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JSON Proof Algorithms
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Abstract

The JSON Proof Algorithms (JPA) specification registers cryptographic algorithms and identifiers to be used with the JSON Web Proof, JSON Web Key (JWK), and COSE specifications. It defines IANA registries for these identifiers.

Status of This Memo

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

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This Internet-Draft will expire on 23 April 2026.

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1. Introduction

The JSON Web Proof (JWP) [I-D.ietf-jose-json-web-proof] draft establishes a new secure container format that supports selective disclosure and unlinkability using Zero-Knowledge Proofs (ZKPs) or other cryptographic algorithms.

| Editor's Note: This draft is still early and incomplete. There will be significant changes to the algorithms as currently defined here. Please do not use any of these definitions or examples for anything except personal experimentation and learning. Contributions and feedback are welcomed at https://github.com/ietf-wg-jose/json-web-proof (https://github.com/ietf-wg-jose/json-web-proof).

2. Conventions and Definitions

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.

The roles of "issuer", "holder", and "verifier" are used as defined by the VC Data Model [VC-DATA-MODEL-2.0]. The term "presentation" is also used as defined by this source, but the term "credential" is avoided in this specification to minimize confusion with other definitions.

3. Terminology

The terms "JSON Web Signature (JWS)", "Base64url Encoding", "Header Parameter", "JOSE Header", "JWS Payload", "JWS Signature", and "JWS Protected Header" are defined by [RFC7515].

The terms "JSON Web Proof (JWP)", "JWP Payload", "JWP Proof", and "JWP Header" are defined by [I-D.ietf-jose-json-web-proof].

These terms are defined by this specification:

Stable Key: An asymmetric key-pair used by an issuer that is also shared via an out-of-band mechanism to a verifier to validate the signature.

Issuer Ephemeral Key: An asymmetric key-pair that is generated for one-time use by an issuer and never stored or used again outside of the creation of a single JWP.

Holder Presentation Key: An asymmetric key-pair that is generated by a holder and used to ensure that a presentation is not able to be replayed by any other party.

4. Background

JWP defines a container binding together a Header, one or more payloads, and a cryptographic proof. It does not define any details about the interactions between an application and the cryptographic libraries that implement proof-supporting algorithms.

Due to the nature of ZKPs, this specification also documents the subtle but important differences in proof algorithms versus those defined by the JSON Web Algorithms [RFC7518]. These differences help support more advanced capabilities such as blinded signatures and predicate proofs.

5. Algorithm Basics

The four principal interactions that every proof algorithm MUST support are issue (#issue), confirm (#confirm), present (#present), and verify (#verify).

5.1. Issue

The JWP is first created as the output of a JPA’s issue operation.

Every algorithm MUST support a JSON issuer Header along with one or more octet string payloads. The algorithm MAY support using additional items provided by the holder for issuance such as blinded payloads, keys for replay prevention, etc.

All algorithms MUST provide integrity protection for the Issuer Header and all payloads and MUST specify all digest and/or hash2curve methods used.

5.2. Confirm

Performed by the holder to validate that the issued JWP is correctly formed and protected.

Each algorithm MAY support using additional input items options, such as those sent to the issuer for issuance. After confirmation, an algorithm MAY return a modified JWP for serialized storage without the local state (such as with blinded payloads now unblinded).

The algorithm MUST fully verify the issued proof value against the Issuer Header and all payloads. If given a presented JWP instead of an issued one, the confirm process MUST return an error.

5.3. Present

Used to apply any selective disclosure choices and perform any unlinkability transformations, as well as to show binding.

An algorithm MAY support additional input options from the requesting party, such as for predicate proofs and verifiable computation requests.

Every algorithm MUST support the ability to hide any or all payloads. It MUST always include the Issuer Header unmodified in the presentation.

The algorithm MUST replace the issued proof value and generate a new presented proof value. It also MUST include a new Presentation Header that provides replay protection.

5.4. Verify

Performed by the verifier to verify the Headers along with any disclosed payloads and/or assertions about them from the proving party, while also verifying they are the same payloads and ordering as witnessed by the issuer.

The algorithm MUST verify the integrity of all disclosed payloads and MUST also verify the integrity of both the Issuer and Presentation Headers.

If the presented proof contains any assertions about the hidden payloads, the algorithm MUST also verify all of those assertions. It MAY support additional options, such as those sent to the holder to generate the presentation.

If given an issued JWP for verification, the algorithm MUST return an error.

6. Algorithm Specifications

This section defines how to use specific algorithms for JWPs.

6.1. Single Use

The Single Use (SU) algorithm is based on composing multiple traditional asymmetric signatures into a single JWP proof. It enables a very simple form of selective disclosure without requiring any advanced cryptographic techniques.

It does not support unlinkability if the same JWP is presented multiple times, therefore when privacy is required the holder will need to interact with the issuer again to receive new single-use JWPs (dynamically or in batches).

6.1.1. JWS Algorithm

The Single Use algorithm uses multiple signing keys to protect the Header as well as individual payloads of an Issued JWP. The issuer uses a stable public key to sign each Header, and a per-JWP ephemeral key (conveyed within the Header) to protect the individual payloads. These signatures are all created using the same Asymmetric Algorithm, with the JOSE and COSE name/label of this algorithm being part of registration for a fully-specified Single Use algorithm identifier.

The Issuer Header also conveys a holder presentation key, an ephemeral asymmetric key meant to only be used for presenting a single JWP. The fully-specified algorithm the holder must use for presentations is also included. This algorithm MAY be different from the algorithm used by the issuer.

The chosen algorithms MUST be asymmetric signing algorithms, so that each signature can be verified without sharing any private values between the parties.

6.1.2. Holder Setup

In order to support the protection of a presentation by a holder to a verifier, the holder MUST use a Holder Presentation Key during the issuance and the presentation of every Single Use JWP. This Holder Presentation Key MUST be generated and used for only one JWP if unlinkability is desired.

The issuer MUST verify that the holder has possession of this key. The holder-issuer communication to exchange this information is out of scope of this specification, but can be accomplished by the holder using this key to generate a JWS that signs a value the issuer can verify as unique.

The issuer MUST determine an appropriate holder presentation algorithm corresponding to the holder presentation key. If the holder and verifier cannot be assumed to know this algorithm is the appropriate choice for a given holder presentation key, this value MUST be conveyed in the hpa Issuer Header.

6.1.3. Issuer Setup

To create a Single Use JWP, the issuer first generates a unique Ephemeral Key using the selected internal algorithm. This key-pair will be used to sign each of the payloads of a single JWP and then discarded.

6.1.4. Signing Payloads

Each individual payload is signed using the selected internal algorithm using the Ephemeral Key.

6.1.5. Issuer Header

The Issuer’s Ephemeral Key MUST be included via the Issuer Ephemeral Key Header Parameter.

The Holder’s Presentation Key MUST be included via the Holder Presentation Key Header Parameter.

The Holder’s Presentation Algorithm MUST be included via the Holder Presentation Algorithm Header Parameter unless there is another way for the holder and verifier to unambiguously determine the appropriate algorithm to use.

The Issuer Header is signed using the appropriate internal signing algorithm for the given fully-specified single use algorithm, using the issuer’s Stable Key.

6.1.6. Payloads

Each JWP payload is processed in order and signed using the given JWA using the issuer’s Ephemeral Key.

6.1.7. Proof

The proof value is an octet string array. The first entry is the octet string of the Issuer Header signature, with an additional entry for each payload signature.

6.1.8. Presentation Header #{presentation-protected-header}

To generate a new presentation, the holder first creates a Presentation Header that is specific to the verifier being presented to. This Header MUST contain a parameter that both the holder and verifier trust as being unique and non-replayable. Use of the nonce Header Parameter is RECOMMENDED for this purpose.

This specification registers the nonce Header Parameter for the Presentation Header that contains a string value either generated by the verifier or derived from values provided by the verifier. When present, the verifier MUST ensure the nonce value matches during verification.

The Presentation Header MAY contain other Header Parameters that are either provided by the verifier or by the holder. These Presentation Header Parameters SHOULD NOT contain values that are common across multiple presentations and SHOULD be unique to a single presentation and verifier.

The Presentation Header MUST contain the same Algorithm protected header as the Issuer Header. The Holder Presentation Algorithm Header Parameter MUST NOT be included.

6.1.9. Presentation

The holder derives a new proof as part of presentation. The holder will also use these components to generate a presentation internal representation (#presentation-internal-representation). The number of components depends on the number of payloads which are being disclosed in the presented JWP.

The first proof component will be the signature over the Issuer Header made by the issuer’s Stable Key.

For each payload which is to be disclosed, the corresponding payload signature (from the issued JWP) is included as a subsequent proof component. If the payload is being omitted, the corresponding payload signature is omitted from the proof components.

The Presentation Header, Issuer Header, payload slots (distinguishing which are being disclosed) and these proof components are inputs to determine the presentation internal representation.

The holder’s signature over the presentation internal representation (using the holder’s private key and the holder presentation algorithm) is then included as one additional proof component in the final presentation.

For example, if only the second and fifth of five payloads are being disclosed, then the proof at this stage will consist of three values:

1. The issuer’s signature over the Issuer Header
2. The payload signature corresponding to the second payload
3. The payload signature corresponding to the fifth payload.

The presentation internal representation would be calculated with these three proof components, while the final presentation would have an additional fourth component containing the signature using the holder’s private key.

Since the individual signatures in the proof value are unique and remain unchanged across multiple presentations, a Single Use JWP SHOULD only be presented a single time to each verifier in order for the holder to remain unlinkable across multiple presentations.

6.1.10. Verification of Presentation

Verification is performed using the following steps.

1. Check that the number of proof components is appropriate for the number of disclosed payloads. There MUST be two more proof components than disclosed payloads.
2. Verify the first proof component is a valid signature over Issuer Header octets, using the issuer’s stable key.
3. Extract the holder presentation key and holder presentation algorithm (if present) from the Issuer Header.
4. Omitting the final payload component, calculate the presentation internal representation (#presentation-internal-representation).
5. Verify the final proof component is a valid signature over the presentation internal binary form, using the holder’s presentation key and the extracted (or otherwise determined) holder presentation algorithm.
6. For each remaining proof component, verify they form a valid signature over each disclosed payload in sequence, using the issuer’s ephemeral key.

6.1.11. JPA Registration

The proposed JWP alg value is of the format "SU-" appended with the relevant JWS alg value for the chosen public and ephemeral key-pair algorithm, for example "SU-ES256".

6.2. Presentation Internal Representation

Some algorithms (such as Single use and MAC) use a holder key to provide integrity over the presentation. For these algorithms, an internal binary form of the presentation must be generated both for signing by the holder, and for verification by the verifier. Other algorithms MAY use this same form for consistency.

The instructions for creating this binary representation will also create well-formed CBOR, although this data is not meant to be shared outside the implementing algorithm. Instead, it focuses on simplicity of generation by the holder and verifier implementations. Although CBOR has multiple representations of the same underlying information, this same octet string MUST be generated by an implementation.

When a length or count is added by the steps below, it is added as its 8-byte, network-ordered representation. For example, the length of a 1,234 byte payload would have a length representation of 0x00 00 00 00 00 00 04 D2.

The binary representation is created by appending data into a single octet string in the following order:

1. 0x84 5B

2. The length and octets of the Presentation Header

3. 0x5B

4. The length and octets of the Issuer Header

5. 0x9B

6. The number of payload slots in the issued message

7. For each payload representation:

   * If the payload is being omitted, the value 0xF6

   * Otherwise:

     1. 0x5B
     2. The length and octets of the payload

8. 0x9B

9. The number of proof components as specified by the algorithm

10. For each proof component, append:

    1. 0x5B
    2. The length and octets of the proof component

6.3. BBS

The BBS Signature Scheme [I-D.irtf-cfrg-bbs-signatures] is under active development within the CRFG.

This algorithm supports both selective disclosure and unlinkability, enabling the holder to generate multiple presentations from one issued JWP without a verifier being able to correlate those presentations together based on the proof.

6.3.1. JPA Algorithms

The BBS algorithm corresponds to a cipher suite identifier of BBS_BLS12381G1_XMD:SHA-256_SSWU_RO_.

6.3.2. Key Format

The key used for the BBS algorithm is an elliptic curve-based key pair, specifically against the G_2 subgroup of a pairing friendly curve. Additional details on key generation can be found in Section 3.4. The JWK and Cose Key Object representations of the key are detailed in [I-D.ietf-cose-bls-key-representations].

There is no additional holder presentation key necessary for presentation proofs.

6.3.3. Issuance

Issuance is performed using the Sign operation from Section 3.5.1 of [I-D.irtf-cfrg-bbs-signatures]. This operation utilizes the issuer’s BLS12-381 G2 key pair as SK and PK, along with desired Header octets as header, and the array of payload octet string as messages.

The octets resulting from this operation form a single octet string in the issuance proof array, to be used along with the Header and payloads to serialize the JWP.

6.3.4. Issuance Proof Verification

Holder verification of the signature on issuance form is performed using the Verify operation from [@!I-D.irtf-cfrg-bbs-signatures, section 3.5.2].

This operation utilizes the issuer’s public key as PK, the proof as signature, the Header octets as header and the array of payload octets as messages.

6.3.5. Presentation

Derivation of a presentation is done by the holder using the ProofGen operation from Section 3.5.3 of [I-D.irtf-cfrg-bbs-signatures].

This operation utilizes the issuer’s public key as PK, the Issuer Header as header, the issuance proof as signature, the issuance payloads as messages, and the holder’s Presentation Header as ph.

The operation also takes a vector of indexes into messages, describing which payloads the holder wishes to disclose. All payloads are required for proof generation, but only these indicated payloads will be required to be disclosed for later proof verification.

The output of this operation is the presentation proof, as a single octet string.

Presentation serialization leverages the two Headers and presentation proof, along with the disclosed payloads. Non-disclosed payloads are represented with the absent value of null in CBOR serialization and a zero-length string in compact serialization.

6.3.6. Presentation Verification

Verification of a presentation is done by the verifier using the ProofVerify operation from [@!I-D.irtf-cfrg-bbs-signatures, Section 3.5.4].

This operation utilizes the issuer’s public key as PK, the Issuer Header as header, the issuance proof as signature, the holder’s Presentation Header as ph, and the payloads as disclosed_messages.

In addition, the disclosed_indexes scalar array is calculated from the payloads provided. Values disclosed in the presented payloads have a zero-based index in this array, while the indices of absent payloads are omitted.

6.4. Message Authentication Code

The Message Authentication Code (MAC) JPA uses a MAC to both generate ephemeral secrets and to authenticate payloads, along with an asymmetric signature to provide integrity to the issued JWP.

The holder can manipulate which payloads are disclosed from the issued JWP, and uses the Holder Presentation Key to create a presentation. The signature created from the Holder Presentation Key MAY use a different algorithm than the Issuer used to sign the issued form.

Like the Single Use algorithm family, it also does not support unlinkability if the same JWP is presented multiple times and requires an individually issued JWP for each presentation in order to fully protect privacy. When compared to the JWS approach, using a MAC requires less computation but can result in potentially larger presentation proof values.

The design is intentionally minimal and only involves using a single standardized MAC method instead of a mix of MAC/hash methods or a custom hash-based construct. It is able to use any published cryptographic MAC method such as HMAC [RFC2104] or KMAC (https://nvlpubs.nist.gov/nistpubs/SpecialPublications/NIST.SP.800-185.pdf). It uses traditional public key-based signatures to verify the authenticity of the issuer and holder.

6.4.1. Holder Setup

In order to support the protection of a presentation by a holder to a verifier, the holder MUST use a Holder Presentation Key during the issuance and the presentation of every MAC JWP. This Holder Presentation Key MUST be generated and used for only one JWP if unlinkability is desired.

The issuer MUST verify that the holder has possession of this key. The holder-issuer communication to exchange this information is out of scope of this specification, but can be accomplished by the holder using this key to generate a JWS that signs a value the issuer can verify as unique.

The holder’s presentation key MUST be included in the Issuer Header using the Holder Presentation Key Header Parameter.

The issuer MUST determine an appropriate holder presentation algorithm corresponding to the holder presentation key. If the holder and verifier cannot be assumed to know this algorithm is the appropriate choice for a given holder presentation key, this value MUST be conveyed in the Holder Protected Algorithm Header Parameter.

6.4.2. Issuer Setup

To use the MAC algorithm, the issuer must have a stable public key pair to perform signing. To start the issuance process, a single 32-byte random Shared Secret must first be generated. This value will be shared privately with the holder as part of the issuer’s JWP proof value.

The Shared Secret is used by both the issuer and holder as the MAC method’s key to generate a new set of unique ephemeral keys. These keys are then used as the input to generate a MAC that protects each payload.

6.4.3. Combined MAC Representation

The combined MAC representation is a single octet string representing the MAC values of the Issuer Header, along with each payload provided by the issuer. This representation is signed by the issuer, but not shared - parties will recreate this octet string and verify the signature to verify the integrity of supplied Issuer Header and the integrity of any disclosed payloads.

The steps below describe a sequential concatenation of binary values to generate the Combined MAC Representation. The instructions for generating this octet string will also generate well-formed CBOR, although this data is not meant to be shared outside the implementing algorithm. Instead, it focuses on simplicity of generation by the issuer, holder, and verifier implementations. Although CBOR has multiple representations of the same underlying information, this same octet string MUST be generated by an implementation.

When a length or count is added by steps in this section, it is added as its 8-byte, network-ordered representation. For example, the length of a 1,234-byte payload would have a length representation of 0x00 00 00 00 00 00 04 D2.

The holder will a unique key per payload value using a MAC, with the Shared Secret as the key and a generated binary value. This binary value is constructed by appending data into a single octet string:

1. 0x82 67 70 61 79 6C 6F 61 64 1B
2. The zero indexed count of the payload slot

The holder will also compute a corresponding MAC of each payload. This MAC uses the unique key above and the payload octet string as the value.

When verifying a presentation, the shared secret will be unavailable so the unique key cannot be calculated. The payload octet string may also be omitted in the presentation. The following instructions describe how to get the corresponding MAC of each payload:

* If the payload is disclosed, the corresponding proof component (as described in MAC Presentation Proof (#mac-presentation-proof)) will contain the generated unique key. The payload MAC will be calculated using this key and the payload octets as the value.
* If the payload is not disclosed, the corresponding proof component will be the payload MAC.

The binary representation is created by appending data into a single octet string in the following order:

1. 0x82 5B
2. The length and octets of the Issuer Header
3. 0x9B
4. The number of payload slots in the issued JWP
5. For each payload representation:
    1. 0x5B
    2. The length and value of the per payload MAC

6.4.4. Issuer Header

The Holder’s Presentation Key MUST be included via the Holder Presentation Key Header Parameter.

The Holder’s Presentation Algorithm MUST be included via the Holder Presentation Algorithm Header Parameter unless there is another way for the holder and verifier to unambiguously determine the appropriate algorithm to use.

6.4.5. Issuer Proof

The issuer proof consists of two octet strings.

The first octet string is the issuer signature over the combined MAC representation. The issuer signs the combined MAC representation using its stable public key, and the internal signing algorithm for the given fully-specified MAC algorithm variant.

The second octet string is the Shared Secret used to generate the per-payload keys for the combined representation.

6.4.6. Presentation Header

See the Presentation Header (#presentation-protected-header) section given for Single Use algorithms.

6.4.7. Presentation Proof

The presentation proof is made of multiple components.

The first proof component is the issuer signature over the Combined MAC Representation, which is provided as the first proof component from the issued form.

There will now be one proof component per payload slot in the issued JWP. These are used by the verifier to reconstruct the combined MAC representation without access to the Shared Secret. The proof components are calculated per the instructions used to generate the Combined MAC Representation (#combined-mac-representation)

If a payload is disclosed, the corresponding proof component will be the unique key.

If a payload is not disclosed, the corresponding proof component will be the payload’s MAC (using the unique key.)

The Presentation Header, Issuer Header, payload slots (distinguishing which are being disclosed) and above proof components are inputs to determine the presentation internal representation (#presentation-internal-representation).

The holder’s signature over the presentation internal representation (using the holder’s private key and the holder presentation algorithm) is then included as one additional proof component in the final presentation.

The presented form should have two more proof components than payload slots in the issued JWP.

Note that the second component of the issued JWP is a shared secret for use by the holder to generate the unique keys used in the Combined MAC Representation. This MUST NOT be included in the presentation.

6.4.8. Verification of the Presentation Proof

Verification is performed using the following steps.

1. Check the number of proof components is appropriate for the number of disclosed payloads. There MUST be two more proof components than disclosed payloads.
2. Using the fully-specified MAC algorithm in use, use the Issuer Header, disclosed payloads, and the proof components corresponding to the payloads to regenerate the Combined MAC Representation.
3. Verify the first proof component is a valid signature over the Issuer Header octets, using the issuer’s stable key.
4. Extract the holder presentation key and holder presentation algorithm (if present) from the Issuer Header.
5. Omitting the final payload component, calculate the presentation internal representation (#presentation-internal-representation).
6. Verify the final proof component is a valid signature over the presentation internal binary form, using the holder’s presentation key and the extracted (or otherwise determined) holder presentation algorithm.

6.4.9. JPA Registration

Proposed JWP alg value is of the format "MAC-" appended with a unique identifier for the set of MAC and signing algorithms used. Below are the initial registrations:

* MAC-H256 uses HMAC SHA-256 as the MAC and ECDSA using P-256 and SHA-256 for the signatures
* MAC-H384 uses HMAC SHA-384 as the MAC and ECDSA using P-384 and SHA-384 for the signatures
* MAC-H512 uses HMAC SHA-512 as the MAC and ECDSA using P-521 and SHA-512 for the signatures
* MAC-K25519 uses KMAC SHAKE128 as the MAC and EdDSA using Curve25519 for the signatures
* MAC-K448 uses KMAC SHAKE256 as the MAC and EdDSA using Curve448 for the signatures
* MAC-H256K uses HMAC SHA-256 as the MAC and ECDSA using secp256k1 and SHA-256 for the signatures

7. Security Considerations

| Editor’s Note: This will follow once the algorithms defined here
| have become more stable.

* Data minimization of the proof value
* Unlinkability of the Header contents

8. IANA Considerations

The following registration procedure is used for all the registries established by this specification.

Values are registered on a Specification Required [RFC5226] basis after a three-week review period on the jose-reg-review@ietf.org (mailto:jose-reg-review@ietf.org) mailing list, on the advice of one or more Designated Experts. However, to allow for the allocation of values prior to publication, the Designated Experts may approve registration once they are satisfied that such a specification will be published.

Registration requests sent to the mailing list for review should use an appropriate subject (e.g., "Request to register JWP algorithm: example").

Within the review period, the Designated Experts will either approve or deny the registration request, communicating this decision to the review list and IANA. Denials should include an explanation and, if applicable, suggestions as to how to make the request successful.

Registration requests that are undetermined for a period longer than 21 days can be brought to the IESG's attention (using the iesg@ietf.org (mailto:iesg@ietf.org) mailing list) for resolution.

Criteria that should be applied by the Designated Experts include determining whether the proposed registration duplicates existing functionality, whether it is likely to be of general applicability or useful only for a single application, and whether the registration description is clear.

IANA must only accept registry updates from the Designated Experts and should direct all requests for registration to the review mailing list.

It is suggested that multiple Designated Experts be appointed who are able to represent the perspectives of different applications using this specification, in order to enable broadly informed review of registration decisions. In cases where a registration decision could be perceived as creating a conflict of interest for a particular Expert, that Expert should defer to the judgment of the other Experts.

8.1. JSON Web Proof Algorithms Registry

This specification establishes the IANA "JSON Web Proof Algorithms" registry for values of the JWP alg (algorithm) parameter in Header Parameters. The registry records the algorithm name, the algorithm description, the algorithm usage locations, the implementation requirements, the change controller, and a reference to the specification that defines it. The same algorithm name can be registered multiple times, provided that the sets of usage locations are disjoint.

It is suggested that the length of the key be included in the algorithm name when multiple variations of algorithms are being registered that use keys of different lengths and the key lengths for each need to be fixed (for instance, because they will be created by key derivation functions). This allows readers of the JSON text to more easily make security decisions.

The Designated Experts should perform reasonable due diligence that algorithms being registered either are currently considered cryptographically credible or are being registered as Deprecated or Prohibited.

The implementation requirements of an algorithm may be changed over time as the cryptographic landscape evolves, for instance, to change the status of an algorithm to Deprecated or to change the status of

an algorithm from Optional to Recommended+ or Required. Changes of implementation requirements are only permitted on a Specification Required basis after review by the Designated Experts, with the new specification defining the revised implementation requirements level.

8.1.1. Registration Template

- Algorithm Name: Brief descriptive name of the algorithm (e.g., Single-Use JWP using ES256.) Descriptive names may not match other registered names unless the Designated Experts state that there is a compelling reason to allow an exception.
- Algorithm JSON Label: The string label requested (e.g., SU-ES256). This label is a case-sensitive ASCII string. JSON Labels may not match other registered labels in a case-insensitive manner unless the Designated Experts state that there is a compelling reason to allow an exception.
- Algorithm CBOR Label: The integer label requested (e.g., 1). CBOR Labels may not match other registered labels unless the Designated Experts state that there is a compelling reason to allow an exception.
- Algorithm Description: Optional additional information clarifying the algorithm. This may be used for example to document additional chosen parameters.
- Algorithm Usage Location(s): The algorithm usage locations, which should be one or more of the values Issued or Presented. Other values may be used with the approval of a Designated Expert.
- JWP Implementation Requirements: The algorithm implementation requirements for JWP, which must be one of the words Required, Recommended, Optional, Deprecated, or Prohibited. Optionally, the word can be followed by a + or -. The use of + indicates that the requirement strength is likely to be increased in a future version of the specification. The use of - indicates that the requirement strength is likely to be decreased in a future version of the specification. Any identifiers registered for algorithms that are otherwise unsuitable for direct use as JWP algorithms must be registered as Prohibited.
- Change Controller: For Standards Track RFCs, list the "IETF". For others, give the name of the responsible party. Other details (e.g., postal address, email address, home page URI) may also be included.
- Specification Document(s): Reference to the document or documents that specify the parameter, preferably including URIs that can be used to retrieve copies of the documents. An indication of the relevant sections may also be included but is not required.
- Algorithm Analysis Documents(s): References to a publication or publications in well-known cryptographic conferences, by national standards bodies, or by other authoritative sources analyzing the cryptographic soundness of the algorithm to be registered. The

Designated Experts may require convincing evidence of the cryptographic soundness of a new algorithm to be provided with the registration request unless the algorithm is being registered as Deprecated or Prohibited. Having gone through working group and IETF review, the initial registrations made by this document are exempt from the need to provide this information.

8.1.2. Initial Registry Contents

8.1.2.1. Single-Use JWP using ES256 Algorithm

* Algorithm Name: Single-Use JWP using ES256
* Algorithm JSON Label: SU-ES256
* Algorithm CBOR Label: 1
* Algorithm Usage Location(s): Issued, Presented
* JWP Implementation Requirements: Recommended
* Change Controller: IETF
* Specification Document(s): Section 6.1.11 of this specification
* Algorithm Analysis Documents(s): n/a

8.1.2.2. Single-Use JWP using ES384 Algorithm

* Algorithm Name: Single-Use JWP using ES384
* Algorithm JSON Label: SU-ES384
* Algorithm CBOR Label: 2
* Algorithm Usage Location(s): Issued, Presented
* JWP Implementation Requirements: Optional
* Change Controller: IETF
* Specification Document(s): Section 6.1.11 of this specification
* Algorithm Analysis Documents(s): n/a

8.1.2.3. Single-Use JWP using ES512 Algorithm

* Algorithm Name: Single-Use JWP using ES512
* Algorithm JSON Label: SU-ES512
* Algorithm CBOR Label: 3
* Algorithm Usage Location(s): Issued, Presented
* JWP Implementation Requirements: Optional
* Change Controller: IETF
* Specification Document(s): Section 6.1.11 of this specification
* Algorithm Analysis Documents(s): n/a

8.1.2.4. BBS using SHA-256 Algorithm

* Algorithm Name: BBS using SHA-256
* Algorithm JSON Label: BBS
* Algorithm CBOR Label: 4

* Algorithm Description: Corresponds to a cipher suite identifier of BBS_BLS12381G1_XMD:SHA-256_SSWU_RO_H2G_HM2S_
* Algorithm Usage Location(s): Issued, Presented
* JWP Implementation Requirements: Required
* Change Controller: IETF
* Specification Document(s): Section 6.3.1 of this specification
* Algorithm Analysis Documents(s): n/a

8.1.2.5. MAC-H256 Algorithm

* Algorithm Name: MAC-H256
* Algorithm JSON Label: MAC-H256
* Algorithm CBOR Label: 5
* Algorithm Description: MAC-H256 uses HMAC SHA-256 as the MAC, and ECDSA using P-256 and SHA-256 for the signatures
* Algorithm Usage Location(s): Issued, Presented
* JWP Implementation Requirements: Optional
* Change Controller: IETF
* Specification Document(s): Section 6.4.9 of this specification
* Algorithm Analysis Documents(s): n/a

8.1.2.6. MAC-H384 Algorithm

* Algorithm Name: MAC-H384
* Algorithm JSON Label: MAC-H384
* Algorithm CBOR Label: 6
* Algorithm Description: MAC-H384 uses HMAC SHA-384 as the MAC, and ECDSA using P-384 and SHA-384 for the signatures
* Algorithm Usage Location(s): Issued, Presented
* JWP Implementation Requirements: Optional
* Change Controller: IETF
* Specification Document(s): Section 6.4.9 of this specification
* Algorithm Analysis Documents(s): n/a

8.1.2.7. MAC-H512 Algorithm

* Algorithm Name: MAC-H512
* Algorithm JSON Label: MAC-H512
* Algorithm CBOR Label: 7
* Algorithm Description: MAC-H512 uses HMAC SHA-512 as the MAC, and ECDSA using P-521 and SHA-512 for the signatures
* Algorithm Usage Location(s): Issued, Presented
* JWP Implementation Requirements: Optional
* Change Controller: IETF
* Specification Document(s): Section 6.4.9 of this specification
* Algorithm Analysis Documents(s): n/a

8.1.2.8. MAC-K25519 Algorithm

- Algorithm Name: MAC-K25519
- Algorithm JSON Label: MAC-K25519
- Algorithm CBOR Label: 8
- Algorithm Description: MAC-K25519 uses KMAC SHAKE128 as the MAC, and EdDSA using Curve25519 for the signatures
- Algorithm Usage Location(s): Issued, Presented
- JWP Implementation Requirements: Optional
- Change Controller: IETF
- Specification Document(s): Section 6.4.9 of this specification
- Algorithm Analysis Documents(s): n/a

8.1.2.9. MAC-K448 Algorithm

- Algorithm Name: MAC-K448
- Algorithm JSON Label: MAC-K448
- Algorithm CBOR Label: 9
- Algorithm Description: MAC-K448 uses KMAC SHAKE256 as the MAC, and EdDSA using Curve448 for the signatures
- Algorithm Usage Location(s): Issued, Presented
- JWP Implementation Requirements: Optional
- Change Controller: IETF
- Specification Document(s): Section 6.4.9 of this specification
- Algorithm Analysis Documents(s): n/a

8.1.2.10. MAC-H256K Algorithm

- Algorithm Name: MAC-H256K
- Algorithm JSON Label: MAC-H256K
- Algorithm CBOR Label: 10
- Algorithm Description: MAC-H256K uses HMAC SHA-256 as the MAC, and ECDSA using secp256k1 and SHA-256 for the signatures
- Algorithm Usage Location(s): Issued, Presented
- JWP Implementation Requirements: Optional
- Change Controller: IETF
- Specification Document(s): Section 6.4.9 of this specification
- Algorithm Analysis Documents(s): n/a

9. References

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Appendix A. Example JWPs

The following examples use algorithms defined in JSON Proof Algorithms and also contain the keys used, so that implementations can validate these samples.

A.1. Example JSON-Serialized Single-Use JWP

This example uses the Single-Use Algorithm as defined in JSON Proof Algorithms to create a JSON Proof Token. It demonstrates how to apply selective disclosure using an array of traditional JWS-based signatures. Unlinkability is only achieved by using each JWP one time, as multiple uses are inherently linkable via the traditional ECDSA signature embedded in the proof.

To begin, we need two asymmetric keys for Single Use: one that represents the JPT Issuer’s stable key and the other is an ephemeral key generated by the Issuer just for this JWP.

This is the Issuer’s stable private key used in this example in the JWK format:

```
{
  "kty": "EC",
  "crv": "P-256",
  "x": "xw1VbXzkXXz5NTlVd5p_CTh6OpFFDuVS3pZXSHJRiAU",
  "y": "nYOtgIELw15Hgrdxz06L_eRoMSFQZ_gLadZwkcCrvT0",
  "d": "l8QSf6TTCnlj8QWp66MK0fd2LeP7KwcOCwf4dGWF6Q8"
}
```

Figure 1: Issuer Private Key (ES256 in JWK)

This is the ephemeral private key used in this example in the JWK format:

```
{
  "kty": "EC",
  "crv": "P-256",
  "x": "EYVvzBgbqbwM9oE0JTD9fR-giO4jzzTMS0wo88EMj5E",
  "y": "nIXC4hTLWgOEtkyxkcE36YZKZ0bay-g2dJLU0ZTwFm4",
  "d": "xuCP2FCUmbVvzid6Sjo-wtN7z3yFVGBSEdmqOkE8Y0Y"
}
```


Figure 2: Issuer Ephemeral Private Key (ES256 in JWK)

This is the Holder’s presentation private key used in this example in the JWK format:


```
{
  "kty": "EC",
  "crv": "P-256",
  "x": "d0xNA3o7ygCqIW_leGjvpbuA1W3uIiIkpURznKiMji4",
  "y": "Qwt590yEH5SOjOo_drkKoEpqB7yLt-30IQ63Z4Ih6ww",
  "d": "GQWGAdlk1PlwEr-TNgSm_0OuPTrMOKf-iqRADem9QAU"
}
```


Figure 3: Holder Presentation Private Key (ES256 in JWK)

The Header declares that the data structure is a JPT and the JWP Proof Input is secured using the Single-Use ECDSA algorithm with the P-256 curve and SHA-256 digest. It also includes the ephemeral public key, the Holder’s presentation public key and list of claims used for this JPT.

```
{
  "alg": "SU-ES256",
  "typ": "JPT",
  "iss": "https://issuer.example",
  "hpa": "ES256",
  "claims": [
    "iat",
    "exp",
    "family_name",
    "given_name",
    "email",
    "address",
    "age_over_21"
  ],
  "iek": {
    "kty": "EC",
    "crv": "P-256",
    "x": "EYVvzBgbqbwM9oE0JTD9fR-giO4jzzTMS0wo88EMj5E",
    "y": "nIXC4hTLWgOEtkyxkcE36YZKZ0bay-g2dJLU0ZTwFm4"
  },
  "hpk": {
    "kty": "EC",
    "crv": "P-256",
    "x": "d0xNA3o7ygCqIW_leGjvpbuA1W3uIiIkpURznKiMji4",
    "y": "Qwt590yEH5SOjOo_drkKoEpqB7yLt-30IQ63Z4Ih6ww"
  }
}
```


Figure 4: Issuer Header (SU-ES256, JSON)


```
eyJhbGciOiJTVS1FUzI1NiIsInR5cCI6IkpQVCIsImlzcyI6Imh0dHBzOi8vaXNzdWVyL
mV4YW1wbGUiLCJocGEiOiJFUzI1NiIsImNsYWltcyI6WyJpYXQiLCJleHAiLCJmYW1pbH
lfbmFtZSIsImdpdmVuX25hbWUiLCJlbWFpbCIsImFkZHJlc3MiLCJhZ2Vfb3Zlcl8yMSJ
dLCJpZWsiOnsia3R5IjoiRUMiLCJjcnYiOiJQLTI1NiIsIngiOiJFWVZ2ekJnYnFid005
b0UwSlREOWZSLWdpTzRqenpUTVMwd284OEVNajVFIiwieSI6Im5JWEM0aFRMV2dPRXRre
XhrY0UzNllaS1owYmF5LWcyZEpMVTBaVHdGbTQifSwiaHBrIjp7Imt0eSI6IkVDIiwiY3
J2IjoiUC0yNTYiLCJ4IjoiZDB4TkEzbzd5Z0NxSVdfbGVHanZwYnVBMVczdUlpSWtwVVJ
6bktpTWppNCIsInkiOiJRd3Q1OTB5RUg1U09qT29fZHJrS29FcHFCN3lMdC0zMElRNjNa
NEloNnd3In19
```


Figure 5: Encoded Issuer Header (SU-ES256, JSON, encoded)

The Single Use algorithm utilizes multiple individual JWS Signatures. Each signature value is generated by creating a JWS with a single Header with the associated alg value. In this example, the fixed Header used for each JWS is the serialized JSON Object {"alg":"ES256"}. This Header will be used to generate a signature over each corresponding payload in the JWP. The corresponding octet value in the proof is the octet string (base64url-decoded) value of the signature.

The final proof value from the Issuer is an array with the octets of the Header signature, followed by entries for each payload signature.

```
[
    1714521600,
    1717199999,
    "Doe",
    "Jay",
    "jaydoe@example.org",
    {
        "formatted": "1234 Main St.\nAnytown, CA 12345\nUSA",
        "street_address": "1234 Main St.",
        "locality": "Anytown",
        "region": "CA",
        "postal_code": 12345,
        "country": "USA"
    },
    true
]
```

Figure 6: Issuer payloads (JSON, as array)

The compact serialization of the same JPT is:

eyJhbGciOiJTVS1FUzI1NiIsInR5cCI6IkpQVCIsImlzcyI6Imh0dHBzOi8vaXNzdWVyL
mV4YW1wbGUiLCJocGEiOiJFUzI1NiIsImNsYWltcyI6WyJpYXQiLCJleHAiLCJmYW1pbH
lfbmFtZSIsImdpdmVuX25hbWUiLCJlbWFpbCIsImFkZHJlc3MiLCJhZ2Vfb3Zlcl8yMSJ
dLCJpZWsiOnsia3R5IjoiRUMiLCJjcnYiOiJQLTI1NiIsIngiOiJFWVZ2ekJnYnFid005
b0UwSlREOWZSLWdpTzRqenpUTVMwd284OEVNajVFIiwieSI6Im5JWEM0aFRMV2dPRXRre
XhrY0UzNllaS1owYmF5LWcyZEpMVTBaVHdGbTQifSwiaHBrIjp7Imt0eSI6IkVDIiwiY3
J2IjoiUC0yNTYiLCJ4IjoiZDB4TkEzbzd5Z0NxSVdfbGVHanZwYnVBMVczdUlpSWtwVVJ
6bktpTWppNCIsInkiOiJRd3Q1OTB5RUg1U09qT29fZHJrS29FcHFCN3lMdC0zMElRNjNa
NEloNnd3In19.MTcxNDUyMTYwMA~MTcxNzE5OTk5OQ~IkRvZSI~IkpheSI~ImpheWRvZU
BleGFtcGxlLm9yZyI~eyJmb3JtYXR0ZWQiOiIxMjM0IE1haW4gU3QuXG5Bbnl0b3duLCB
DQSAxMjM0NVxuVVNBIiwic3RyZWV0X2FkZHJlc3MiOiIxMjM0IE1haW4gU3QuIiwibG9j
YWxpdHkiOiJBbnl0b3duIiwicmVnaW9uIjoiQ0EiLCJwb3N0YWxfY29kZSI6MTIzNDUsI
mNvdW50cnkiOiJVU0EifQ~dHJ1ZQ.sinHGhGLPBiadS1-Qo3Aqc3RZ_q-KaOFXi8JOZK1
SU0G9g3qE4pRP3rMsjy4-0ADAZCtQbpXJKRlmiKiv2Kmrg~lIh1dT23M0jxki4PCacwac
FKfEElV2QjPn4lY0pDXf7WWfgk2d4fOXdOD0hYNCrKbA3IvBLEV0VfGmQqDxOfjw~IyRP
gRabuIY20tGwmgf2mpbClurCqzO3B0jne3MRhDC8pO79m4pAn4wOKGcHB8v2AK2gktn_o
QAVOewXskvZFw~5ShDluA0CYXcuJZ2KG1oHyXEs6T1CDs-xEA1LIo9UfIv6qDzzzPbMJ_
BzvU4LUpVMcLTs00DmVgUWSDaduBkag~95MiBwk0pk3CyZqHzrpFpUz82Ci7_YnQ_H4ku
9yLu_XX-lE5mTcFSCfddrZboNBgK1nqey-_GQT0OIhS0MXGcA~Igmjul1veaBdEoTgeHg
57AfPot2EEXO0TOjJ9O3Zm7be0jVFLEfIyTw9_uZiSiEfIMN0JaWcKnibFuAcfddJIQ~0
1T6a702FnsWVWafPa3h4OivJgOtlLVZ-plTrtOzaL6U69bhrV-bXxLW7HLnBylroMUMJh
Jg0WcXWpScG_odpA~05QnUvfOcanOIRwysYyIc2ToYn4rY-xmjMCum1uD3MuF3DNYxNzP
dr_yNrYrqZ2I0mAkeIyGRi8Cv1ySOILJaQ

Figure 7: Issued JWP (SU-ES256, JSON, Compact Serialization)

To present this JPT, we first use the following Presentation Header with a nonce (provided by the Verifier):

```
{
  "alg": "SU-ES256",
  "aud": "https://recipient.example.com",
  "nonce": "5CDhgn8kR6jgYBlM29d7pKd_IYP5Vt1IPvGYngDwpc8"
}
```

Figure 8: Presentation Header (SU-ES256, JSON)

eyJhbGciOiJTVS1FUzI1NiIsImF1ZCI6Imh0dHBzOi8vcmVjaXBpZW50LmV4YW1wbGUuY
29tIiwibm9uY2UiOiI1Q0RoZ244a1I2amdZQmxNMjlkN3BLZF9JWVA1VnQxSVB2R1luZ0
R3cGM4In0

Figure 9: Presentation Header (SU-ES256, JSON, Base64url-Encoded)

We apply selective disclosure of only the given name and age claims (family name and email hidden), and remove the proof components corresponding to these entries.

Using the selectively disclosed information, we generate the presentation internal representation. Using that and the selectively disclosed payloads, we get the following presented JPT in compact serialization:

eyJhbGciOiJTVS1FUzI1NiIsImF1ZCI6Imh0dHBzOi8vcmVjaXBpZW50LmV4YW1wbGUuY
29tIiwibm9uY2UiOiI1Q0RoZ244a1I2amdZQmxNMjlkN3BLZF9JWVA1VnQxSVB2R1luZ0
R3cGM4In0.eyJhbGciOiJTVS1FUzI1NiIsInR5cCI6IkpQVCIsImlzcyI6Imh0dHBzOi8
vaXNzdWVyLmV4YW1wbGUiLCJocGEiOiJFUzI1NiIsImNsYWltcyI6WyJpYXQiLCJleHAi
LCJmYW1pbHlfbmFtZSIsImdpdmVuX25hbWUiLCJlbWFpbCIsImFkZHJlc3MiLCJhZ2Vfb
3Zlcl8yMSJdLCJpZWsiOnsia3R5IjoiRUMiLCJjcnYiOiJQLTI1NiIsIngiOiJFWVZ2ek
JnYnFid005b0UwSlREOWZSLWdpTzRqenpUTVMwd284OEVNajVFIiwieSI6Im5JWEM0aFR
MV2dPRXRreXhrY0UzNllaS1owYmF5LWcyZEpMVTBaVHdGbTQifSwiaHBrIjp7Imt0eSI6
IkVDIiwiY3J2IjoiUC0yNTYiLCJ4IjoiZDB4TkEzbzd5Z0NxSVdfbGVHanZwYnVBMVczd
UlpSWtwVVJ6bktpTWppNCIsInkiOiJRd3Q1OTB5RUg1U09qT29fZHJrS29FcHFCN3lMdC
0zMElRNjNaNEloNnd3In19.MTcxNDUyMTYwMA~MTcxNzE5OTk5OQ~IkRvZSI~IkpheSI~
ImpheWRvZUBleGFtcGxlLm9yZyI~eyJmb3JtYXR0ZWQiOiIxMjM0IE1haW4gU3QuXG5Bb
nl0b3duLCBDQSAxMjM0NVxuVVNBIiwic3RyZWV0X2FkZHJlc3MiOiIxMjM0IE1haW4gU3
QuIiwibG9jYWxpdHkiOiJBbnl0b3duIiwicmVnaW9uIjoiQ0EiLCJwb3N0YWxfY29kZSI
6MTIzNDUsImNvdW50cnkiOiJVU0EifQ~dHJ1ZQ~~.sinHGhGLPBiadS1-Qo3Aqc3RZ_q-
KaOFXi8JOZK1SU0G9g3qE4pRP3rMsjy4-0ADAZCtQbpXJKRlmiKiv2Kmrg~lIh1dT23M0
jxki4PCacwacFKfEElV2QjPn4lY0pDXf7WWfgk2d4fOXdOD0hYNCrKbA3IvBLEV0VfGmQ
qDxOfjw~IyRPgRabuIY20tGwmgf2mpbClurCqzO3B0jne3MRhDC8pO79m4pAn4wOKGcHB
8v2AK2gktn_oQAVOewXskvZFw~5ShDluA0CYXcuJZ2KG1oHyXEs6T1CDs-xEA1LIo9UfI
v6qDzzzPbMJ_BzvU4LUpVMcLTs00DmVgUWSDaduBkag~95MiBwk0pk3CyZqHzrpFpUz82
Ci7_YnQ_H4ku9yLu_XX-lE5mTcFSCfddrZboNBgK1nqey-_GQT0OIhS0MXGcA~Igmjul1
veaBdEoTgeHg57AfPot2EEXO0TOjJ9O3Zm7be0jVFLEfIyTw9_uZiSiEfIMN0JaWcKnib
FuAcfddJIQ~6mRn4X6bhGps5nD58frihU_WghXh2Qoo6ICP-KwRMuj-GY-5Dq2_O6zPiy
xGcG2Pf_mvVtsidJSeY3ebq23p2w

| Figure: Presentation (SU-ES256, JSON, Compact Serialization)

A.2. Example CBOR-Serialized Single-Use CPT

This example is meant to mirror the prior compact serialization, using RFC8392 (CWT) and claims from [I-D.ietf-spice-oidc-cwt], illustrated using [I-D.ietf-cbor-edn-literals] (EDN).

To simplify this example, the same information is represented as the JPT example above, including the same public and private keys.

```
{          / protected header /
  1: 1,     / alg: "SU-ES256" /
  3: 20,    / typ: "JPT" (20CPA) /
  5: "https://issuer.example",  / iss: "https://issuer.example" /
  6: [      / claims /
    6,      / "iat" /
    4,      / "exp" /
    170,    / "family_name" (I-D.maldant-spice-oidc-cwt TBD1) /
    171,    / "given_name"  (I-D.maldant-spice-oidc-cwt TBD2) /
    179,    / "email"       (I-D.maldant-spice-oidc-cwt TBD10) /
    187,    / "address"     (I-D.maldant-spice-oidc-cwt TBD18) /
    "age_over_21"
  ],
  8: {      / iek /
    1: 2,   / kty : "EC2" /
    -1: 1,  / crv: "P-256" /
    -2: h'11856fcc181ba9bc0cf681342530fd7d1fa088ee23cf34cc4b4c28f3' +
        h'c10c8f91', / x /
    -3: h'9c85c2e214cb5a0384b64cb191c137e9864a6746dacbe8367492d4d1' +
        h'94f0166e'  / y /
  },
  9: {      / hpk /
    1: 2,   / kty: "EC2" /
    -1: 1,  / crv: "P-256" /
    -2: h'774c4d037a3bca00aa216fe57868efa5bb80d56dee222224a544739c' +
        h'a88c8e2e', / x /
    -3: h'430b79f74c841f948e8cea3f76b90aa04a6a07bc8bb7edf4210eb767' +
        h'8221eb0c'  / y /
  },
  10: -9    / hpa: "ESP256" (I-D.ietf-jose-fully-specified-algorithms TBD-9) /
}
```

| Figure: Issuer Header (SU-ES256, CBOR)

```
[ / payloads    /
  / iat         / 171452160,
  / exp         / 171719999,
  / family_name / "Doe",
  / given_name  / "Jay",
  / email       / "jaydoe@example.org",
  / address     / {
    / formatted / 1: "1234 Main St.\nAnytown, CA 12345\nUSA",
    / street    / 2: "1234 Main St.",
    / locality  / 3: "Anytown",
    / region    / 4: "CA",
    / post code / 5: "90210",
    / country   / 6: "USA"
  },
  / age_over_21 / true
]
```

| Figure: Issuer Payloads (as CBOR array)

When signed and serialized, the CPT is represented by the following CBOR (in hex):

```
8358cfa701010314057668747470733a2f2f6973737565722e6578616d706c65
0687060418aa18ab18b318bb6b6167655f6f7665725f323108a4010220012158
2011856fcc181ba9bc0cf681342530fd7d1fa088ee23cf34cc4b4c28f3c10c8f
912258209c85c2e214cb5a0384b64cb191c137e9864a6746dacbe8367492d4d1
94f0166e09a401022001215820774c4d037a3bca00aa216fe57868efa5bb80d5
6dee222224a544739ca88c8e2e225820430b79f74c841f948e8cea3f76b90aa0
4a6a07bc8bb7edf4210eb7678221eb0c0a28871a0a3827001a0a3c3d3f63446f
65634a6179726a6179646f65406578616d706c652e6f7267a601782331323334
204d61696e2053742e0a416e79746f776e2c204341203132333435 0a55534102
6d31323334204d61696e2053742e0367416e79746f776e046243410565393032
31300663555341f58858402cf31e84e47568f8cccaa2f494e3754248b941a2d7
227d287479aeccb8b995f6968b2088c2f529b8014628e8662b978fd4c41b89f3
b25adc6cb06954f8827313584013912720c8a913c53491e7b54186ba28841842
4361abc2d95ffab91e8dfac5b1ef683e6c1acc869954677d3048cfb8fa98cbc5
e392d7d9196a4974ddf26b07215840458f4a72460bfa88ea555bd1d796fb45a2
e3690fcc1159f88b0ee94d82481651514d6327f1260427e293ba48f93a4c4a8f
6f21222df2dc6f4b458831966f58f1584023919572074b543728b14147ae100e
edb503ccdb95732e62a14f1e882a13af0b89ae678fa2dc3772a4782910ddff91
188f4783dffa2625d0d70f8586ee4fe5ed584071c07f91cc3510bdedf1fbae99
d1f56daf5c2a5765ac410d30d5f022282bf87087e5912db6bf2e92b3573651aa
c6ed31941cc1f60b4251fbdf9832fbf5572f11584084c313b7f87e99314fc3b1
32675883b3494b2b05b7e47e5b6572ccdadbbbbc5e3b1f9b2652fc55a0ec7449
fc7fd910364355b9d2b1461365e91834485cb9bae658403a3f2c1b6896ae0420
a7ad1072cd6c29a9afae6d44da5bd043d6cfa1cfc6c6719c0c254d4d167a84b1
7f626e1046f889c6d584e52de8043a0c00bbba8ba7cc525840c02d1a0ce659ad
b7f9686f56deeffc6674bff61faac3443b48acf5dd8c734570a0a9f4aef8b2e1
24d322cc6781b48efa7b18ae75345b87918dca70c1e5eaca54
```

| Fixtures: Issued Form (SU-ES256, CBOR)

The presented form, similarly to the issued form above, is made with the holder conveying the same parameters and the same set of selectively disclosed payloads as the JPT above:

```
{          / protected header /
  1: 1,    / alg: "SU-ES256" /
  6: "https://recipient.example.com", / aud /
  7: h’e420e1827f2447a8e060194cdbd77ba4a77f2183f956dd483ef1989e00f0a5cf’, / nonce /
}
```

| Figure: Presentation Header (SU-ES256, CBOR)

When the appropriate proof is generated, the CPT is serialized into the following CBOR (in hex):

```
845846a3010106781d68747470733a2f2f726563697069656e742e6578616d70
6c652e636f6d075820e420e1827f2447a8e060194cdbd77ba4a77f2183f956dd
483ef1989e00f0a5cf58cfa701010314057668747470733a2f2f697373756572
2e6578616d706c650687060418aa18ab18b318bb6b6167655f6f7665725f3231
08a401022001215820 11856fcc181ba9bc0cf681342530fd7d1fa088ee23cf34
cc4b4c28f3c10c8f912258209c85c2e214cb5a0384b64cb191c137e9864a6746
dacbe8367492d4d194f0166e09a401022001215820774c4d037a3bca00aa216f
e57868efa5bb80d56dee222224a544739ca88c8e2e225820430b79f74c841f94
8e8cea3f76b90aa04a6a07bc8bb7edf4210eb7678221eb0c0a28891a0a382700
1a0a3c3d3f63446f65634a6179726a6179646f65406578616d706c652e6f7267
a601782331323334204d61696e2053742e0a416e79746f776e2c204341203132
3334350a555341026d31323334204d61696e2053742e0367416e79746f776e04
624341056539303231300663555341f5f6f68758402cf31e84e47568f8cccaa2
f494e3754248b941a2d7227d287479aeccb8b995f6968b2088c2f529b8014628
e8662b978fd4c41b89f3b25adc6cb06954f882731358401391272 0c8a913c534
91e7b54186ba288418424361abc2d95ffab91e8dfac5b1ef683e6c1acc869954
677d3048cfb8fa98cbc5e392d7d9196a4974ddf26b07215840458f4a72460bfa
88ea555bd1d796fb45a2e3690fcc1159f88b0ee94d82481651514d6327f12604
27e293ba48f93a4c4a8f6f21222df2dc6f4b458831966f58f158402391957207
4b543728b14147ae100eedb503ccdb95732e62a14f1e882a13af0b89ae678fa2
dc3772a4782910ddff91188f4783dffa2625d0d70f8586ee4fe5ed584071c07f
91cc3510bdedf1fbae99d1f56daf5c2a5765ac410d30d5f022282bf87087e591
2db6bf2e92b3573651aac6ed31941cc1f60b4251fbdf9832fbf5572f11584084
c313b7f87e99314fc3b132675883b3494b2b05b7e47e5b6572ccdadbbbbc5e3b
1f9b2652fc55a0ec7449fc7fd910364355b9d2b1461365e91834485cb9bae658
404a581185f711b16cda877bf14c99b5918bd7779eafedde3391794aee474a68
fa6810e2a22dbcff72bcc48db1e105b6034cb1a5c108e15b0b4f2dd1664dc90c
ec
```

| Figure: Presented Form (SU-ES256, CBOR)

A.3. Example BBS JWP

The following example uses the BBS algorithm.

This is the Issuer’s stable private key in the JWK format:

```
{
  "kty": "EC2",
  "alg": "BBS",
  "use": "proof",
  "crv": "BLS12381G2",
  "x": "BuNQIeE3SCkKFFJt2jkXLnW8-1yWADlUixxpz7buHibsGOHiWV7Sbrtw59jRQ
       JRYBskL8PM0ljeQ4SQzL1ufX2EoOxtOuA_hZ5q_84ouEVYJO3PPb7kSh2KD3tH
       4fdqP",
  "y": "DjIGf9W4NdJ-T5uNYQdgVzg_9t1a9IMfzaITNTMlmX_cpCPElw2crIqFcjbch
       Bz-Chkxsqdg-LbjUaysB0hFj9LPO5NLjN0lW1qn7C46w3HBdIbwRi3C2S4z7rR
       iXc09",
  "d": "Nacmg4DQGnTsX467r3hJ3ak8rXzfQ5pqTk1QXuffroo"
}
```

Figure 10: BBS private key in JWK format

There is no additional holder key necessary for presentation proofs.

For the following protected header and array of payloads:

```
{
  "kid": "HjfcpyjuZQ-O8Ye2hQnNbT9RbbnrobptdnExR0DUjU8",
  "alg": "BBS"
}
```

Figure 11: Example Issuer Header

These components are signed using the private issuer key previously given, which is then representable in the following serialization:

```
eyJraWQiOiJIamZjcHlqdVpRLU84WWUyaFFuTmJUOVJiYm5yb2JwdGRuRXhSMERValU4I
iwiYWxnIjoiQkJTIn0.MTcxNDUyMTYwMA~MTcxNzE5OTk5OQ~IkRvZSI~IkpheSI~Imph
eWRvZUBleGFtcGxlLm9yZyI~eyJmb3JtYXR0ZWQiOiIxMjM0IE1haW4gU3QuXG5Bbnl0b
3duLCBDQSAxMjM0NVxuVVNBIiwic3RyZWV0X2FkZHJlc3MiOiIxMjM0IE1haW4gU3QuIi
wibG9jYWxpdHkiOiJBbnl0b3duIiwicmVnaW9uIjoiQ0EiLCJwb3N0YWxfY29kZSI6MTI
zNDUsImNvdW50cnkiOiJVU0EifQ~dHJ1ZQ.uRaclcQXxqmDzhkMC__X30tfQ4uk9jov-y
zpq-HIHkf5yLcuQQYBKYnu5rAg3cN1Pjre-frd5wpZBSYXi-m8hO6CDR2eDydye0ZVdS3
Sh8M
```

Figure 12: Issued JWP (BBS, JSON, Compact Serialization)

For a presentation with the following Presentation Header:

```
{
    "alg": "BBS",
    "aud": "https://recipient.example.com",
    "nonce": "wrmBRkKtXjQ"
}
```

Figure 13: Presentation Header

The holder decides to share all information other than the email address, and generates a proof. That proof is represented in the following serialization:

eyJhbGciOiJCQlMiLCJhdWQiOiJodHRwczovL3JlY2lwaWVudC5leGFtcGxlLmNvbSIsI
m5vbmNlIjoid3JtQlJrS3RYalEifQ.eyJraWQiOiJIamZjcHlqdVpRLU84WWUyaFFuTmJ
UOVJiYm5yb2JwdGRuRXhSMERValU4IiwiYWxnIjoiQkJTIn0.MTcxNDUyMTYwMA~MTcxN
zE5OTk5OQ~IkRvZSI~IkpheSI~~~.hC5ioWDfxim8Jcz1geBXda-FqHttJyIb5ztXuYD_
WRDEfb9yVCx2dwJu0cXpnqTogLGzxXJKqbj4yPbR7uQEdsTsuc3HIkuERO6FaZTRqDrNS
oO1BlmCaHiv6ZfUpQRXjkSKztGBJKII9IMZyVvVm8Kb8zTsfweUtPKB7SI6cCmqwGHCrn
EhZR3y3C3TXTKVUV9mgyGTIrV4E9uLdUclNRk9atTe1kjw0FVfyZkzWi80kEcLGy5c96C
Iqac-0chFY4VSNh34g3XSCXDNhVYmzWlWQKfL-qV4ddtJnl_e8rsc90BT2h803wwLgTHB
wU03WMeR4k1ZPcirLywNWcMQhsacMZGar_6lr2LlEsHS9p0hkkdxDEp9a4Hqt8wP3O1WQ
fzDVom5ejZ2Dq1ZoOTqcVoG0F-GKMV2uXBeWoH724WKg9thI0NO259WCjORmDjEXHFTg0
DZeaTmxaf0gFsxxl0a8Bqw0tnjUV5GEp0tNFY

Figure 14: Presentation JWP (BBS, JSON, Compact serialization)

A.4. Example MAC JWP

The following example uses the MAC-H256 algorithm.

This is the Issuer’s stable private key in the JWK format:

{
  "kty": "EC",
  "crv": "P-256",
  "x": "xw1VbXzkXXz5NTlVd5p_CTh6OpFFDuVS3pZXSHJRiAU",
  "y": "nYOtgIELw15Hgrdxz06L_eRoMSFQZ_gLadZwkcCrvT0",
  "d": "l8QSf6TTCnlj8QWp66MK0fd2LeP7KwcOCwf4dGWF6Q8"
}

Figure 15: Issuer private key

This is the Issuer’s ephemerally generated shared secret:

"NbP2rTsKBJMdF_X3s7-G0PJ17cpzDtYIfVGS4I0aT7U"

Figure 16: Shared Secret

This is the Holder’s presentation private key in the JWK format:

```
{
  "kty": "EC",
  "crv": "P-256",
  "x": "d0xNA3o7ygCqIW_leGjvpbuA1W3uIiIkpURznKiMji4",
  "y": "Qwt590yEH5SOjOo_drkKoEpqB7yLt-30IQ63Z4Ih6ww",
  "d": "GQWGAdlk1PlwEr-TNgSm_0OuPTrMOKf-iqRADem9QAU"
}
```

Figure 17: Holder private key

For the following Header and array of payloads:

```
{
  "alg": "MAC-H256",
  "hpa": "ES256",
  "typ": "JPT",
  "iss": "https://issuer.example",
  "claims": [
    "iat",
    "exp",
    "family_name",
    "given_name",
    "email",
    "address",
    "age_over_21"
  ],
  "hpk": {
    "kty": "EC",
    "crv": "P-256",
    "use": "sign",
    "x": "d0xNA3o7ygCqIW_leGjvpbuA1W3uIiIkpURznKiMji4",
    "y": "Qwt590yEH5SOjOo_drkKoEpqB7yLt-30IQ63Z4Ih6ww"
  }
}
```

Figure 18: Example Issuer Header

```
[
    1714521600,
    1717199999,
    "Doe",
    "Jay",
    "jaydoe@example.org",
    {
        "formatted": "1234 Main St.\nAnytown, CA 12345\nUSA",
        "street_address": "1234 Main St.",
        "locality": "Anytown",
        "region": "CA",
        "postal_code": 12345,
        "country": "USA"
    },
    true
]
```

Figure 19: Example issuer payloads (as members of a JSON array)

The issuer generates an array of derived keys, one per payload slot. This is done using the shared secret as the key and a binary value based on the payload slot index (from zero) as input to the HMAC operation.

This results in the following set of derived keys:

```
[
  "_ZbwOOEV6thkpiXGCS1YSHMdVDZVYbgujEsCnNHbnGM",
  "2JSrjS09KTlUnKKmHgftXXG9ePcCSRZ0b3EmMuFi1to",
  "O0WYiG6LpjCR2t8d-AxUVHPTtaOy2v-pnRSRA1kdloY",
  "8ebG-oEHidWOEyPigx9ng_TuozN3qlXn9iGNi0JUzo8",
  "q5mIRuWFyMB9jEFjSJ9f48KQH_bXy8j0CZ3BiSd_uD0",
  "5_kZh8GyWXopCNIZfP8diV1xbMHmIuSRtiRLb_BD-RA",
  "A91ZyVU9fM3Tsod3-BBnp8544byIqMF2BSuA0oe9Nl8"
]
```

Figure 20: Derived payload keys (Base64url-Encoded)

A MAC is generated for each payload using the corresponding derived payload key. This results in the following set of MAC values:

```
[
  "LH7V0pEmw-s6GFzHrf2CtaJv9j-NdFXXEg2A8IK0F-I",
  "Uc59Mf22GRV5Bpvx0rAPbgl5AlzLkXy8G_6LCDnyBjw",
  "q3q-qqIDRvHjzC_JkjT8Cw6WKbaJw4svcAbzLjfr8PU",
  "vwR4-jRyRZJwV2ml_HeSZgdisAOz6zK3sihaSrs6THk",
  "woIgTV4oqFlfdUL_AIlKrKSVniuLsMgusCdvV-CTTV8",
  "2vY4mqZajeGJyzJXhuNR-Hu-KvqhnlWLQs6-bVYSpXU",
  "OS4HotliqS5dnsAoW15P3sRFEzSen0GBrTufq0vzhXw"
]
```

Figure 21: Payload MAC values (Base64url-Encoded)

The Issuer Header and payload MAC values are combined into a binary representation known as the Compact MAC Representation. This representation is signed with the issuer’s private key.

The proof consists of two octet string values: the signature over the combined MAC representation, and the shared secret.

```
[
  "8yBOL0x9bnQTGBNey8wtBoi5ukXpJYNgQPdgbYep_sHXFYC_F7d2fIyLZ-wzercR6B
QHsR6bXPvXZVyilML5eQ",
  "gr5vqnAufo5zMfGWXbTF6YRqZNjeIKJgdCpSRtezKxQ"
]
```

Figure 22: Issued Proof (Base64url-Encoded)

The final issued JWP in compact serialization is:

```
eyJhbGciOiJNQUMtSDI1NiIsImhwYSI6IkVTMjU2IiwidHlwIjoiSlBUIiwiaXNzIjoia
HR0cHM6Ly9pc3N1ZXIuZXhhbXBsZSIsImNsYWltcyI6WyJpYXQiLCJleHAiLCJmYW1pbH
lfbmFtZSIsImdpdmVuX25hbWUiLCJlbWFpbCIsImFkZHJlc3MiLCJhZ2Vfb3Zlcl8yMSJ
dLCJocGsiOnsia3R5IjoiRUMiLCJjcnYiOiJQLTI1NiIsInVzZSI6InNpZ24iLCJ4Ijoi
ZDB4TkEzbzd5Z0NxSVdfbGVHanZwYnVBMVczdUlpSWtwVVJ6bktpTWppNCIsInkiOiJRd
3Q1OTB5RUg1U09qT29fZHJrS29FcHFCN3lMdC0zMElRNjNaNEloNnd3In19.MTcxNDUyM
TYwMA~MTcxNzE5OTk5OQ~IkRvZSI~IkpheSI~ImpheWRvZUBleGFtcGxlLm9yZyI~eyJm
b3JtYXR0ZWQiOiIxMjM0IE1haW4gU3QuXG5Bbnl0b3duLCBDQSAxMjM0NVxuVVNBIiwic
3RyZWV0X2FkZHJlc3MiOiIxMjM0IE1haW4gU3QuIiwibG9jYWxpdHkiOiJBbnl0b3duIi
wicmVnaW9uIjoiQ0EiLCJwb3N0YWxfY29kZSI6MTIzNDUsImNvdW50cnkiOiJVU0EifQ~
dHJ1ZQ.8yBOL0x9bnQTGBNey8wtBoi5ukXpJYNgQPdgbYep_sHXFYC_F7d2fIyLZ-wzer
cR6BQHsR6bXPvXZVyilML5eQ~gr5vqnAufo5zMfGWXbTF6YRqZNjeIKJgdCpSRtezKxQ
```

Figure 23: Issued JWP (MAC-H256, JSON, Compact Serialization)

Next, we show the presentation of the JWP with selective disclosure.

For presentation with the following Presentation Header:

```
{
  "alg": "MAC-H256",
  "aud": "https://recipient.example.com",
  "nonce": "5CDhgn8kR6jgYBlM29d7pKd_IYP5Vt1IPvGYngDwpc8"
}
```

Figure 24: Presentation Header

The holder will take the issuer proof (including shared secret) and derive the same individual payload MAC values (above).

In this case, the holder has decided not to disclose the last three claims provided by the issuer (corresponding to email, address, and age_over_21)

For each payload slot, the holder will provide one of two values as part of the proof value. For a disclosed payload, the holder will provide the corresponding derived key. For a non-disclosed payload, the holder will provide the corresponding MAC value.

The final presented proof value is an array of octet strings. The contents are Presentation Header signature, followed by the issuer signature, then the value disclosed by the holder for each payload. This results in the following proof:

```
[
  "8yBOL0x9bnQTGBNey8wtBoi5ukXpJYNgQPdgbYep_sHXFYC_F7d2fIyLZ-wzercR6B
QHsR6bXPvXZVyilML5eQ",
  "_ZbwOOEV6thkpiXGCS1YSHMdVDZVYbgujEsCnNHbnGM",
  "2JSrjS09KTlUnKKmHgftXXG9ePcCSRZ0b3EmMuFi1to",
  "O0WYiG6LpjCR2t8d-AxUVHPTtaOy2v-pnRSRA1kdloY",
  "8ebG-oEHidWOEyPigx9ng_TuozN3qlXn9iGNi0JUzo8",
  "woIgTV4oqFlfdUL_AIlKrKSVniuLsMgusCdvV-CTTV8",
  "2vY4mqZajeGJyzJXhuNR-Hu-KvqhnlWLQs6-bVYSpXU",
  "OS4HotliqS5dnsAoW15P3sRFEzSen0GBrTufq0vzhXw",
  "jyQY3jBS7HvSxwmjc3Ah8sPCvkBieliefpXPLtwq2RSlFBVZK5hQOcCfZP1okUhwuZ
zSqDAO4-ZdkBG2qgraXw"
]
```

Figure 25: Presentation proof (Base64url-Encoded)

The final presented JWP in compact serialization is:

eyJhbGciOiJNQUMtSDI1NiIsImF1ZCI6Imh0dHBzOi8vcmVjaXBpZW50LmV4YW1wbGUuY
29tIiwibm9uY2UiOiI1Q0RoZ244a1I2amdZQmxNMjlkN3BLZF9JWVA1VnQxSVB2R1luZ0
R3cGM4In0.eyJhbGciOiJNQUMtSDI1NiIsImhwYSI6IkVTMjU2IiwidHlwIjoiSlBUIiw
iaXNzIjoiaHR0cHM6Ly9pc3N1ZXIuZXhhbXBsZSIsImNsYWltcyI6WyJpYXQiLCJleHAi
LCJmYW1pbHlfbmFtZSIsImdpdmVuX25hbWUiLCJlbWFpbCIsImFkZHJlc3MiLCJhZ2Vfb
3Zlcl8yMSJdLCJocGsiOnsia3R5IjoiRUMiLCJjcnYiOiJQLTI1NiIsInVzZSI6InNpZ2
4iLCJ4IjoiZDB4TkEzbzd5Z0NxSVdfbGVHanZwYnVBMVczdUlpSWtwVVJ6bktpTWppNCI
sInkiOiJRd3Q1OTB5RUg1U09qT29fZHJrS29FcHFCN3lMdC0zMElRNjNaNEloNnd3In19
.MTcxNDUyMTYwMA~MTcxNzE5OTk5OQ~IkRvZSI~IkpheSI~~~.8yBOL0x9bnQTGBNey8w
tBoi5ukXpJYNgQPdgbYep_sHXFYC_F7d2fIyLZ-wzercR6BQHsR6bXPvXZVyilML5eQ~_
ZbwOOEV6thkpiXGCS1YSHMdVDZVYbgujEsCnNHbnGM~2JSrjS09KTlUnKKmHgftXXG9eP
cCSRZ0b3EmMuFi1to~O0WYiG6LpjCR2t8d-AxUVHPTtaOy2v-pnRSRA1kdloY~8ebG-oE
HidWOEyPigx9ng_TuozN3qlXn9iGNi0JUzo8~woIgTV4oqFlfdUL_AIlKrKSVniuLsMgu
sCdvV-CTTV8~2vY4mqZajeGJyzJXhuNR-Hu-KvqhnlWLQs6-bVYSpXU~OS4HotliqS5dn
sAoW15P3sRFEzSen0GBrTufq0vzhXw~jyQY3jBS7HvSxwmjc3Ah8sPCvkBieliefpXPLt
wq2RSlFBVZK5hQOcCfZP1okUhwuZzSqDAO4-ZdkBG2qgraXw

Figure 26: Presented JWP (MAC-H256, JSON, Compact Serialization)

Appendix B. Acknowledgements

This work was incubated in the DIF Applied Cryptography Working Group (https://identity.foundation/working-groups/crypto.html).

We would like to thank Alberto Solavagione for his valuable contributions to this specification.

The BBS examples were generated using the library at https://github.com/mattrglobal/pairing_crypto (https://github.com/mattrglobal/pairing_crypto) .

Appendix C. Document History

[[To be removed from the final specification]] -11

* Change Issuer Protected Header to Issuer Header
* Change Presentation Protected Header and Holder Presentation Header to Presentation Header

-10

* Clarify MAC issuance and presentation using new "payload slot" nomenclature.
* Define a new binary "Presentation Internal Representation" so that the holder signature protects the entire presentation
* Leverage the new "Holder Presentation Algorithm" to allow the holder algorithm to be independent from the signature algorithm used by the issuer

* Redefine computation of the "Combined MAC Representation" to more closely match the new Presentation Internal Representation.
* Change the MAC algorithm to directly sign the binary Combined MAC Representation rather than convert it to a JWS.
* Do not unnecessarily hash the issuer protected header inside the Combined MAC Representation, so that it can provide some manner of domain separation.
* Clarify how verifiers are to generate the Combined MAC Representation from available information.
* Provider step-by-step instructions for verification of a presentation
* Change Proof Key to Issuer Ephemeral Key and Presentation Key to Holder Presentation Key

-09

* Remove JSON serialization
* Added CBOR (CPT) example to the appendix using SU-ES256

-08

* Made some additional references normative.
* Corrected SU-ES256 issuer protected header including private keys

-07

* Changing primary editor
* Update registry template for algorithms to account for integer CBOR labels
* Restylize initial registry entries for readability
* Defer BBS key definition to [I-D.ietf-cose-bls-key-representations]
* Modify example generation to use proof_key and presentation_key names
* Change proof_jwk to proof_key and presentation_jwk to presentation_key to better represent that the key may be JSON or CBOR-formatted.
* Moved the registry for proof_key and presentation_key to JWP where they are defined. Consolidated usage, purpose, and requirements from algorithm usage under these definitions.
* Combined BBS-PROOF into BBS

-06

* Update reference to new repository home
* Fixed #77: Removed vestigial use of presentation_header.
* Correct pjwk to presentation_jwk

-05

* Update of appendix describing MAC-H256 to now also be generated by the build system from a common set of code and templates.
* Update single use algorithm to use an array of octet values rather than requiring splitting an octet buffer into parts during generation of a presentation and during verification.
* Update BBS algorithm description and examples to clarify the proof is an array with a single octet string.
* Update MAC algorithm to use an array of octet values for the proof, rather than requiring splitting an octet buffer into parts.
* Add new section on the Combined MAC Representation to clarify operations are serving to recreate this octet string value.
* Correct reference to the latest BBS draft.
* SU and MAC families now use raw JWA rather than JWS and synthesized headers
* Change algorithms to not use base64url-encoding internally. Algorithms are meant to operate on octets, while base64url-encoding is used to represent those octets in JSON and compact serializations.

-04

* Refactoring figures and examples to be built from a common set across all three documents
* Move single-use example appendix from JWP to JPA
* Change algorithm from BBS-DRAFT-5 to BBS, and from BBS-PROOF-DRAFT-5 to BBS-PROOF
* Update BBS ciphersuite ID to BBS_BLS12381G1_XMD:SHA-256_SSWU_RO_
* Update to draft 5 BLS key representations

-03

* Improvements resulting from a full proofreading.
* Populated IANA Considerations section.
* Updated to use BBS draft -05.
* Updated examples.

-02

* Add new BBS-DRAFT-3 and BBS-PROOF-DRAFT-3 algorithms based on draft-irtf-cfrg-bbs-signatures-03.
* Remove prior BBS-X algorithm based on a particular implementation of earlier drafts.

-01

* Correct cross-references within group

* Describe issuer_header and presentation_header
* Update BBS references to CFRG drafts
* Rework reference to HMAC (RFC2104)
* Remove ZKSnark placeholder

-00

* Created initial working group draft based on draft-jmiller-jose-json-proof-algorithms-01

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