Federal Identity, Credentialing, and Access Management

Security Assertion Markup Language (SAML) 2.0 Profile

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Executive Summary

Security Assertion Markup Language (SAML) 2.0 Profile as described in this document has been adopted by Federal Identity, Credential, and Access Management (ICAM) for the purpose of Level of Assurance (LOA) 1, 2, and 3 identity authentication and holder-of-key assertions for binding keys or other attributes to an identity at LOA 4. Proper use of this Profile ensures that implementations:

- Meet Federal standards, regulations, and laws;
- Minimize risk to the Federal government;
- Maximize interoperability; and
- Provide end users (e.g., citizens) with a consistent context or user experience at a Federal Government site.

This Profile is a deployment profile based on the Organization for the Advancement of Structured Information Standards (OASIS) SAML 2.0 specifications [SAML2 *], and the Liberty Alliance eGov Profile v.1.5 [eGov Profile]. This Profile relies on the SAML 2.0 Web Browser SSO Profile [SAML2 Profiles] to facilitate end user authentication.

This Profile does not alter these standards, but rather specifies deployment options and requirements to ensure technical interoperability with Federal government applications. Where this Profile does not explicitly provide guidance, the standards upon which this Profile is based take precedence. In addition, this Profile recognizes the [eGov Profile] conformance requirements[1], and to the extent possible reconciles them with other SAML 2.0 Profiles.

The objective of this document is to define the ICAM SAML 2.0 Profile so that persons deploying, managing, or supporting an application based upon it can fully understand its use in ICAM transaction flows.

In general, the SAML 2.0 protocol facilitates exchange of SAML messages (requests and/or responses) between endpoints. For this Profile, messages pertain primarily to the exchange of an identity assertion that includes authentication and attribute information. Message support for additional features is also available. In ICAM, the endpoints are typically the Relying Party (RP) and the Identity Provider (IdP).

SAML 2.0 Profile defined herein includes the following features: single sign-on, session reset, and attribute exchange. In addition, this Profile defines two main SAML 2.0 use cases: the end user starting at the RP, and the end user starting at the IdP. Use case diagrams and sequence diagrams are provided to illustrate the use cases. Privacy, security, and end user activation are also discussed. Programmed trust (a mechanism to indicate to RPs which IdPs are approved for use within ICAM) is also discussed, and a high-level process flow diagram is provided to illustrate the concept.

[1] A deployment profile outlines requirements for using SAML software in a given context, whereas a conformance (or product) profile describes the requirements for a software implementation.

The Profile concludes with detailed technical guidance that scopes SAML 2.0 for ICAM purposes. Like most specifications, SAML 2.0 provides options. Where necessary, ICAM specifies or removes options in order to achieve better security, privacy, and interoperability. The Technical Profile section addresses the authentication request and response, metadata, and transaction security. This Profile does not recommend Single Log-out and IdP Discovery.

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1. INTRODUCTION

1.1 Background

In December 2003, the Office of Management and Budget (OMB) issued memorandum M-04-04, *E-Authentication Guidance for Federal Agencies* [OMB M-04-04], which established four levels of identity assurance (LOA) for the authentication of electronic transactions. The four (4) M-04-04 LOA are:

Level 1: Little or no confidence in the asserted identity's validity.
Level 2: Some confidence in the asserted identity's validity.
Level 3: High confidence in the asserted identity's validity.
Level 4: Very high confidence in the asserted identity's validity.

M-04-04 also tasked the National Institute of Standards and Technology (NIST) with providing technical standards for each LOA. Consequently, NIST developed Special Publication 800-63-1, *Electronic Authentication Guideline* [NIST SP 800-63], as the standard agencies must use when conducting electronic authentication.

The General Services Administration's (GSA) Office of Governmentwide Policy (OGP) is responsible for government-wide coordination and oversight of Federal Identity, Credential, and Access Management (ICAM). These activities are aimed at improving access to electronic government services internally, with other government partners, with business partners, and with the American citizen constituency. Toward that end, the ICAM Subcommittee assesses identity authentication schemes under consideration for adoption by the Federal Government in accordance with the ICAM Identity Scheme Adoption Process [Scheme Adopt]. The adoption process includes assessment of the scheme for compliance with [NIST SP 800-63] and other privacy and security requirements.

The Security Assertion Markup Language (SAML) 2.0 Profile as described in this document has been adopted by ICAM for the purpose of LOA 1, 2 and 3[2] identity authentication and holder-of-key assertions for binding keys or other attributes to an identity at LOA 4. Proper use of this Profile ensures that implementations:

- Meet Federal standards, regulations, and laws;
- Minimize risk to the Federal government;
- Maximize interoperability; and
- Provide end users (e.g., citizens) with a consistent context or user experience at a Federal Government site.

This Profile is a deployment profile based on the Organization for the Advancement of Structured Information Standards (OASIS) SAML 2.0 specifications [SAML2 *], and the Liberty Alliance eGov Profile v.1.5 [eGov Profile]. This Profile does not alter these standards, but rather specifies deployment options and requirements to ensure technical interoperability with Federal government applications. Where this Profile does not explicitly provide guidance, the standards upon which this Profile is based

[2] See *ICAM Trust Framework Provider Adoption Process (TFPAP) For Levels of Assurance 1, 2, and Non-PKI 3* [TFPAP].

take precedence. In addition, this Profile recognizes the [eGov Profile] conformance requirements[3], and to the extent possible reconciles them with other SAML 2.0 Profiles.

1.2 Objective and Audience

The objective of this document is to define the ICAM SAML 2.0 Profile so that persons deploying, managing, or supporting an application based upon it can fully understand its use in ICAM transaction flows. The definition includes:

1. A high-level overview of the ICAM SAML 2.0 Profile and its features;
2. General requirements for Identity Providers (IdPs) and Relying Parties (RPs) that extend outside the reach of SAML 2.0 specifications (e.g., privacy, security, activation, governance).
3. An ICAM deployment profile of the SAML 2.0 Profile specification [SAML2 Profiles].

Section 2 provides a high-level overview of the Profile, and includes discussion of features, use cases, and process flows. The section provides the context and understanding necessary to implement and manage an ICAM SAML 2.0 application. The audience for this section includes both technical personnel (e.g., designers, implementers) and non-technical personnel (e.g., senior managers, project managers).

Section 3 provides technicians guidance on how to implement the ICAM SAML 2.0 Profile (i.e., send or receive SAML 2.0 messages within ICAM). It is assumed that readers of section 3 are familiar with the SAML 2.0 specification [SAML2 Core].

1.3 Notation

The keywords "MUST", "MUST NOT", "REQUIRED", "SHALL", "SHALL NOT", "SHOULD", "SHOULD NOT", "RECOMMENDED", "MAY", and "OPTIONAL" in this specification are to be interpreted as described in IETF RFC 2119 [RFC 2119].

Conventional XML namespace prefixes are used throughout the listings in this specification to stand for their respective namespaces as follows:

Prefix	XML Namespace
saml:	urn:oasis:names:tc:SAML:2.0:assertion
samlp:	urn:oasis:names:tc:SAML:2.0:protocol
md:	urn:oasis:names:tc:SAML:2.0:metadata
ds:	http://www.w3.org/2000/09/xmldsig#

2. SCHEME OVERVIEW

2.1 SAML 2.0 Overview

In general, the SAML 2.0 protocol facilitates exchange of SAML messages (requests and/or responses) between endpoints. For this Profile, messages pertain primarily to the exchange of an identity assertion that includes authentication and attribute information. Message support for additional features is also

[3] A deployment profile outlines requirements for using SAML software in a given context, whereas a conformance (or product) profile describes the requirements for a software implementation.

available (see Section 2.3). In ICAM, the endpoints are typically the Relying Party (RP) and the Identity Provider (IdP).

The ICAM SAML 2.0 Profile can be used to conduct transactions with the Federal government. At this time, SAML 2.0 is suitable for LOA 1, 2 and 3 authentication only. See Appendix A for a summary of message transactions supported by this Profile.

This Profile relies on the SAML 2.0 Web Browser SSO Profile [SAML2 Profiles] to facilitate end user authentication.

2.2 SAML 2.0 Bindings

Each SAML 2.0 profile uses one or more SAML 2.0 bindings. SAML bindings are frameworks for embedding and conveying SAML protocol messages. That is, a SAML binding is a specific means of conveying SAML protocol messages using standard transport protocols (e.g., HTTP POST). The SAML bindings used for this Profile are:

- **SAML HTTP POST binding** – communication mechanism for an IdP to pass a SAML assertion to an RP. The HTTP POST binding defines a mechanism by which SAML protocol messages are transmitted within the base64-encoded content of an HTML form control. Advantages of this binding include (1) ease of implementation because no firewall reconfigurations are required; (2) scalability because HTTP POST is stateless (i.e., having no information about what occurred previously) and requires fewer hardware resources; and (3) HTTP POST is less complex and expensive to deploy than SAML Artifact based binding.
- **HTTP Redirect binding** – the communication mechanism for passing a SAML authentication request from an RP to an IdP. The HTTP Redirect binding defines a mechanism by which SAML protocol messages are embedded within an HTTP URL. Advantages of the HTTP Redirect binding are similar to those offered by the SAML HTTP POST binding.

These bindings can be used (singularly or in combination) to communicate directly between an RP and IdP. In addition, the bindings can be used (singularly or in combination) to indirectly communicate between an RP and IdP via the end user's browser.

2.3 Use Cases

The usual portable identity model includes three main actors: the end user, the IdP, and the RP. In all use cases within this model, the following always occurs:

1. The end user chooses to use an identity that he or she establishes with the IdP to interact with the RP;
2. The end user authenticates (e.g., enters a username and password) to the IdP;
3. The IdP asserts the identity of the end user to the RP via a SAML assertion; and
4. The RP relies on the identity information from the assertion to identify the end user.

In this model, the end user does not have to create a new identity at every RP with which he or she interacts. In addition, the RP does not have to integrate credential management features (e.g., identity proofing, password reset) because those features are "outsourced" to the IdP.

This Profile defines two main SAML 2.0 use cases. The use cases are differentiated by where the end user starts the SAML 2.0 transaction. The two main use cases are:

1. **End User starts at the RP** – The RP requests an assertion from the IdP. Both HTTP Post Binding and HTTP Redirect binding are used. Figures 1 and 2 illustrate this use case.
2. **End User starts at the IdP** – This is considered an unsolicited transaction because the RP does not request an assertion. Only HTTP Post binding is used. Figures 3 and 4 illustrate this use case.

All features defined in this Profile (e.g., SSO, session reset) derive from the two main use cases. All cookies set by a Federal agency are session based per [OMB M-03-22]. The cookies are deleted when the browser session ends.

Figure 1 Starting at the RP Use Case

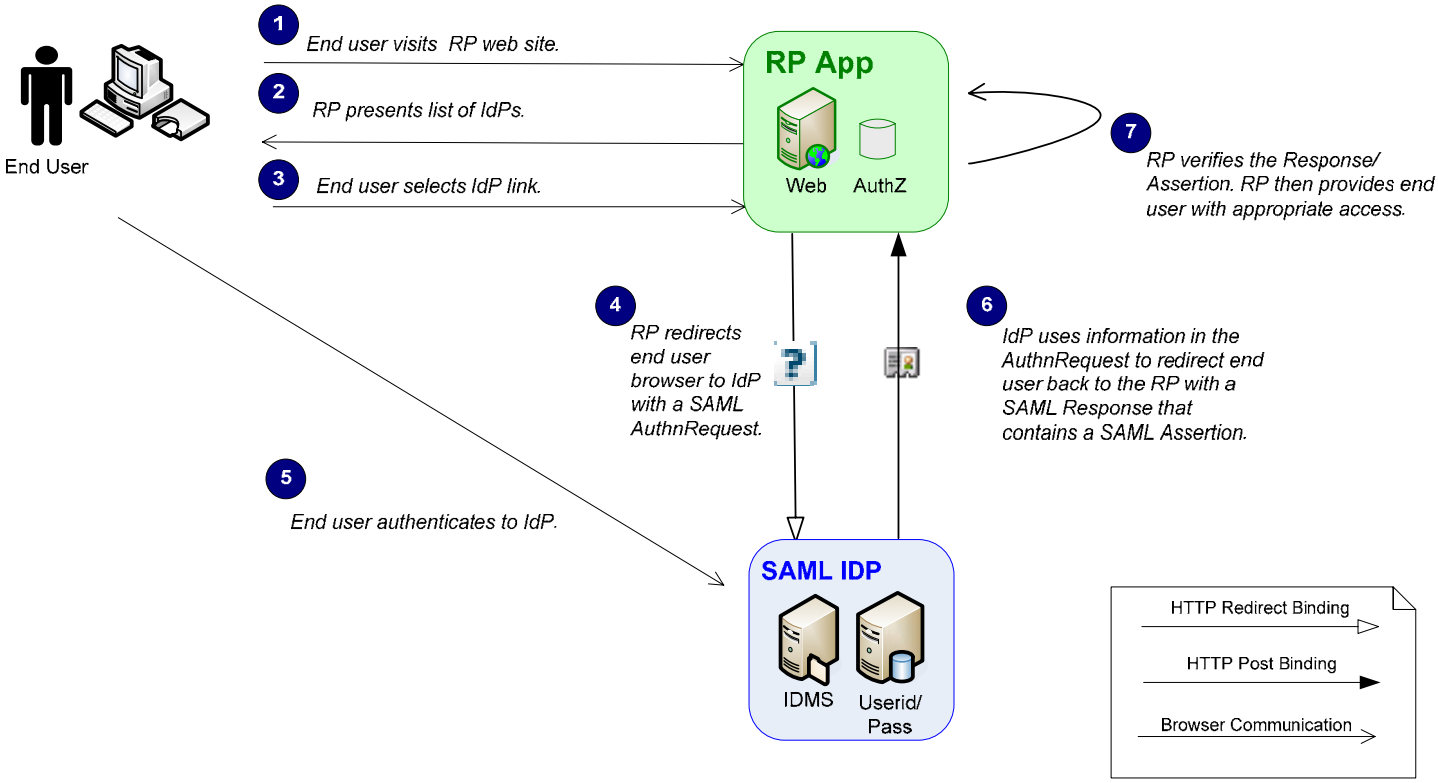


Figure 2 Starting at the RP Sequence Diagram

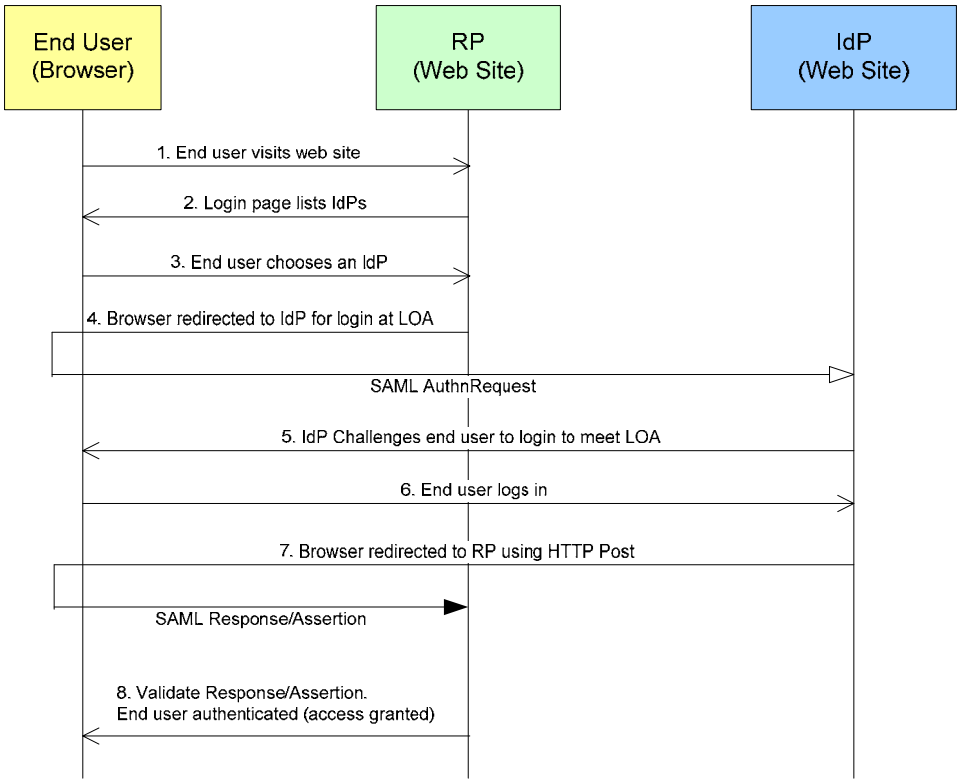


Figure 3 Starting at the IdP Use Case

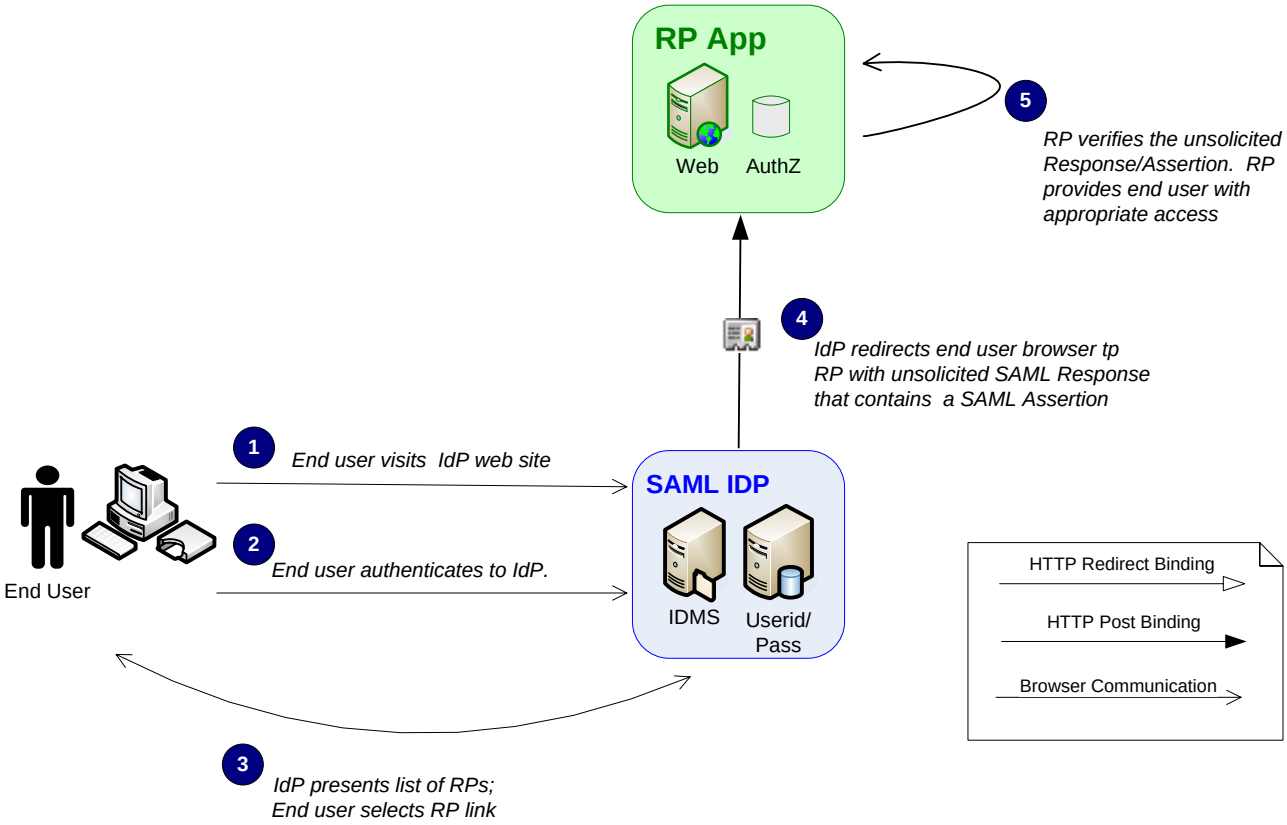
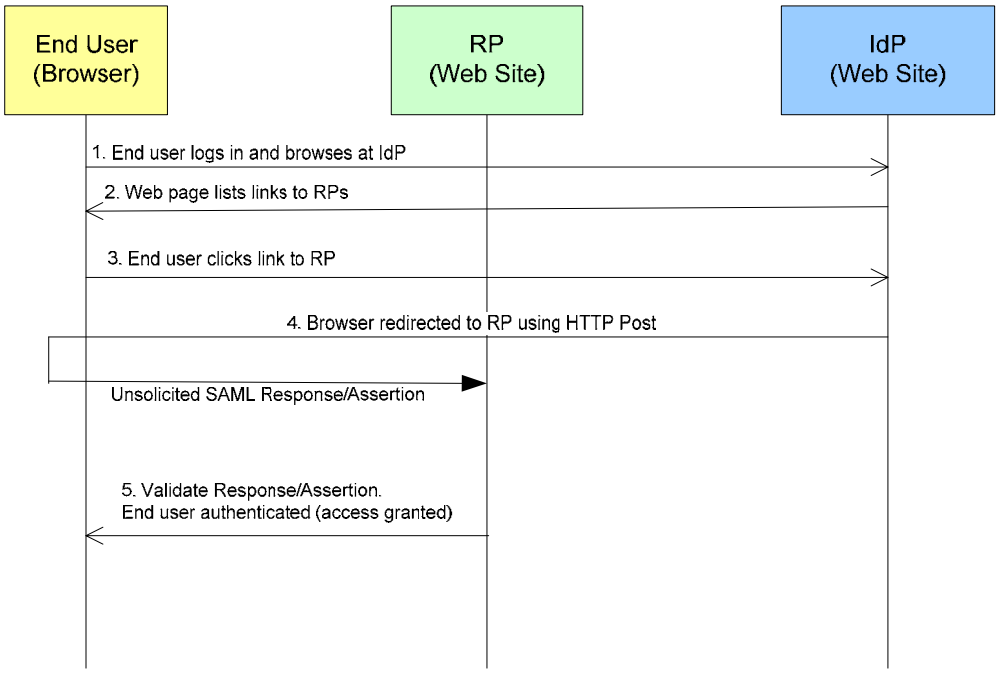


Figure 4 Starting at the IdP (Unsolicited Assertion) Sequence Diagram



2.4 Features

The following sections describe the features included in this Profile.

2.4.1 Single Sign-on

Single Sign-on (SSO) can be achieved when the end user has recently authenticated and has an active session with the IdP. If policy permits, the end user is not prompted to log in (re-authenticate) when another RP accessed by the end user requests a SAML assertion. In other words, the end user is seamlessly logged into any other RP that interoperates with the IdP.

2.4.2 Session Reset

Session reset allows an RP to force end user re-authentication in order to obtain a fresh identity assertion. Reasons include, but are not limited to the following:

1. RP policy requires end user authentication to the IdP even when SSO is in effect;
2. The end user has been idle for a while, and the RP wants to confirm that the end user is still there;
3. The end-user wants to initiate a transaction deemed sensitive by the RP; and
4. The RP has a policy for maximum RP session duration.

The RP requests a session reset by sending a SAML `AuthnRequest` with the `ForceAuthn` attribute set to 'true' to the IdP responsible for the end user's current authentication session. Upon receipt, the IdP re-authenticates the end user, even if SSO is in effect or the IdP's own policies do not require re-authentication at that time (i.e., the end user's authentication session has not yet expired).

2.4.3 Attribute Exchange

Attribute exchange is supported. This Profile recommends the use of attribute names from well-known registries. All attributes are optional. An RP that requires assertions containing attributes must publish its needed attributes via metadata. Attribute queries are supported for dynamic, real-time attribute requests.

IdPs must publish attributes they support via metadata. For authentication requests, IdPs should return an authentication assertion (i.e., an assertion that contains an authentication statement) even if they don't support the requested attributes.

2.5 Privacy

Privacy is of paramount importance. *ICAM Trust Framework Provider Adoption Process (TFPAP) For Levels of Assurance 1, 2, and Non-PKI 3* [TFPAP] includes several privacy requirements. Those privacy requirements must be followed. Privacy requirements include, but are not limited to the following:

1. The RP must not request attributes that it does not need, or has not included in a Privacy Impact Assessment or System of Records notification;
2. IdPs must not send attributes that are not requested by the RP;
3. This Profile uses pseudonymous identifiers to enhance end user privacy; and
4. Prior to any attribute exchange:
   a. The end user must be notified of the attributes to be exchanged; and

b. The end user must consent to the exchange. An RP cannot require the end user to consent to attribute exchange as a condition of accessing the RP. An alternative method for obtaining and verifying attributes or of obtaining another credential must be provided.

2.6 Security

In accordance with [SAML2 Security], this Profile includes high-level security measures for SAML 2.0 message transactions (see Section 3 of this Profile for additional details). RPs and IdPs digitally sign, in whole or in part, all SAML messages exchanged, and encrypt the entire SAML assertion contained within a SAML response message:

1. Digitally signing messages allows the message recipient to authenticate the sender as a trusted party. The recipient does not further process the received message until such positive verification;
2. Digitally signing message allows the message recipient to determine whether anyone or anything has tampered with the message (i.e., compromised message data integrity). The recipient does not further process a tampered message;
3. Digitally signing messages ensures non-repudiation (i.e., the sender cannot later deny that they sent the message); and
4. Digitally encrypting a SAML assertion ensures only intended recipients can read the contents of the SAML assertion, which contains personally identifiable information (i.e., confidential information).

2.7 End User Activation

The first time an end user authenticates to an RP via assertion, the RP must perform end user activation. End user activation is the process whereby an RP associates a new or existing local identity record (i.e., account[4]) with the end user's identifier from the IdP.

While the SAML 2.0 identity assertion provides the RP with a unique end user identifier, the RP often needs additional information about the end user before it can associate him/her with a local account and conduct a transaction. Sometimes that information can be retrieved from the assertion. Other times, the information can be retrieved directly from the end user and verified through an RP-determined process (e.g., knowledge-based questions/answers). The RP determines the need for activation and facilitates it when necessary. There are two primary use cases for activation: existing account linking and new account provisioning.

In existing account linking, the RP has existing end user records that it can link to the identifier in the assertion. For instance, the Social Security Administration (SSA) has records for all U.S. citizens, many of whom it has not conducted business with online. For example, by correlating the information it receives from the assertion with information in their databases, SSA can link the end user’s credential at the IdP with an existing local account.

In new account provisioning, the RP has no prior knowledge of the end user and must establish an account for the end user. The RP uses information gathered from the assertion and other processes determined by the RP to establish the new account and associate it with credential at the IdP.

[4] An account does not imply that the end user has local credentials.

Both use cases are discussed further below. In either case, the RP application does not have to allow access to its services immediately after receiving the assertion. For example, the RP may delay end user access if additional steps are required (e.g., out-of-band review and approval of some or all data entered by the end user). Appendix B provides an example activation process.

2.7.1 Existing Account Linking

If the end user already has an account with the RP, the RP may be able to use the information contained in the assertion (i.e., attributes) to automatically link the identifier in the assertion with the existing account. If the information in the assertion is insufficient to definitively identify the end user, the RP application could ask the end user to answer questions based on information contained in their existing records in order to verify that they are the person in question (i.e., knowledge-based authentication). Other processes can be defined by the RP to collect and verify information about the end user. The processes can be online or out-of-band. For example, the RP can mail a special code to the end user to verify the end user's address. Once the identifier from the assertion is linked to the account, subsequent visits by the end user with an assertion should result in immediate access to the RP application.

Note that an authentication assertion exchanged using SAML 2.0 should never be used to give an end user access to an application with a higher LOA requirement than is present in the assertion, even if the accounts are linked.

2.7.2 New Account Provisioning

The first time an end user visits an RP application, the application may not have an account for the end user. In this case, the RP needs to establish an account and associate the end user's identifier from the IdP with the new account. The RP usually needs some information about the end user in order to establish the account. This information can be supplied by the end user through interactive prompting of the end user, or by the IdP through backend attribute exchange. The RP must determine the information it needs and the process for collecting and verifying the needed information. Once the account is provisioned, subsequent visits by the end user with an assertion should result in immediate access to the RP application.

2.8 Programmed Trust

In addition to the governance outlined in [TFPAP], some mechanism to indicate which RPs and IdPs are approved for use must be provided. For the ICAM SAML 2.0 Profile, ICAM issues and distributes metadata to each ICAM member. In addition, ICAM issues certificates to ICAM members to sign their metadata prior to publication[5].

2.8.1 Metadata

SAML 2.0 message exchange between two ICAM-approved systems requires each to have specific knowledge about the other prior to trusted technical interoperation. One example of metadata is the URL of the service with which other systems will deliver SAML messages. Without such knowledge, other ICAM-approved systems do not know where to send SAML messages. Metadata describes and conveys such information. In general:

[5] See section 3.3.1.1.d for more information.

1. Metadata is the primary means of trust within ICAM. Therefore, it must be updated and consumed frequently[6].
2. Signed metadata is used to bind ICAM members to their digital signature and encryption keys.
3. Prior to run time, trust of ICAM members' signing and encryption certificates is determined when metadata is configured into the ICAM member system.
4. At run time, ICAM members must validate that the key used to sign inbound messages matches the message sender's key in metadata.

ICAM maintains and distributes metadata for all ICAM members. All ICAM members must produce and submit (and should publish) their own metadata, and consume the metadata of others as appropriate:

- Federal ICAM member:
  a. Must produce a metadata file with an `<md:EntityDescriptor> element formed` in accordance with Section 3.3.1 of this Profile.
  b. Must digitally sign the `<md:EntityDescriptor>` element using an ICAM-approved certificate.
  c. Should publish the most recent version of their signed metadata via HTTPS per [SAML2 Metadata].
  d. Must immediately update and re-submit metadata to ICAM and if applicable, re-publish metadata when the ICAM member's metadata information changes.
  e. Must verify metadata for correctness and completeness prior to consumption.
  f. Should check for and consume new or revised metadata on a periodic basis as prescribed by ICAM.
- Non-Federal ICAM members:
  a. Produce metadata as required by their TFP.
  b. Submit metadata to their TFP as required by their TFP.
     i. The TFP consolidates its members' `<md:EntityDescriptor>`s into an `<md:EntitiesDescriptor>`.
     ii. The `<md:EntitiesDescriptor>` must be signed using a key that is negotiated with ICAM.
  c. Consume metadata published by ICAM.

Failure to consume and configure metadata completely and correctly can preclude technical interoperation, or result in unexpected consequences or negative impacts to any number of ICAM member systems. ICAM Members should only consume metadata that is published or approved by ICAM.

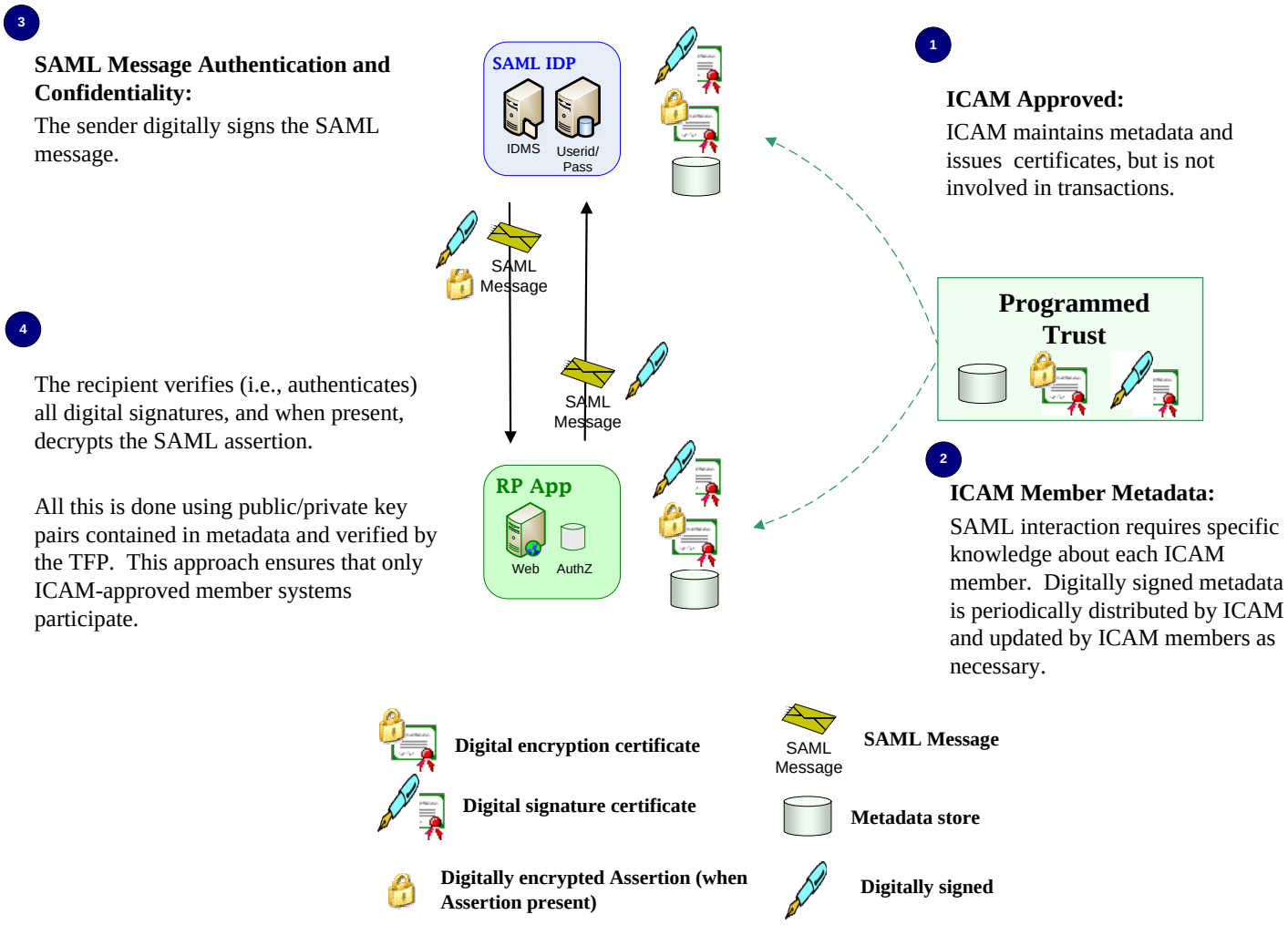
Despite its role in facilitating metadata distribution, ICAM is not involved in authentication transaction processing. ICAM members use the metadata to interact directly with each other for authentication transactions purposes. This Profile addresses metadata in accordance with [SAML2 Metadata], which includes:

1. Standards-based, XML encoded metadata files; and
2. Digitally signed metadata for the following purposes:
   a. Authenticate the metadata owner as a trusted participant; and
   b. Ensure metadata integrity (i.e., no tampering has occurred).

[6] Frequent publication and consumption of metadata serves a similar purpose to that of certificate revocation lists and should be treated with equal importance.

Figure 5 illustrates the high-level programmed trust process flow for applicable to all SAML 2.0 uses cases.

Figure 5 High-level Programmed Trust Process Flow



3. TECHNICAL PROFILE

Like most specifications, SAML 2.0 provides options. Where necessary, the Federal government may further specify or remove an option in order to achieve better security, privacy, or interoperability. The following sections outline the Federal ICAM Profile for the SAML 2.0 specification.

3.1 Authentication Request

1. The `<samlp:AuthnRequest>` MUST include a `<saml:Issuer>` element matching the `EntityID` in the metadata of the RP.
   a. The `EntityID` MUST be a URL that is in the RP's control.
2. Omitting `<saml:Subject>` and `<saml:Conditions>` from `<samlp:AuthnRequest>` is RECOMMENDED.
   a. Conditions are useful for delegation scenarios. However, delegation is out of scope for this Profile. If Federation partners wish to use `<saml:Conditions>`, they SHOULD establish an agreement as to its use.
3. Omitting `<saml:Scoping>` from `<samlp:AuthnRequest>` is RECOMMENDED.
   a. `<saml:Scoping>` and the extensions necessary to enable it are out of scope for this Profile. If Federation partners wish to use `<saml:Scoping>`, they SHOULD establish an agreement as to its use.
4. `ForceAuthn` MUST be supported.
   a. `ForceAuthn` MAY be used to require the IdP to force the end user to authenticate.
5. `isPassive` MUST be supported.
   a. If `isPassive` is true, the IdP MUST NOT take control of the end user interface (i.e., browser).
6. IdPs MUST use the `AssertionConsumerServiceURL` in metadata.
   a. IdPs MUST NOT rely on the `AssertionConsumerServiceURL` found in the `<samlp:AuthnRequest>`, if present.
7. `<samlp:AuthnRequest>` MUST include `<samlp:RequestedAuthnContext>` with one or more `<saml:AuthnContextClassRef>s` .
   a. The value of the `Comparison` operator MUST be set to "`exact`" unless RP and IdP have previously negotiated the use of other operators.
   b. The value of at least one `<saml:AuthnContextClassRef>` element MUST be one of the following ICAM LOA URLs:
      - http://idmanagement.gov/icam/2009/12/saml_2.0_profile/assurancelevel1
      - http://idmanagement.gov/icam/2009/12/saml_2.0_profile/assurancelevel2
      - http://idmanagement.gov/icam/2009/12/saml_2.0_profile/assurancelevel3
      - http://idmanagement.gov/icam/2009/12/saml_2.0_profile/assurancelevel4
      - Other ICAM-approved LOA URL value
8. `<samlp:NameIDPolicy> Format` MUST be present.
   a. The value for `<samlp:NameIDPolicy> Format` MUST be set to one of the following:.
      - urn:oasis:names:tc:SAML:2.0:nameid-format:persistent[7]
      - urn:oasis:names:tc:SAML:2.0:nameid-format:transient[8]

[7] The persistent `<NameID>` format requires a pseudonymous identifier that is unique to an IdP/RP pair for the end user.

9. The <samlp:AuthnRequest> issued by the RP MUST be communicated to the IdP using the HTTP-REDIRECT binding.
10. <samlp:AuthnRequest> MUST be signed.
    a. Key signing algorithm and key length MUST be conformant with [NIST SP 800-63].
11. If present, <samlp:AuthnRequest> ProtocolBinding MUST be set to urn:oasis:names:tc:SAML:2.0:bindings:HTTP-POST.

3.2 Response

1. An IdP MAY send unsolicited <saml:Assertion>s.
    a. If received, RPs MUST process unsolicited <saml:Assertion>s.
    b. RPs SHOULD accept <saml:Assertion>s only from IdPs whose EntityIDs are found in metadata.
2. The urn:oasis:names:tc:SAML:2.0:bindings:HTTP-POST binding MUST be supported.
    a. Parties who wish to use any other SAML binding SHOULD negotiate its use.
3. The <samlp:Response> MUST include a <saml:Issuer> element whose value matches the EntityID for the IdP in metadata.
4. At LOA 1, if successful the <samlp:Response> MUST contain exactly one <saml:Assertion> or <saml:EncryptedAssertion>.
5. At LOA 2 and higher, if successful the <samlp:Response> MUST contain exactly one <saml:EncryptedAssertion>.
6. The <saml:Assertion> MUST contain one <saml:AuthnStatement>.
    a. <saml:AuthnStatement> SessionIndex parameter SHOULD be present.
    b. <saml:AuthnStatement> SessionNotOnOrAfter MAY be present.
7. <saml:AuthnContext> MUST be present with one or more <saml:AuthnContextClassRef> elements.
    a. The value of at least one <saml:AuthnContextClassRef> element MUST be set to one of the following ICAM LOA URLs:
        - http://idmanagement.gov/icam/2009/12/saml_2.0_profile/assurancelevel1
        - http://idmanagement.gov/icam/2009/12/saml_2.0_profile/assurancelevel2
        - http://idmanagement.gov/icam/2009/12/saml_2.0_profile/assurancelevel3
        - http://idmanagement.gov/icam/2009/12/saml_2.0_profile/assurancelevel4
        - Other ICAM-approved LOA URL value
8. The <saml:Assertion> MUST contain a <saml:Subject>.
    a. <saml:Subject> MUST contain a <saml:NameID>.
    b. <saml:NameID> Format in the response MUST be either of the following:
        - urn:oasis:names:tc:SAML:2.0:nameid-format:transient
        - urn:oasis:names:tc:SAML:2.0:nameid-format:persistent
    c. <saml:SubjectConfirmationData> MUST be used per [SAML2 Profiles].
        - For holder-of-key assertions that meet LOA , the Method attribute of <saml:SubjectConfirmationData> MUST be urn:oasis:names:tc:SAML:2.0:cm:holder-of-key

[8] A transient identifier is used only one time.

9. The <saml:Assertion> MUST contain zero or one <saml:AttributeStatement>-s.
    a. Each <saml:AttributeStatement> MUST contain one or more <saml:Attribute>s, which MAY contain any number of <saml:AttributeValue>s.
    b. The IdP MUST use the attribute format urn:oasis:names:tc:SAML:2.0:attrname-format:uri.
    c. <saml:AttributeStatement> MUST use <saml:Attribute> and MUST NOT use <saml:EncryptedAttribute>.
    d. The use of URI-formatted Attribute names from well known registries is RECOMMENDED.
    e. IdPs MUST NOT send attributes that are not requested by the RP.
    f. RPs SHOULD NOT accept <saml:Assertion>s containing attributes that have not been negotiated out of band or via metadata.
        - AttributeConsumingServiceIndex MAY be included in the <samlp:AuthnRequest> in order to indicate a set of attributes that can be found in the metadata.
    g. At run time, before returning attributes to an RP, IdPs MUST notify the end user of the attributes to be shared with the RP, and obtain end user consent.
        - Once the end user has consented to share specific attributes with the requesting RP, the IdP MAY return those attributes without subsequent run-time notification and consent.
10. The <saml:Assertion> MUST include a <saml:Conditions>.
    a. <saml:AudienceRestriction> MUST be used per [SAML2 Profiles].
11. The <saml:Assertion> MUST be digitally signed.

3.2.1 LOA 4 Holder-of-key Assertion Requirements

At LOA 4, bearer assertions SHALL NOT be used to authenticate the end user to the RP. However, holder-of-key assertions made by the IdP MAY be used to bind keys or other attributes to an identity. Holder-of-key assertions may be used at LOA 4 provided that the following requirements are met[9]:

1. The end user MUST authenticate to the IdP using a certificate that is cross-certified with the Federal Bridge Certification Authority or issued under the Common Policy Framework Certification Authority at a certificate policy that meets the requirements of LOA 4 (See [FBCA CP] or [CPFCA CP]).
2. The IdP MUST generate a holder-of-key assertion that references the LOA 4 certificate that the end user used to authenticate to the IdP.
    a. The value of at least one <saml:AuthnContextClassRef> element MUST be:
        - http://idmanagement.gov/icam/2009/12/saml_2.0_profile/assurancelevel4.
    b. The value of the Method attribute of <saml:SubjectConfirmationData> MUST be urn:oasis:names:tc:SAML:2.0:cm:holder-of-key.
        - The <saml:SubjectConfirmationData> element MUST include a <ds:KeyInfo> with one <ds:X509Certificate> element as a child of <ds:X509Data>.
        - The <ds:X509Certificate> element MUST contain the certificate that the end user used to authenticate to the IdP.

[9] See [NIST SP 800-63-3] Section 10.3.2.4.

3. The RP MUST verify that the end user possesses the private key to the certificate that is referenced in the holder-of-key assertion using a LOA 4 protocol as specified in Section 9 of [NIST SP 800-63].

3.3 Metadata

3.3.1 Metadata Production

1. ICAM Member metadata MUST include at least one `<md:EntityDescriptor>` element.
   a. `<md:EntityDescriptor>` MUST contain a unique `entity-id`.
   b. `<Organization>` SHOULD be present and include `OrganizationName` or `OrganizationDisplayName`.
   c. `validUntil` and `cacheDuration` Attributes MUST be present.
   d. Prior to metadata distribution, `<md:EntityDescriptor>` MUST be digitally signed.
      - Federal ICAM members must sign metadata with an ICAM-approved certificate.
   e. `<md:KeyDescriptor>` MUST include a `<ds:KeyInfo>` with one `<ds:X509Certificate>` element as a child of `<ds:X509Data>`.
      - Other sub elements of `<ds:KeyInfo>` are permitted (e.g., `<ds:keyvalue>`) but they MUST all represent the same key.
2. RPs MUST include a `<md:SPSSODescriptor>` in their `<md:EntityDescriptor>` element.
   a. `protocolSupportEnumeration` MUST be present and set to `urn:oasis:names:tc:SAML:2.0:protocol`.
   b. `WantAssertionsSigned` MUST be set to true.
   c. `<md:SPSSODescriptor>` MUST contain `<md:KeyDescriptor>` with `Use` set to signing.
   d. `<md:SPSSODescriptor>`MUST contain one `<md:KeyDescriptor>` with `Use` set to encryption.
   e. `<md:SPSSODescriptor>` MAY contain `<md:SingleLogOutService>`.
   f. `<md:SPSSODescriptor>` MAY contain `<md:AttributeConsumingService>`.
      i. RPs wishing to request attributes in an `<samlp:AuthnRequest>` MUST publishing or more `<md:AttributeConsumingService>` in their metadata that includes the set of desired attributes.
3. IdPs MUST include `<md:IDPSSODescriptor>` in their `<md:EntityDescriptor>` element.
   a. `protocolSupportEnumeration` MUST be present and set to `urn:oasis:names:tc:SAML:2.0:protocol`.
   b. `WantAuthnRequestSigned` MUST be set to true.
   c. `<md:IDPSSODescriptor>` MUST contain one `<md:KeyDescriptor>` with `Use` set to signing .
   d. One or more `<md:SingleSignOnService>` MUST be present in `<md:IDPSSODescriptor>`.
      - `Binding` SHOULD be set to urn:oasis:names:tc:SAML:2.0:bindings:HTTP-Redirect.
   e. `<md:IDPSSODescriptor>` MAY contain `<md:AttributeAuthorityDescriptor>`.
      - IdPs SHOULD include `<Attribute>` for attributes they are capable of sharing.

f. `<md:EntityDescriptor>` MUST include the IdP's LOA expressed in accordance with OASIS *Expressing Identity Assurance in SAML 2.0*, Section 5 [Assurance]
   - The LOA expressed in metadata MUST be the highest LOA the IdP is certified to assert.

3.3.2 Metadata Consolidation

1. ICAM MAY consolidate `<md:EntitiesDescriptor>` metadata files issued by other organizations into one `<md:EntitiesDescriptor>` file for ICAM use. Support for the use of nested `<md:EntitiesDescriptor>` elements in a single file is REQUIRED.
   a. The root element of consolidated metadata MUST be `<md:EntitiesDescriptor>.`
      - The root element MAY contain one or more `<md:EntitiesDescriptor>` elements.
      - The root element MAY also contain one or more `<md:EntityDescriptor>` elements.
   b. ICAM MUST digitally sign the root `<md:EntitiesDescriptor>` and all its contents.
      - Each `<md:EntitiesDescriptor>` within the root element MUST be signed by the issuing organization using an ICAM-approved key.
   c. `validUntil` and `cacheDuration` attributes MUST be present.

3.3.3 Metadata Consumption

1. ICAM member implementations MUST support at least one of the following metadata import mechanisms:
   a. Local file (e.g., obtained out of band).
   b. Remote resource at fixed location accessible via HTTP 1.1 [RFC 2616] or HTTP 1.1 over TLS/SSL [RFC 2818].
      - In the case of HTTP resolution, ICAM member implementations MUST support use of the "ETag" header for cache management.
      - Other cache control support is OPTIONAL.
      - ICAM member implementations MAY import metadata from more than one source.
      - When an ICAM member encounters multiple `<md:EntityDescriptor>s` with the same `<md:EntityId>,` the ICAM member SHOULD use the metadata with the most recent `<md:EntityDescriptor>`.
2. At consumption time, the metadata consumer MUST perform XML-signature verification at the root element level.
3. At consumption time, the metadata consumer MUST support one of the following mechanisms for establishment of signature key trust:
   a. Direct comparison against preconfigured keys.
   b. Path-based certificate validation against one or more trusted root certificates combined with either certificate revocation list (CRL) or OCSP.
4. The `validuntil` attribute in an `<md:EntityDescriptor>` or `<md:EntitiesDescriptor>` element MUST be honored. ICAM members MUST refresh the metadata before it is expired. If for some reason the metadata cannot be refreshed before it expires, the member MUST make a risk-based determination whether or not to continue transacting with the effected entities.
5. Metadata consumers SHOULD be capable of processing one or more consolidated metadata per section 3.3.2.

3.4 Security

1. TLS/SSL MUST be used to protect all protocol endpoints.
2. All protocol messages, including metadata, MUST be digitally signed.
3. At run time, the message recipient MUST validate that the key used to sign the `<saml:Assertion>` matches the key in the metadata for that `entityID` in the `<saml:Assertion>`.

3.5 Single Logout (SLO)

1. SLO is NOT RECOMMENDED.
   a. Communities of interest who wish to utilize SLO MAY negotiate its use.

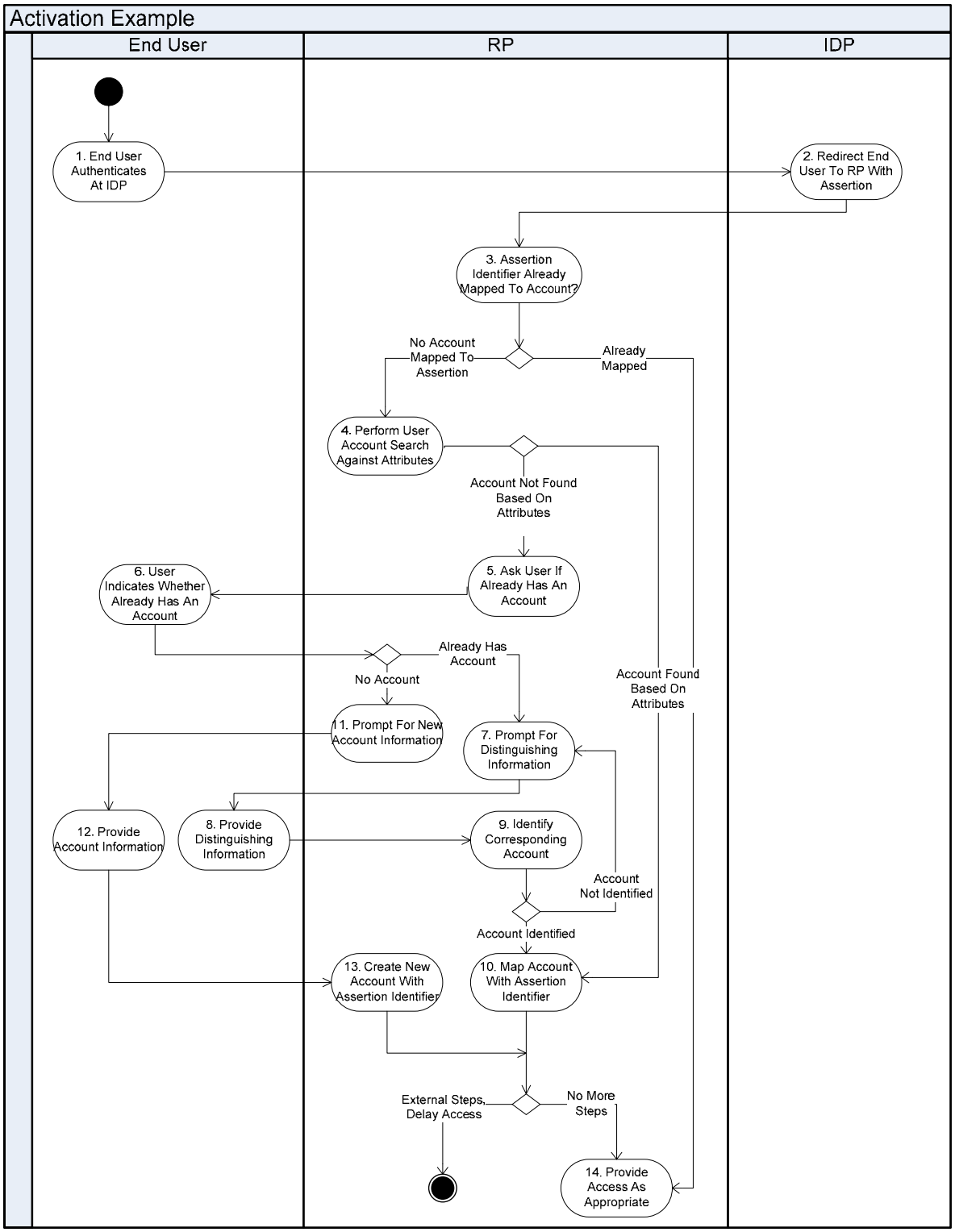
3.6 IdP Discovery

1. IdP Discovery is NOT RECOMMENDED.
   b. Communities of interest who wish to utilize IdP Discovery MAY negotiate its use.

APPENDIX A – SAML 2.0 PROFILE MESSAGE SUMMARY

SAML Feature	SAML Request Message	SAML Response Message	Comments
Authentication	AuthnRequest	Response	▪ No AuthnRequest if end user starts at the IdP ("Unsolicited HTTP POST") ▪ Encrypted assertion ▪ Signed assertion ▪ HTTP Redirect for AuthnRequest ▪ HTTP POST for Response
Single Sign-on	AuthnRequest	Response	▪ Encrypted assertion ▪ Signed assertion ▪ HTTP Redirect for AuthnRequest ▪ HTTP POST for Response
Session Reset	AuthnRequest	Response	▪ ForceAuthn attribute set to true ▪ Encrypted assertion ▪ Signed assertion ▪ HTTP Redirect for AuthnRequest ▪ HTTP POST for Response

APPENDIX B – END USER ACTIVATION EXAMPLE



APPENDIX C – GLOSSARY

Term	Definition
Account	An account is used to associate transactional records with an end user or organization. Presence of an account does not necessarily mean that there are credentials (e.g., username and password) associated with the account.
Approved	Acceptance by ICAM to technically interoperate with other ICAM members.
Assert	To make a statement about the properties of a user or user's act of authentication.
Authentication Session	Period of time that an end user remains trusted after the end user authenticates. That is because an IdP typically does not require an end user to re-authenticate for every page requested. Each IdP defines its own authentication session duration. If an end user returns to the IdP and an earlier authentication session has expired, the IdP re-authenticates the end user – even if single sign-on is in effect.
Binding	Mappings of SAML request-response message exchanges onto standard messaging or communication protocols.
Consolidated Metadata	Multiple <md:EntityDescriptor> or <md:EntitiesDescriptor> files into a single <md:EntitiesDescriptor> file.
Cookie (Transient Cookie)	A message given to a web browser (e.g., end user's web browser) by an ICAM entity. The web browser stores the message in a file that is accessible only to the entities within the domain where the message was provided. The cookie to facilitate single sign-on, and to manage sessions (e.g., RP session, authentication session). In addition, the ICAM only uses transient cookies, which are stored in temporary memory and erased when the end user closes their web browser. Cookies do not collect information from the end user's computer. Cookies typically store information in the form of a session identification that does not personally identify the end user.
Digital Encryption	Private key data encryption that converts data into a form that cannot be easily understood by unauthorized people. Decryption is the process of converting encrypted data back into its original form, so it can be understood.
Digital Signature	An asymmetric key operation where the private key is used to digitally sign an electronic document and the public key is used to verify the signature. Digital signatures provide authentication and integrity protection.
Discovery	Process of an end user finding a IdP and/or RP.

Term	Definition
Extensible Markup Language (XML)	XML is a specification developed by the W3C that enables the definition, transmission, validation, and interpretation of data between applications and between organizations. In a nutshell, XML describes data and focuses on what data is. XML facilitates technical interoperability, and is used in identity management standards such as SAML (e.g., to convey information in a SAML assertion).
Holder-of-Key Assertion	A holder-of-key assertion contains a reference to a public key (corresponding to a private key) or a symmetric key possessed by the end user. The RP requires the end user to prove possession of the private key or secret that is referenced in the assertion. In proving possession, the end user also proves that he or she is the rightful owner of the assertion.
Metadata	Information shared between endpoints (e.g., RP, IdP) necessary for technical interoperation.
Persistent	Ability to maintain data.
Pseudonymous Identifier	Private end user pseudonym that will only be used with one site. The site will always know it's you when you come back, but it won't be able to look up any other information about you, or correlate your profile with other sites.
Security Assertion Markup Language (SAML)	The set of specifications describing security assertions that are encoded in XML, profiles for attaching the assertions to various protocols and frameworks, the request/response protocol used to obtain the assertions, and bindings of this protocol to various transfer protocols (for example, SOAP and HTTP). SAML addresses web single sign-on, web services authentication, attribute exchange, authorization, non-repudiation, and secure communications. SAML defines assertion message formats that are referenced in Liberty Alliance, Shibboleth, WS-Security, and other specifications. SAML has become the standard web SSO identity management solution. Several versions have been released to date, including SAML 1.0, SAML 1.1, and SAML 2.0. The Organization for the Advancement of Structured Information Standards (OASIS) oversees SAML.
Signature Verification	The process of checking the digital signature by reference to the original message and a given public key, thereby determining whether the digital signature was created for that same message using the private key that corresponds to the referenced public key.
Single Sign-on (SSO)	Once an end user has authenticated their identity at an IdP, he or she may, by their choice, move among RPs that interoperate with the IdP without re-authenticating. In other words, the end user is seamlessly logged into any other RP that interoperates with the IdP. For privacy considerations, end users must take explicit actions to opt-in to SSO. SSO applies to assertion based ICAM member systems only. In addition, SSO is in effect only for the duration of the end user's current browser session and authentication session. An end user must opt-in to SSO each

Term	Definition
	time he or she opens a new web browser session.

APPENDIX D - ACRONYMS

Acronym	Definition
CRL	Certificate revocation List
GSA	General Services Administration
HTTP	HyperText Transfer Protocol
HTTPS	HyperText Transfer Protocol Secure
ICAM	Identity, Credential, and Access Management
IdP	Identity Provider
IETF	Internet Engineering Task Force
LOA	Level of Assurance
NIST	National Institute of Standards and Technology
OASIS	Organization for the Advancement of Structured Information Standards
OGP	Office of Governmentwide Policy
OMB	Office of Management and Budget
RFC	Request for Comment
RP	Relying Party
SAML	Security Assertion Markup Language
SLO	Single Log-out
SSA	Social Security Administration
SSL	Secure Sockets Layer
SSO	Single Sign-on
TFPAP	Trust Framework Provider Application Process
TLS	Transport Layer Security
URI	Uniform Resource Identifier
URL	Uniform Resource Locator
XML	Extensible Markup Language

APPENDIX E - DOCUMENT REFERENCES

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[RFC 2616] Hypertext Transfer Protocol.
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[RFC 2218] HTTP Over TLS
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[RFC 3339] Date and Time on the Internet: Timestamps
http://www.ietf.org/rfc/rfc3339.txt

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http://docs.oasis-open.org/security/saml/v2.0/saml-bindings-2.0-os.pdf

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