits has to be set-up as alternative verification method. Entering the PIN will be required to re-activate fingerprint based user verification after it has been blocked.

#### EXAMPLE 2: User Verification Methods Entry

```
[
  [ { "userVerification": 2, "baDesc": { "FAR": 0.00002, "maxReferenceDataSets": 5,
                                        "maxRetries": 5, "blockSlowdown": 0 } } ],
  [ { "userVerification": 4, "caDesc": { "base": 10, "minLength": 4 } } ]
]
```

## 5.2 U2F Example

Example of the metadata statement for an U2F authenticator with:

- authenticatorVersion 2.
- Touch based user presence check.
- Authenticator is a USB pluggable hardware token.
- The authentication keys are protected by a secure element.
- The user presence check is implemented in the chip.
- The Authenticator is a pure second factor authenticator.
- It supports the "U2FV1BIN" assertion scheme.
- It uses the [ALG\\_SIGN\\_SECP256R1\\_ECDSA\\_SHA256\\_RAW](#) authentication algorithm.
- It uses the [ALG\\_KEY\\_ECC\\_X962\\_RAW](#) public key format (0x100=256 decimal).
- It only implements the [TAG\\_ATTESTATION\\_BASIC\\_FULL](#) method (0x3E07=15879 decimal).
- It implements U2F protocol version 1.0 only.

#### EXAMPLE 3: MetadataStatement for U2F Authenticator

```
{ "description": "FIDO Alliance Sample U2F Authenticator",
  "attestationCertificateKeyIdentifiers": ["7c0903708b87115b0b422def3138c3c864e44573"],
  "protocolFamily": "u2f",
  "authenticatorVersion": 2,
  "upv": [ { "major": 1, "minor": 0 } ],
  "assertionScheme": "U2FV1BIN",
  "authenticationAlgorithm": 1,
  "publicKeyAlgAndEncoding": 256,
  "attestationTypes": [15879],
  "userVerificationDetails": [ [ { "userVerification": 1 } ] ],
  "keyProtection": 10,
  "matcherProtection": 4,
  "attachmentHint": 2,
  "isSecondFactorOnly": "true",
  "tcDisplay": 0,
  "attestationRootCertificates": [
    "MIICPTCCAeOgAwIBAgIJAOueXvU30y2wMAoGCCqGSM49BAMCMHsxIDAeBgNVBAMM
    F1NhbXBsZSBDbHRlc3RhdGlubiB5b290MRYwFAYDVQQKDA1GSURPIEFsbGhbmNl
    MREwDwYDVQQLEAhVQUYyVfVdHLEDSBAGAlUEBwwJUGFsbYBbbHRvMQswCQYDVQQI
    DAJDQTELMakGAlUEBhMCVVMwHhcNMTQwNjE4MTMzMzMyWWhcNDE4MTMzMzMy
    WjB7MSAwHgYDVQDDBdTYW1wbGUgQXR0ZXN0YXRpb24gUm9vdDEwMCQGA1UECgW
    Nrk1ETyBBBgxpYw5jZTERMA8GAlUECwwIVUFGIFRkRyYXNlZjAQBgNVBAMCVCBh
    bG8gQWx0bzZELMAkGAlUECAwCQ0ExCzAJBgNVBAYTA1VTMkFkEwYHKOZiZj0CAQYI
    KOZiZj0DAQCdQGAEH8v2D0HXa59/BmpQ7RZehL/FMGzFd1QBg9vAUUpOZ3ajnuQ94PR7
    aMzH33nUSBr8fHYDrqObb58pxGqHJRyX/6NQME4wHQYDVR0OBBYEFoHA3CLhxFb
    C0It7zE4w8hk5EJ/MB8GAlUdIwQYMBAAFPoHA3CLhxFbC0It7zE4w8hk5EJ/MawG
    AlUdEwQFMAMBAf8wCgYIKoZIzj0EAwIDSAAwRQIhAJ06QsXt9ihIbEKYKIjsPkri
    vdLIgtfsbdsu7ErJfzr4AiBqoYcZf0+zI55aQeAHjIzA9Xm63rruAxzBz9ps9z2XN
    lQ==" ],
}
```

## 6. Additional Considerations

This section is non-normative.

## 6.1 Field updates and metadata

Metadata statements are intended to be stable once they have been published. When authenticators are updated in the field, such updates are expected to improve the authenticator security (for example, improve FRR or FAR). The `authenticatorVersion` must be updated if firmware updates fixing severe security issues (e.g. as reported previously) are available.

### NOTE

The metadata statement is assumed to relate to all authenticators having the same AAID.

### NOTE

The FIDO Server is recommended to assume increased risk if the `authenticatorVersion` specified in the metadata statement is newer (higher) than the one present in the authenticator.

### NORMATIVE

Significant changes in authenticator functionality are not anticipated in firmware updates. For example, if an authenticator vendor wants to modify a PIN-based authenticator to use "Speaker Recognition" as a user verification method, the vendor **must** assign a new AAID to this authenticator.

### NORMATIVE

A single authenticator implementation could report itself as two "virtual" authenticators using different AAIDs. Such implementations **must** properly (i.e. according to the security characteristics claimed in the metadata) protect `UAuth` keys and other sensitive data from the other "virtual" authenticator - just as a normal authenticator would do.

### NOTE

Authentication keys (`UAuth.pub`) registered for one AAID cannot be used by authenticators reporting a different AAID - even when running on the same hardware (see section "Authentication Response Processing Rules for FIDO Server" in [UAFProtocol]).

## A. References

### A.1 Normative references

#### [ISO19795-1]

ISO/IEC JTC 1/SC 37, *Information Technology - Biometric performance testing and reporting - Part 1: Principles and framework*, URL: [http://www.iso.org/iso/catalogue\\_detail.htm?csnumber=41447](http://www.iso.org/iso/catalogue_detail.htm?csnumber=41447)

#### [ISO30107-1]

ISO/IEC JTC 1/SC 37, *Information Technology - Biometrics - Presentation attack detection - Part 1: Framework* URL: [http://www.iso.org/iso/catalogue\\_detail.htm?csnumber=53227](http://www.iso.org/iso/catalogue_detail.htm?csnumber=53227)

#### [RFC2049]

N. Freed, N. Borenstein, *Multipurpose Internet Mail Extensions (MIME) Part Five: Conformance Criteria and Examples (RFC 2049)*, IETF, November 1996, URL: <http://www.ietf.org/rfc/rfc2049.txt>

#### [RFC2119]

S. Bradner. *Key words for use in RFCs to Indicate Requirement Levels* March 1997. Best Current Practice. URL: <https://tools.ietf.org/html/rfc2119>

#### [RFC2397]

L. Masinter. *The "data" URL scheme* August 1998. Proposed Standard. URL: <https://tools.ietf.org/html/rfc2397>

#### [WebIDL-ED]

Cameron McCormack, *Web IDL*, W3C. Editor's Draft 13 November 2014. URL: <http://heycam.github.io/webidl/>

### A.2 Informative references

#### [AndroidUnlockPattern]

*Android Unlock Pattern Security Analysis*. Sinustrom.info web site. URL: <http://www.sinustrom.info/2012/05/21/android-unlock-pattern-security-analysis/>

#### [ECMA-262]

*ECMAScript Language Specification*. URL: <https://tc39.github.io/ecma262/>

#### [FIDOEcdaaAlgorithm]

R. Lindemann, J. Camenisch, M. Drijvers, A. Edgington, A. Lehmann, R. Urian, *FIDO ECDAA Algorithm*. FIDO Alliance Implementation Draft. URLs:

HTML: <fido-ecdaa-v1.1-id-20170202.html>

PDF: <fido-ecdaa-v1.1-id-20170202.pdf>

#### [FIDOGlossary]

R. Lindemann, D. Baghdasaryan, B. Hill, J. Hodges, *FIDO Technical Glossary*. FIDO Alliance Implementation Draft. URLs:

HTML: [fido-glossary-v1.1-id-20170202.pdf](#)

**[FIDOKeyAttestation]**

*FIDO 2.0: Key attestation format* URL: <https://fidoalliance.org/specs/fido-v2.0-ps-20150904/fido-key-attestation-v2.0-ps-20150904.html>

**[FIDOMetadataService]**

R. Lindemann, B. Hill, D. Baghdasaryan, *FIDO Metadata Service v1.0* FIDO Alliance Implementation Draft. URLs:

HTML: [fido-metadata-service-v1.1-id-20170202.pdf](#)

**[FIDORegistry]**

R. Lindemann, D. Baghdasaryan, B. Hill, *FIDO Registry of Predefined Values* FIDO Alliance Implementation Draft. URLs:

HTML: [fido-registry-v1.1-id-20170202.pdf](#)

**[ITU-X690-2008]**

*X.690: Information technology - ASN.1 encoding rules: Specification of Basic Encoding Rules (BER), Canonical Encoding Rules (CER) and Distinguished Encoding Rules (DER), (T-REC-X.690-200811)*. International Telecommunications Union, November 2008 URL: <http://www.itu.int/rec/T-REC-X.690-200811-1/en>

**[MoreTopWorstPasswords]**

*10000 Top Passwords*, Mark Burnett (Accessed July 11, 2014) URL: <https://xato.net/passwords/more-top-worst-passwords/>

**[PNG]**

Tom Lane. *Portable Network Graphics (PNG) Specification (Second Edition)*. 10 November 2003. W3C Recommendation. URL: <https://www.w3.org/TR/PNG/>

**[RFC4648]**

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