Guidelines for Establishing Trust between AARC-compliant AAI services using OpenID Federation (AARC-G100)

Publication Date [2025-10-20]
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Document Code: AARC-G100
DOI: *10.5281/zenodo.17054048*

Community: Architecture Area

Abstract

This specification provides guidance for enabling interaction and establishing trust among AARC-compliant entities such as OAuth 2.0 Authorization Servers (AS) and Resource Servers (RS) residing in distinct domains. These interactions are facilitated through trusted third parties referred to as Trust Authorities, which are entities issuing authoritative statements about entities that participate in an identity federation. The federation uses OpenID Federation. This document is intended for operators and implementers of AAI services and defines two trust profiles: G100.1 (Basic Trust Model), specifying the minimum requirements for establishing trust between proxies using OpenID Federation trust chains, and G100.2 (Fine-Grained Trust Model), which extends the basic model with policy-based trust through the use of Trust Marks and metadata policies.

1 Introduction

This document provides normative guidance for enabling interaction and establishing trust among AARC-compliant entities such as OAuth 2.0 Authorization Servers (AS) and Resource Servers (RS) residing in distinct domains. These interactions are facilitated through trusted third parties referred to as Trust Authorities, which are entities issuing authoritative statements about entities that participate in an identity federation. This guideline assumes that the federation uses OpenID Federation and it complements the [AARC-I058] informational document. I058 explores multiple approaches for establishing trust, and selects a single approach to focus on, the recommended approach *6. Federation Entity Discovery*.

The document is a baseline about what is required to establish trust between proxies. It is a profile for using OpenID Federation with AARC-compliant entities (traditionally called SP-IdP Proxies, nowadays better understood as RP-OP-Proxies). As such it describes the basic behaviour (minimum requirements) that Proxies need to comply with in order to enable communication across their trust domains in a Federation. Actual trust establishment — including whether one Proxy chooses to trust another and whether such trust is mutual — is driven by each Proxy's local policy, not enforced by this baseline. The basic behaviour includes processes like client registration (between the Proxies), use of trustmarks, trust chain evaluation, Trust Authority behaviour, resolving endpoints, etc. The proxied token introspection [AARC-G052] ties into this basic behaviour too.

Since this document focuses on defining a baseline for establishing trust, it does not define an operational infrastructure for federations.

1.1 Notational Conventions

The key words 'MUST', 'MUST NOT', 'REQUIRED', 'SHALL', 'SHALL NOT', 'SHOULD', 'SHOULD NOT', 'RECOMMENDED', 'NOT RECOMMENDED', 'MAY', and 'OPTIONAL' in this document are to be interpreted as described in [RFC2119].

Unless otherwise noted, all the protocol parameter names and values are case sensitive.

Unless otherwise noted, all sections are not normative.

1.2 Terminology

This section defines the terminology used by this specification. This section is normative.

This specification uses the terms "access token", "authorization endpoint", "authorization grant", "authorization server" ("AS"), "client identifier", "protected resource", "refresh token", "resource owner", "resource server" ("RS"), and "token endpoint" as defined by OAuth 2.0 [RFC6749]; the terms "claim names" and "claim values" as defined by JSON Web Token (JWT) [RFC7519]; the terms "token introspection" and "introspection endpoint" as defined by

OAuth 2.0 Token Introspection [RFC7662]; the term “relying party” (“RP”) as defined by OpenID Connect Core [OIDC-Core] (to be synonymous with “client”); the terms "entity", "entity identifier", "trust anchor", "federation entity", "entity statement", "entity configuration", "subordinate statement", "entity type", "entity type identifier", "leaf entity", "subordinate entity", “intermediate entity”, “immediate superior entity”, "federation entity discovery", "trust chain", "trust mark", "federation entity keys", “metadata policy” as defined by OpenID Federation [OID-Fed]; and the terms “infrastructure proxy”, “SP-IdP-Proxy (Proxy)” defined by the AARC Blueprint Architecture 2019 [AARC-G045].

This specification defines the following terms:

Trust Authority
: A Trust Authority is a third party which is trusted to identify entities. In OpenID Federation, any Trust Anchor, Intermediate Entity or Superior Entity is a Trust Authority.

Clients

: Every OIDC Relying Party (“RP”) is an OAuth 2.0 client, but not every OAuth 2.0 client is a Relying Party. Their roles and responsibilities differ.

: The RP is an OAuth2 client with the primary concern of processing authentication and identity assertions (claims about the user from an OP). RPs require an `id_token` to know who the user is. OAuth2 clients are simpler; their primary concern is authorisation to access protected resources. They do not require authentication or identity assertions.

: In this document, when referring to “clients” we refer to clients in the context of client/server connections. Whenever referring to OAuth 2.0 clients specifically, we use the term “OAuth 2.0 clients”.

1.3 Scope of this document

This document elaborates on the basic requirements for establishing trust between different proxies in different domains, and on how to address these requirements. We describe the processes for establishing trust using OpenID Federation (OID-Fed). Two trust profiles are defined: a Basic Trust Model (G100.1) and a Fine-Grained Trust Model (G100.2). The fine-grained model builds upon and requires compliance with the basic model.

Out of scope of this document are all organisational aspects of proxy operation, i.e. decisions regarding which Trust Anchors are trusted and how public keys are published, distributed, or revoked. We do assume that appropriate mechanisms for this are in place.

Furthermore, actual policies, which may be the basis for trust decisions, are also out of scope.

Any entity behind a proxy may be exposed to the federation via the proxy acting as an intermediate. This is a decision of the proxy operator and not in scope of this document.

2. Trust Model

In a federated Authentication and Authorisation Infrastructure (AAI) system, each trust domain — typically representing an administrative, legal or technical boundary — hosts one or more AARC-compliant AAI services.
AARC-compliant AAI services typically incorporate an SP-IdP-Proxy component [AARC-G045], acting as both a Service Provider and an Identity Provider. In the context of OIDC, these roles correspond to a Relying Party and an OpenID Provider: the proxy acts as a Relying Party towards its Identity Providers or upstream AAIs, and as an OpenID Provider towards its Service Providers. To participate in Research and Education (R&E) identity federations, these proxies often require a protocol translation layer (e.g. OIDC to SAML2). The federation model described in this document enables direct participation of OIDC and OAuth 2.0-based entities in federations, eliminating the need for such a translation, by establishing trust through a trusted third party known as a Trust Authority. A Trust Authority is an entity whose primary role is to issue statements about other entities — such as OAuth 2.0 Authorization Servers (AS) and Resource Servers (RS) — that participate in a federation.

The trust model is based on mechanisms from the OpenID Federation Specification [OID-Fed] and enables entities that have no direct trust relationship to establish trust by constructing a Trust Chain (trust path) from the other entity to a trusted third party — a Trust Anchor.

Figure 2.1 shows a single Trust Authority for simplicity, but the trust evaluation mechanisms discussed are designed to support more complex federation topologies, e.g. with multiple Trust Authorities, hierarchical federation structures, or even multiple overlapping federations.

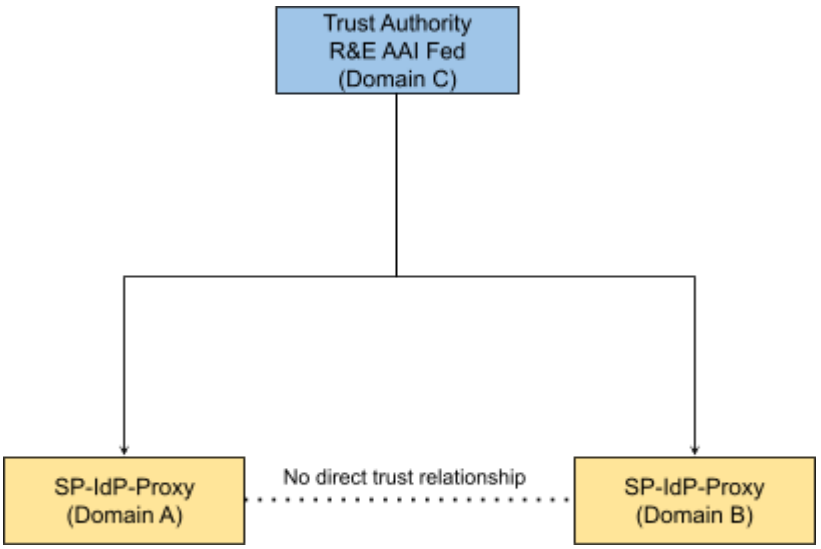


Figure 2.1 Simple federation model based on the use of a common Trust Authority.

While a **Trust Authority** is defined as a third party which is trusted to identify entities — by issuing statements about them — it can take on different roles in a federated environment. For example, from the point of view of a Proxy:

- an **Immediate Superior Entity** is a Trust Authority that represents a federation operator which:
    - onboards the Proxy into its federation through an out-of-band registration process; and,
    - is able to issue statements about the Proxy.

  A Proxy can have multiple Immediate Superiors, i.e. can be part of multiple federations.
- a **Trust Anchor** is a Trust Authority that is inherently trusted by the proxy on the basis of its keys.
    - It does not need to onboard the proxy or trust the proxy, be it directly or indirectly.
    - A Proxy can have multiple Trust Anchors.

A more complex example assumes that proxies can be part of multiple federations (have multiple Immediate Superiors) and trust multiple Trust Anchors. In addition, trust hierarchies are possible, where Trust Authorities can register with other Trust Authorities to be part of their federations.

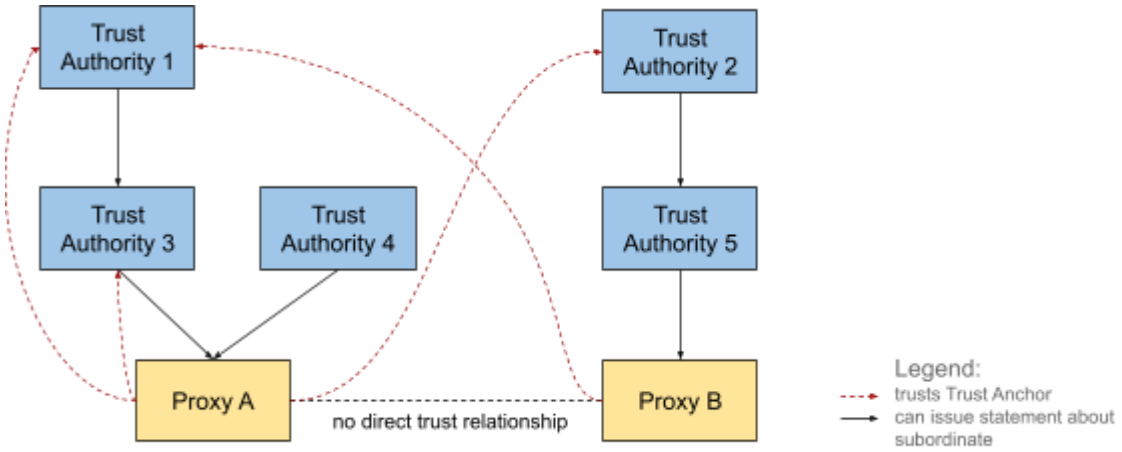


Figure 2.2 A more complex trust model with multiple Trust Authorities, hierarchies, and asymmetric trust.

In the example in Fig. 2.2, the black arrows depict which entities a Trust Authority can issue statements about. As such, we have:

- Proxy A's Immediate Superiors: Trust Authority 3, Trust Authority 4
- Proxy B's Immediate Superiors: Trust Authority 5

In addition, each proxy has its own Trust Anchors, for example:

- Proxy A's Trust Anchors: Trust Authority 3, Trust Authority 1, Trust Authority 2
- Proxy B's Trust Anchors: Trust Authority 1

In this example, Proxy A and Proxy B:

- don't have a direct trust relationship

- can establish trust by constructing a trust path from the other entity to one of their Trust Anchors:
    - Proxy A trusts Proxy B because there is a path from Proxy B to Trust Authority 2
    - Proxy B trusts Proxy A because there is a path from Proxy A to Trust Authority 1

In the real world, a more fine-grained approach to trust might be needed.

- Registering into a federation may be conditioned by compliance with certain federation policies.
- This set of policies may need to be signalled to other proxies that are not part of the same federation in a consistent way, so that proxies can additionally decide to trust other proxies on the basis of these policies.

3. OpenID Federation

This section describes the building blocks of OpenID Federation that are relevant for the trust establishment in the context of this document. This section is not normative.

OpenID Federation provides a scalable framework for establishing trust relationships without pre-existing bilateral agreements. Unlike traditional federations based on manual metadata exchange (e.g. SAML based), OID-Fed allows federation participants to:

- dynamically discover each other's metadata
- dynamically evaluate trust by constructing a verifiable trust chain to a trusted third party
- assert conformance to federation policies using cryptographically verifiable Trust Marks

Federations in OID-Fed are modelled as a directed graph of trust relationships, typically described as a "**tree**", though it may more often resemble a "**mesh**" in more inter-connected, multi-anchor federations.

- **Leaf entities** represent federation participants (e.g. SP-IdP-Proxies).
- **Intermediate entities** and **Trust Anchors** represent federation operators, which issue signed statements about their members.
- **Trust Anchors** are trusted third parties whose (public) signing keys are distributed out-of-band and treated as the basis of trust.

The basis for the OID-Fed trust framework is the **Entity Statement**, a signed JWT using asymmetric cryptography.

- Entities publish their metadata as self-signed entity statements called **Entity Configurations**, at a well-known URL.
- Trust Anchors and Intermediate entities issue signed entity statements called **Subordinate Statements** about their immediate subordinates (containing the subordinate's public key) as a way to assert that the subordinates are members of their federation.

- A set of entity statements can form a path from a leaf entity to a Trust Anchor, called a **Trust Chain**. The Trust Chain can be cryptographically verified using the signature of each statement, with the Trust Anchors's key inherently trusted.
- An entity A can trust an entity B if it can construct a valid trust chain from B to one of A's Trust Anchors.
- Additionally, subordinate statements can contain so-called **Metadata Policies**, which allow Intermediate entities to enforce technical constraints on their subordinates' metadata. This enables a federated resolution of metadata by aggregating metadata policies in a trust chain and applying them to a leaf entity's metadata. Note that metadata policies, as defined by OID-Fed, are different from federation policies, which are more general guidelines and rules that govern a federation, and the interaction and operation of entities within a federation.

Even though not in the scope of the OID-Fed spec, the process of registering entities with their superiors (onboarding in the federation) is a prerequisite for creating the trust fabric. Each federation operator is responsible for providing such a process to exchange keys and verify the eligibility of an entity to join their federation, before being able to issue an entity statement about it. In turn, federation members signal membership by publishing their immediate superiors in their own entity configuration (via authority_hints).

3.1 OpenID Connect Client registration

The OID-Fed specification defines two methods that use Trust Chains to establish trust between an RP and an OP that have no prior explicit configuration or registration between them: Automatic Registration and Explicit Registration. Both methods can also be used for OAuth 2.0 profiles other than OpenID Connect.
For a successful communication, the RP and OP MUST support a common client registration method. Therefore, federations SHOULD agree on the supported client registration methods. The table below shows a comparison of the two methods.

	Automatic registration	**Explicit registration**
Mechanism	• RP can make authentication requests to the OP with no prior registration • RP uses its federation entity id as the client ID in all interactions • OP must dynamically discover and validate trust with RP on the fly, then client is automatically accepted • Must use asymmetric cryptography to authenticate requests since there is no client secret assigned	• Dedicated client registration similar to OIDC, but RP submits an Entity Configuration or a whole Trust Chain instead of just metadata • OP validates trust chains and applies registration policies • Once registration is completed, client id and secret are assigned and subsequently regular OpenID authentication requests can be done
Pros	• No need for prior contact • Fully dynamic	• More control • Allows policy checks and pre-registration processing

		• Allows the use of existing OIDC libraries without OID-fed support for the OIDC communication.
Cons	• Less initial control, policies evaluated at runtime • Must be able to validate on the fly	• Requires client-side registration logic (limited scalability). • Client registration expires; client must be able to handle (periodical) re-registration.
Use cases	• Large federations with many potential clients • Dynamic trust for short-lived integrations	• Federations with specific metadata requirements • Clients where the OIDC communication cannot / should not be changed.

3.2 Trust Marks

OID-Fed also introduces the concept of **Trust Marks**, which can be used to represent conformance to federation policies in a scalable and verifiable way. A Trust Mark, represented as a JWT, is a signed statement of conformance to a well-scoped set of criteria as determined by an accreditation authority, issued and signed by that accreditation authority. Trust Marks are published by an entity in their Entity Configuration, and they can be validated with a trusted accreditation authority, also called Trust Mark Issuer (recognised Trust Marks and their authorised accreditation authorities within the federation should be published by the Trust Anchor). The concept of Trust Mark delegation is also supported (via signed delegation JWTs), for cases where a Trust Mark Owner delegates the issuance of Trust Marks to (one or multiple) Trust Mark Issuers, for various administrative or technical reasons.

Trust Marks might be used in several scenarios:

- Local policies at the proxy: during trust evaluation between leaf entities, in addition to having a valid trust chain, entities might impose additional constraints to establish trust, e.g. entities must conform to specific policies as represented by Trust Marks.
- Federation onboarding: Trust Authorities might require entities to have specific Trust Marks in order to be allowed to join a federation; also, Trust Authorities can issue a membership Trust Mark after registration.
- Entity discovery: Trust Marks can be used to filter entities during discovery processes.

It is important to distinguish between Trust Chains and Trust Marks: they are orthogonal concepts that serve different but complementary purposes. Trust Anchors are used to validate identity, federation membership and metadata integrity, while Trust Marks are used for policy enforcement and authorization filtering. Essentially, a Trust Anchor specifies who the entity is and where it fits in the federation (an “inventory”), while the Trust Mark asserts what the entity complies with (a “filter”).

4. Establishing trust using OID-Fed in the context of the AARC BPA

This section maps the building blocks of OID-Fed to address the trust requirements between Proxies.

Consider the Authorisation Server (AS) and the Client roles. As depicted in Figure 4.1, for an SP/IdP Proxy A to trust a Proxy B, the client interface of Proxy A (Client_A) needs to trust the AS interface of Proxy B (AS_B). To replace the current manual approach with OpenID Federation, several different options exist.

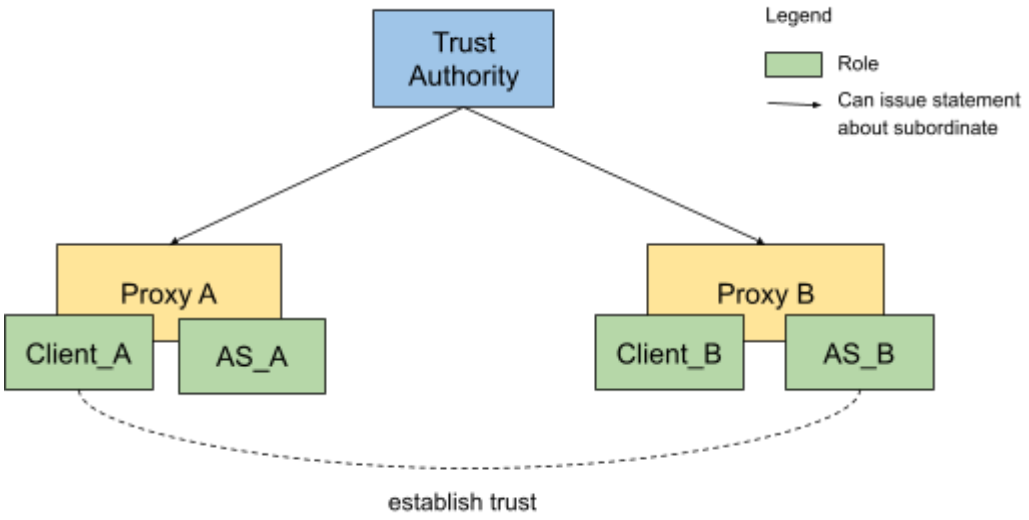


Figure 4.1 Establishing trust between two proxies in a simple trust model with one Trust Authority. The proxies can have multiple roles (Client, Authorisation Server). For Proxy A to trust Proxy B, Client_A needs to trust AS_B.

This document defines two different profiles for the trust model that can enable trust between the two proxies:

1. **[G100.1] Basic trust model**: this profile defines the minimum set of requirements needed to establish trust, based only on registration of proxies with superior entities.
2. **[G100.2] Fine-grained trust model**: this profile adds an additional layer to the basic trust model for finer grained trust, by using Trust Marks and metadata policies to explicitly express federation policy requirements.

Compliance with the guideline defined in this document can be expressed as a two-step process of compliance with these two profiles.

G100.1 Basic Trust Model

This section is normative.

Prerequisites:

- Proxies MUST join the trust fabric by registering with Trust Authorities.
- Both proxies MUST be able to establish a trust chain for the other party.

Notes:

- In this model, requirements for federation policies are implicit, since they are defined and considered out-of-band in the onboarding with Trust Authorities. When a Proxy trusts a Trust Anchor, it implicitly acknowledges all the policies required at the Trust Anchor.

To establish trust with another Entity (AS_B) the following MUST be done (high level):

1. Client_A uses OID-Fed logic to verify AS_B has a valid Trust Chain (Sec 10 of OID-Federation Spec Draft 43) to a Trust Anchor trusted by Client_A.

G100.2 Fine-grained trust model

This section is normative.

Prerequisites:

- Basic Trust Model (G100.1).
- To indicate compliance with policies and policy profiles, both parties MUST use Trust Marks.
    - one Trust Mark per federation policy may make sense (i.e. RAF, DPCoCo, Sirtfi v1/v2, ...)
    - one Trust Mark per profile may make just as much sense (e.g. EOSC-AAI, ...). Such a profile would be similar to a profile in RAF, e.g. RAF Cappuccino.
    - Both concepts can be used at the same time.
    - This requires Trust Mark Owners to issue Trust Marks, or to delegate this to Trust Mark Issuers that issue Trust Marks to the correct entities.
- Proxies MUST be able to apply Metadata Policies coming from upstream Trust Authorities during the Trust Chain Resolution Process.

To establish trust with another Entity (AS_B) the following MUST be done (high-level):

1. Client_A uses OID-Fed logic to verify AS_B has a valid Trust Chain(Sec 10 of OID-Federation Spec Draft 43) to a Trust Anchor trusted by Client_A.
2. Client_A uses OID-Fed logic to apply Metadata Policies during the Trust Chain Resolution process.
3. Client_A verifies that AS_B has a valid Trust Mark for all the Trust Mark Types Client_A requires.

5. Trust Establishment (technical flow)

This section and all its subsections are normative.

In the following sections, features and processes that pertain only to the fine-grained trust model are denoted with [G100.2] and compliance with these is not required in the Basic

model [G100.1]. Optional features in any of the trust models will additionally be denoted with “Optional”.

5.1 Onboarding process

To be able to establish trust, Proxies must already be part of the trust fabric. Proxies become part of the trust fabric by registering with a Trust Authority. The registration process is Trust Authority specific, and as such this guideline cannot mandate a specific process.

A typical process is depicted in Figure 5.1 and consists of the following steps:

- Initiate the onboarding process in some way
- Perform public key exchange between the Proxy and the Trust Authority
- Trust Authority performs eligibility checks, which SHOULD include:
    - Proxy has published an Entity Configuration (EC) at its well-known endpoint
    - The EC is valid, including:
        - It is not expired
        - It is signed with previously exchanged key
        - It contains the Trust Authority in authority_hints (alternatively, this can be done once onboarding is complete)
        - It satisfies any other requirements the Trust Authority might have regarding metadata
    - [G100.2]: EC contains specific required Trust Marks
        - Trust Marks are valid
    - Any non-technical checks
- The Trust Authority adds the Proxy to its internal database as a subordinate
- [G100.2]: Optional: the Trust Authority issues a Trust Mark to the Proxy proving membership
- [G100.2]: Optional: the Proxy adds the issued Trust Mark to its EC

To verify that the onboarding was successful:

- Go to Trust Authority’s fetch endpoint and get a statement about the Proxy
- Check that the statement is valid, i.e. not expired, contains the Proxy's public key, signed with the Trust Authority’s key
- [G100.2]: Optional: the Proxy has a valid membership Trust Mark

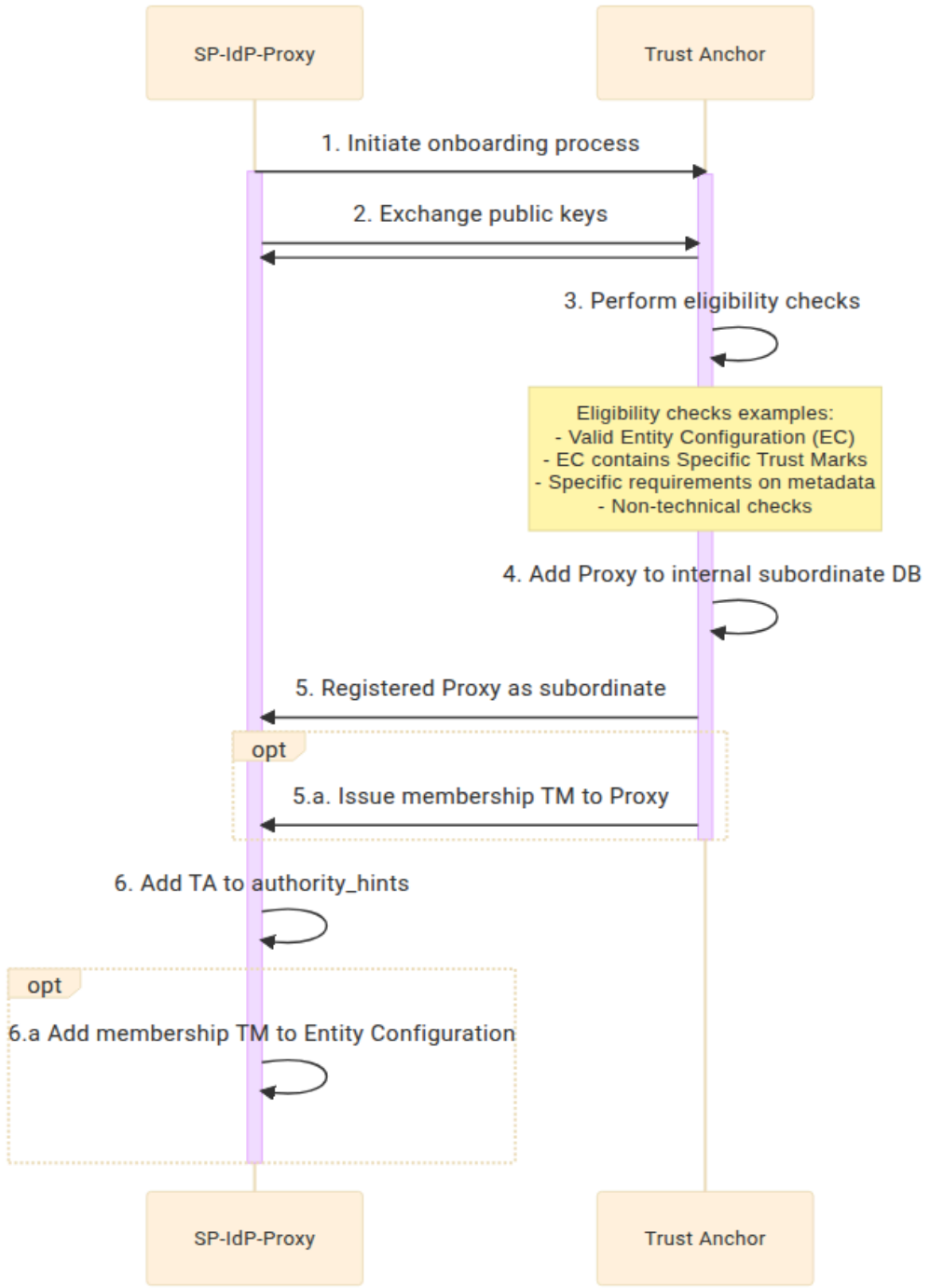


Figure 5.1 A general example for how onboarding could be implemented at a Trust Authority.

5.2 Entity Configuration

Each entity publishes their metadata as a signed statement called Entity Configuration in accordance to [OID-Fed]. The Entity Configuration MUST contain all the information needed for the subject entity to participate in the federation:

- The public part of the subject's signing keys
- The subject's immediate superiors
- The subject's metadata for all the roles the entity has in the federation

- [G100.2] The subject's Trust Marks

All entities in the federation MUST publish an Entity Configuration, including Trust Anchors, Intermediates, Trust Mark Issuers and SP-IdP-Proxies. SP-IdP-Proxies MUST provide OID-Fed metadata for multiple entity types, to be able to act as OIDC or OAuth 2.0 entities, such as: `openid_provider`, `openid_relying_party`, `oauth_authorization_server`, `oauth_resource`, `oauth_client`. Among these, `openid_provider` and `openid_relying_party` are mandatory in order to ensure support for standard authorization code flow, as well as AARC guidelines such as [AARC-G052] (OAuth 2.0 Proxied Token Introspection). Also, proxies MAY publish metadata for "`federation_entity`".

5.3 Resolving Trust

Figure 5.2 illustrates the general flow for how an SP-IdP-Proxy in Domain A can establish trust, acting as a Resource Server, with another SP-IdP-Proxy in Domain B acting as an OAuth 2.0 Authorization Server, both relying on a shared Trust Authority in Domain C.

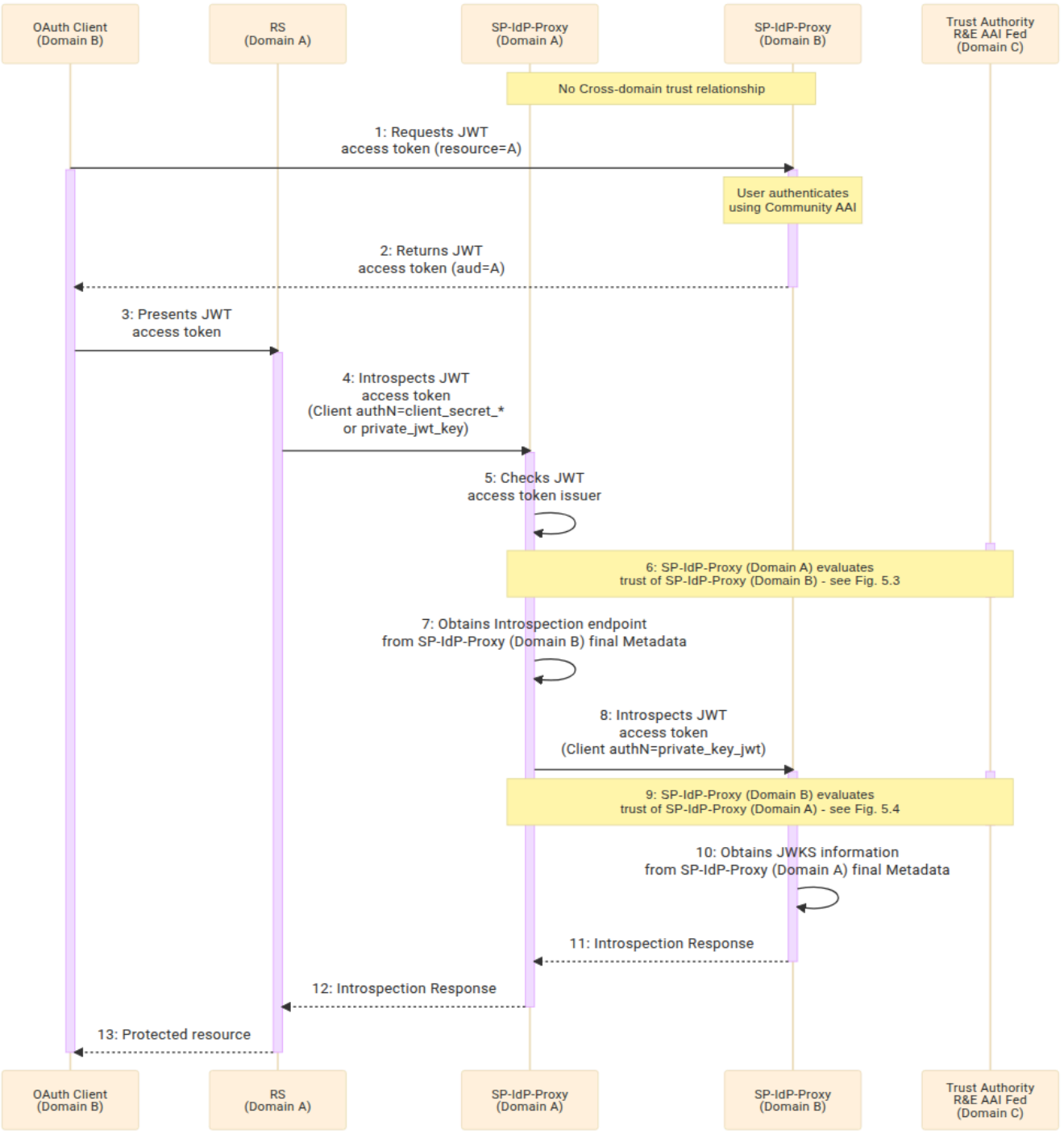


Figure 5.2 General flow for establishing trust between Proxy A acting as a Resource Server and Proxy B acting as an Authorisation Server. The flow assumes that automatic client registration is used. The diagram depicts the simple federation model with a single common Trust Authority.

In steps 6 and 9 in Figure 5.2, each SP-IdP-Proxy retrieves the Entity Configuration from the peer entity and builds a Trust Chain that consists of multiple signed statements, starting with a statement issued and signed by the leaf entity about itself, ending with a statement issued by a Trust Anchor about itself, and all the intermediate statements being issued by a superior

entity about its subordinate. Each superior signs the public key of its subordinate, which enables a top-down verification of the entire chain. The resulting trust chain is valid if:

- It terminates at a recognised Trust Anchor.
- All intermediate statements are validly signed and unexpired.

[G100.2] To resolve trust in the fine-grained model, additional steps are required:

- As part of the Trust Chain resolution, Metadata Policies defined by each Trust Authority in the chain are applied to the subject's metadata, ensuring that technical policies are always respected.
- Required Trust Marks MUST be present and valid.

The following sequence diagram represents the interactions between the SP-IdP-Proxy (Domain A), the SP-IdP-Proxy (Domain B), and the Trust Authority (also a Trust Anchor in this case) during a trust evaluation made by the SP-IdP-Proxy (Domain A) for the SP-IdP-Proxy (Domain B) — Step 6 in Figure 5.2:

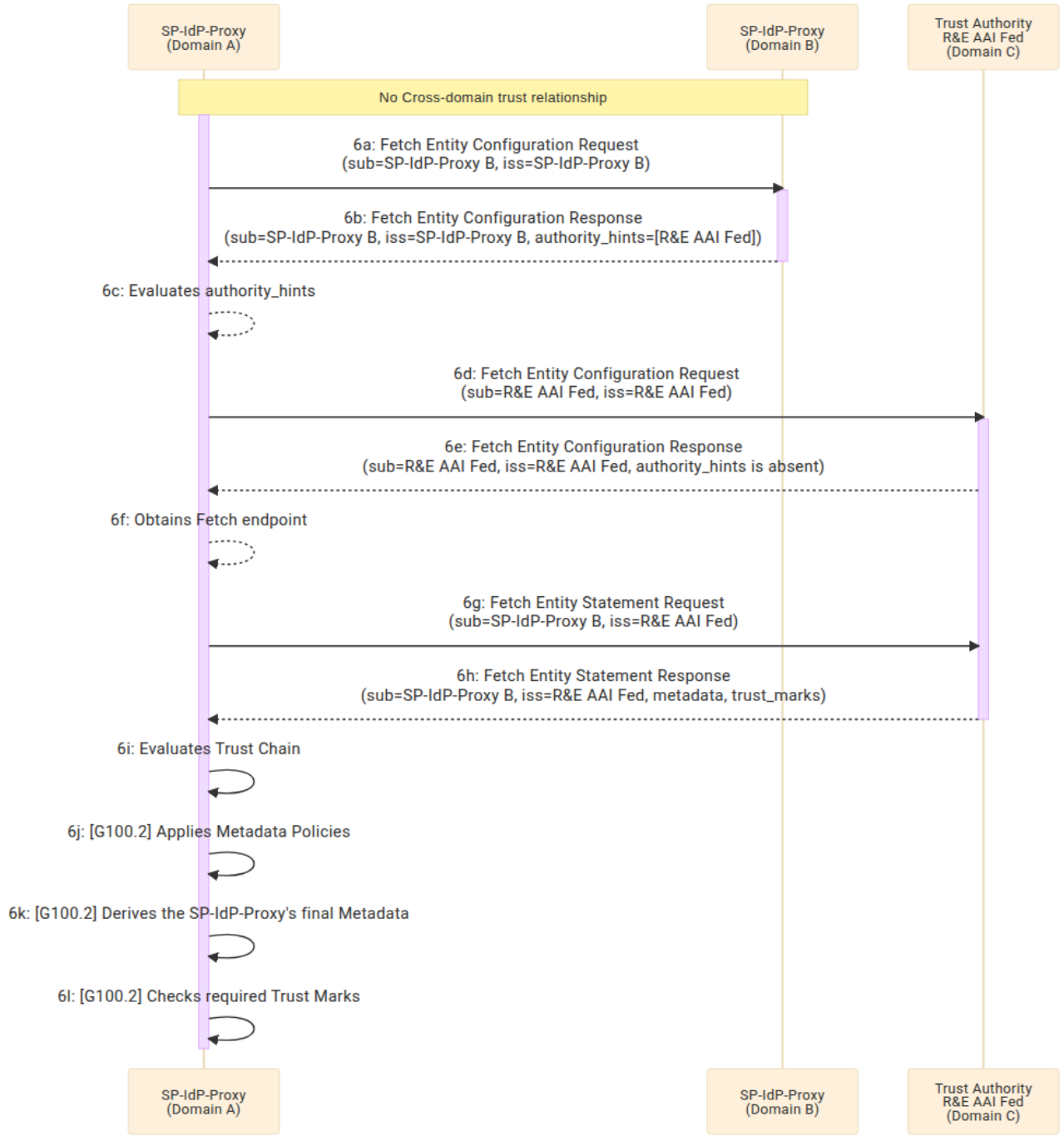


Figure 5.3 SP-IdP-Proxy (Domain A) evaluates trust of SP-IdP-Proxy (Domain B). The diagram depicts a simple federation model with a single Trust Authority. In a more complex federation with a hierarchy of Trust Authorities, steps 6c–6h are repeated until a Proxy A's Trust Anchor is reached, or until the Trust Authority does not contain any authority_hints. Multiple Trust Chains may be found, each Proxy may decide how to choose between multiple valid chains.

The following sequence diagram represents the interactions between the SP-IdP-Proxy (Domain A), the SP-IdP-Proxy (Domain B), and the Trust Authority during a trust evaluation made by the SP-IdP-Proxy (Domain B) for the SP-IdP-Proxy (Domain A) — Step 9 in Figure 5.2:

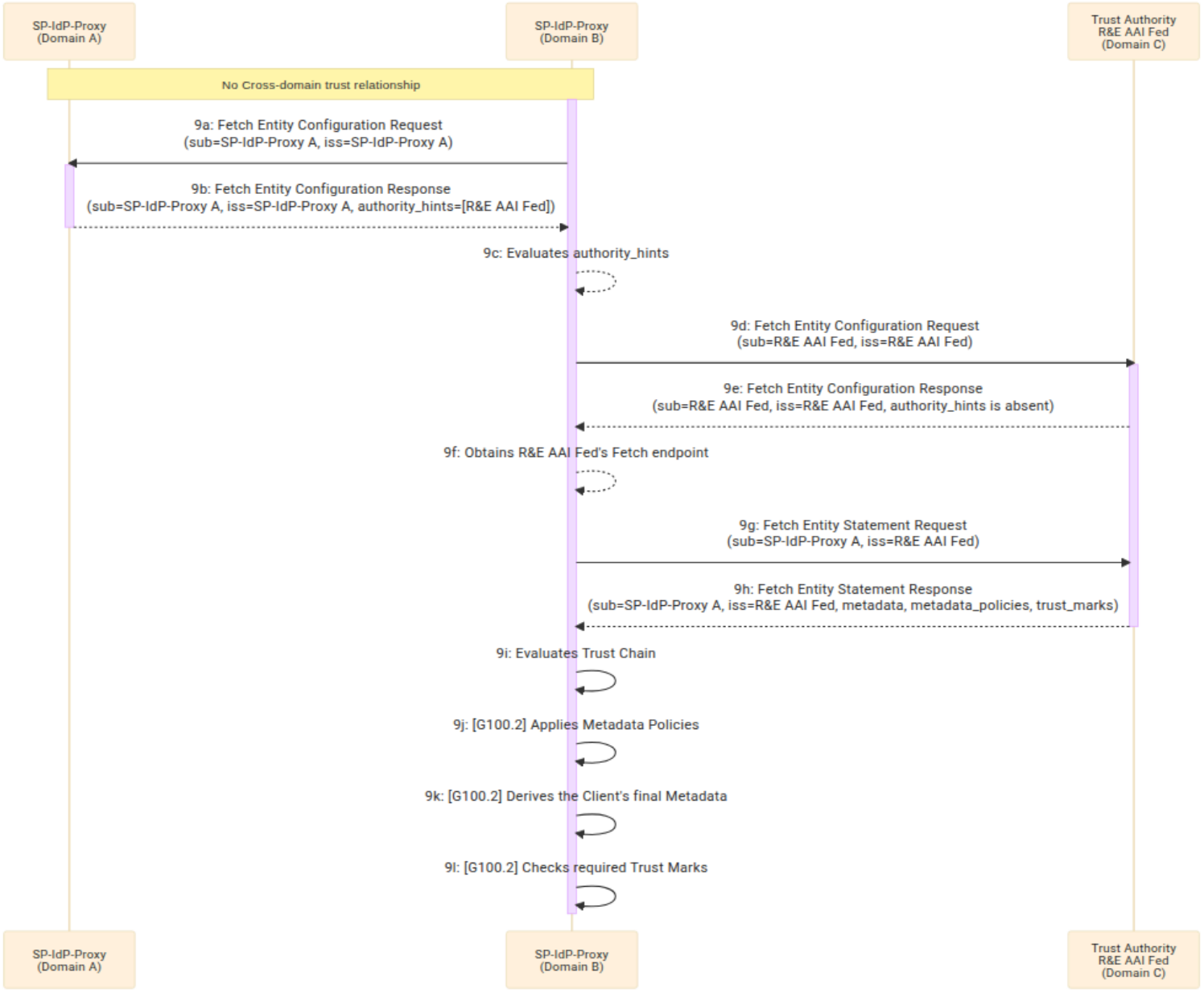
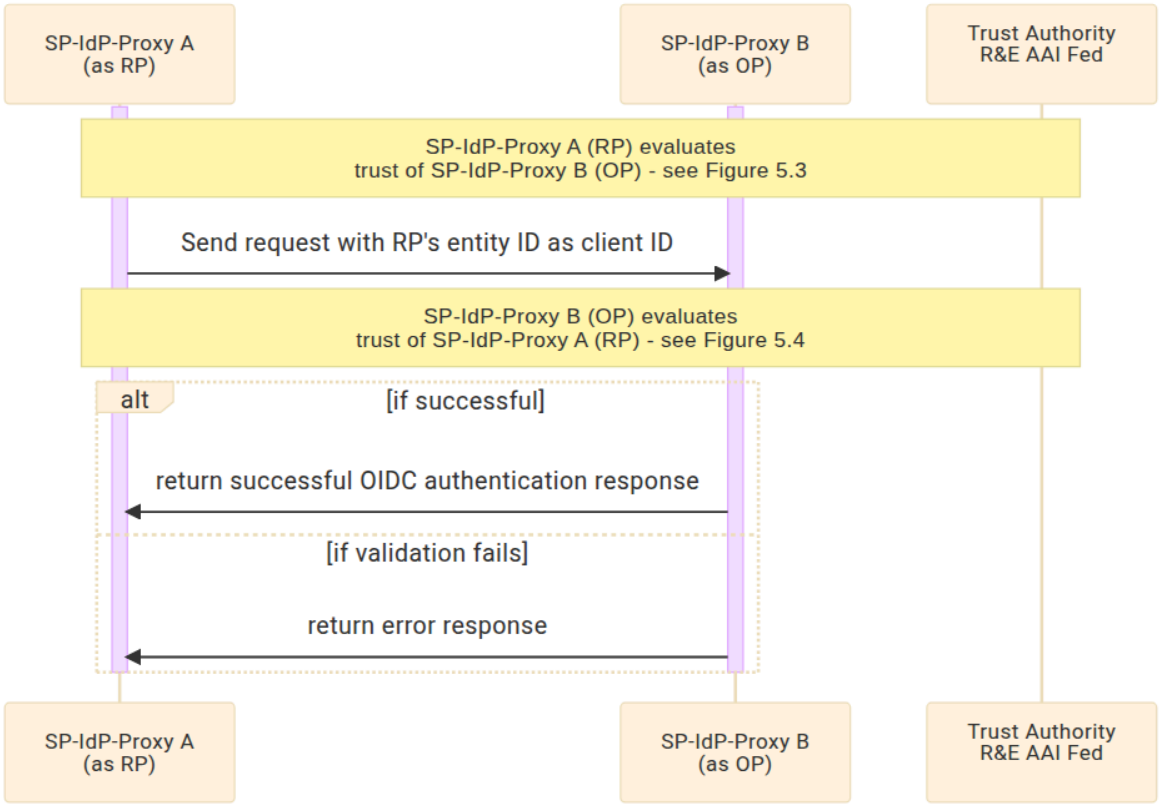


Figure 5.4 SP-IdP-Proxy (Domain B) evaluates trust of SP-IdP-Proxy (Domain A). The diagram depicts a simple federation model with a single Trust Authority. In a more complex federation with a hierarchy of Trust Authorities, steps 9c–9h are repeated until a Proxy B's Trust Anchor is reached, or until the Trust Authority does not contain any authority_hints. Multiple Trust Chains may be found, each Proxy may decide how to choose between multiple valid chains.

5.4 Client registration

For compliance with G100.1 and G100.2: both client registration methods MUST be supported for the OP role, one is REQUIRED for the RP role depending on the federation policies.



Automatic client registration flow:

Fig 5.5 Automatic client registration

Explicit client registration flow:

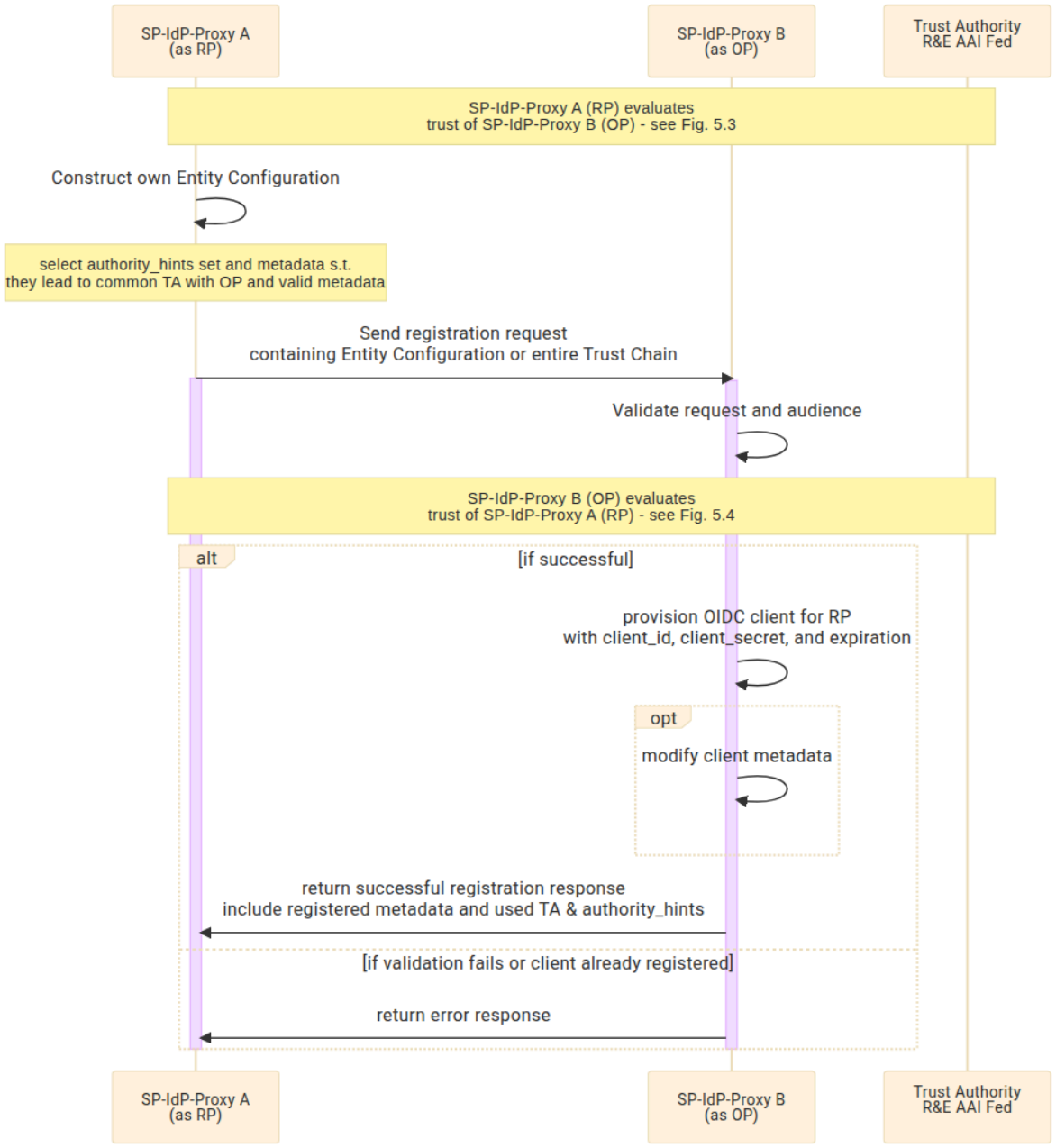


Fig 5.6 Explicit client registration

6. Federation Policies

In a federated AAI environment, federation policies define the expected operational, security, and organisational behaviors that participating entities must follow. These policies enable trust interoperability across distinct trust domains, particularly when entities do not have prior bilateral agreements.

[OID-Fed] provides several mechanisms of expressing and enforcing federation policies. [G100.2] makes use of these mechanisms to enable a more fine-grained control over trust requirements:

- **Trust Marks** can be used to represent conformance to federation policies in a scalable and verifiable way.
  In addition to a Trust Mark, some federation policies might require signalling compliance as part of the transaction, via standard OIDC mechanisms, such as claims or scopes. This is the case for the REFEDS Assurance Framework, which already includes a provision on how to use the specification with OIDC. Still, its presence as a trustmark allows other entities to discover support prior to the transaction and filter based on the support for RAF. The table in Appendix A.1 contains a non-exhaustive list of examples of federation policies that can be expressed as Trust Marks.
- **Metadata Policies** can be used to enforce requirements on the metadata of leaf entities, such as limiting supported scopes or claims, or requiring specific claims.
  Trust Authorities may use metadata policies to require Proxies to comply with specific guidelines. For example, to ensure that Proxies can release the required attributes in [AARC-G056], the metadata policy will require all OPs to support at least the following scopes via the metadata policy operator "`superset_of: email, profile, entitlements`".
  An Example Subordinate Statement issued by a [G100.2] trust authority about a proxy including metadata policies is shown in Appendix A.2.

It is also noted that federation policies still can be expressed and checked outside of OID-Fed. e.g. at the time of enrollment.

7. Implementation Considerations

7.1 Configuration

7.1.1 Trust Authority

The Trust Authority has the following requirements:

- MUST define an onboarding process for subordinates as defined in [Section 5.1]
  - SHOULD allow onboarding of entities with only a subset of the published entity types.
- MUST provide the Fetch endpoint for subordinate statements as defined in [OID-Fed]
- MUST provide the List endpoint as defined in [OID-Fed]
- [G100.2] MUST list accepted trust mark issuers
- [G100.2] MAY act as a Trust Mark issuer for the supported federation policies
- MAY provide a Resolve endpoint as defined in [OID-Fed]

An example Entity Configuration for a [G100.2] trust authority is shown in Appendix B.1.

7.1.2 Trust Mark Issuer

The Trust Mark Issuer has the following requirements:

- MUST implement the Trust Mark endpoint
- MAY implement the Trust Mark Status endpoint
- MAY implement the Trust Marked Entities Listing endpoint

An example Entity Configuration for a trust mark issuer is shown in Appendix B.2.

7.1.3 SP-IdP-Proxy

An SP-IdP-Proxy participating in a federation has the following requirements:

Entity Configuration Publication

- The SP-IdP-Proxy MUST expose an Entity Configuration at the well-known endpoint: `/.well-known/openid-federation` as defined in [OID-Fed].
- The Entity Configuration MUST include:
  - The Proxy's public signing keys.
  - The list of immediate superiors (`authority_hints`).
  - Metadata for all supported roles (see Supported Federation Roles below).
  - [G100.2] Any applicable Trust Marks.

Supported Federation Roles

- The SP-IdP-Proxy MUST publish metadata for at least the following roles:
  - `openid_provider` when acting as a Community AAI as per [AARC-G045] or Collaboration Management as per [AARC-G080]
  - `openid_relying_party` when acting as an Infrastructure Proxy per [AARC-G045] or Infrastructure Integration per [AARC-G080]
- The SP-IdP-Proxy MAY additionally publish metadata for:
  - `oauth_authorization_server` (see [AARC-G052] for additional requirements on OAuth metadata when supporting proxied token introspection)
  - `oauth_resource` (see [AARC-G052] for additional requirements on OAuth metadata when supporting proxied token introspection)
  - `oauth_client`
  - `federation_entity` when publishing generic metadata, such as informational metadata as defined in [OID-Fed] (§5.2.2)

An example Entity Configuration for a Proxy in the OP and RP role is shown in Appendix B.3.

Trust Chain Resolution

- The SP-IdP-Proxy MUST validate peer entities as defined in [OID-Fed].

    - The SP-IdP-Proxy MAY use an external resolver service to offload trust chain construction and validation.
    - Otherwise, the SP-IdP-Proxy MUST construct and verify the Trust Chains itself. Validation MUST include:
        - Digital signature checks.
        - Expiration, subject and issuer checks.
        - [G100.2] Application of metadata policies.
        - [G100.2] Verification of required Trust Marks.
- The SP-IdP-Proxy SHOULD maintain local caching of resolved trust chains to improve performance and availability.

Client Registration

- In the OpenID Provider (OP) role, the SP-IdP-Proxy MUST implement both Automatic Registration and Explicit Registration as defined in [OID-Fed] (§12.1 and §12.2).
    - The OP MUST implement the Federation Registration endpoint as defined in [OID-Fed] (§5.1.3 and §12.2)
- In the Authorization Server (AS) role, the SP-IdP-Proxy MUST implement both Automatic Registration and Explicit Registration as defined in [OID-Fed] (§12.1 and §12.2).
    - The AS MUST implement the Federation Registration endpoint as defined in [OID-Fed] (§5.1.3 and §12.2)
- In the Relying Party (RP) / Client / Resource role, the SP-IdP-Proxy MUST implement at least one client registration mechanism.
    - The SP-IdP-Proxy SHOULD support both registration mechanisms to maximise interoperability.
    - A federation policy MAY require a certain client registration mechanism.

Trust Mark Handling [G100.2]

- The SP-IdP-Proxy MUST have the ability to validate received Trust Marks as described in [OID-Fed] (§7) during the trust resolution (see Section 5.3)
- The SP-IdP-Proxy MUST validate all Trust Marks that are required by federation or local policies
- The SP-IdP-Proxy MUST publish valid Trust Marks in its Entity Configuration
- The SP-IdP-Proxy MUST ensure that published Trust Marks with an expiration are refreshed and updated before they expire.

7.2 Federation Topologies

OpenID Federation enables a variety of federation topologies beyond the simple single Trust Authority model. Depending on deployment needs, different topologies can be combined:

- **Peer-to-peer interactions:** Direct trust establishment between proxies across administrative domains (e.g. for cross-domain resource access via proxied token

introspection [AARC-G052]). Trust chains are constructed to a common Trust Anchor without requiring bilateral agreements.

- **Hierarchical federation structures:** One or more intermediate entities act on behalf of a Trust Authority, delegating trust to proxies. This topology reflects national or thematic federation operators onboarding participants under a higher-level inter-federation Trust Anchor.
- **Multiple overlapping federations:** A proxy may participate in more than one trust chain simultaneously (e.g. national, community, and cross-infrastructure federation contexts). This supports scenarios where policy requirements differ across federations, and trust decisions must consider multiple paths.

7.3 Performance considerations

Federation participants SHOULD consider performance aspects when implementing OpenID Federation trust resolution and client registration.

The OpenID Federation specification does not define explicit performance requirements. However, two provisions have implications for efficiency: the Resolve endpoint ([OID-Fed], Section 10.6]) and the requirement to refresh Trust Chains upon expiration ([OID-Fed], Section 11]). The Resolve endpoint allows entities to offload trust chain discovery and validation to an external resolver, which can reduce repeated computation. The refresh requirement implies the need for caching strategies, since expired Trust Chains MUST be revalidated and renewed in a timely manner.

For trust resolution, proxies acting as RPs or OPs SHOULD cache validated Trust Chains and resolved metadata until the expiration time indicated in the corresponding Entity Statements, and MAY proactively refresh chains before they expire. Where multiple valid Trust Chains exist, entities SHOULD avoid redundant processing by persisting the selected chain or prioritising Trust Anchors. For G100.2 compliance, Metadata Policies MUST be applied during Trust Chain resolution; the aggregated metadata result SHOULD be cached to avoid repeated evaluation overhead. Large-scale deployments SHOULD consider hierarchical federation structures or delegated resolvers to distribute load.

For client registration, performance depends on the chosen method. Automatic registration requires the OP to validate Trust Chains on-the-fly for every authentication request; without effective caching, this introduces latency. Explicit registration involves more up-front processing but allows reuse of the established client record, reducing runtime overhead. Since client registrations expire, implementations SHOULD support efficient re-registration mechanisms, and OPs SHOULD optimise registration endpoints for scale. RPs MUST support reusing cached registration responses until renewal is required.

Note that, apart from Sections 10.6 and 11, the [OID-Fed] specification does not mandate specific performance behaviour. The considerations in this section are therefore implementation guidance for AARC-compliant deployments.

8. Security Considerations

The security considerations of [OID-Fed] (section 18) apply.

References

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[AARC-G056] AARC Profile for Expressing Identity Attributes, Unpublished <https://aarc-community.org/guidelines/aarc-g056>.

[AARC-I058] Methods for Establishing Trust between OAuth 2.0 Proxies in Different Trust Domains. <https://aarc-community.org/guidelines/aarc-i058>

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Appendix A - Federation Policies

A.1 Examples of Trust Marks

Federation Policy	Trust Mark Type	Trust Mark Owner	Trust Mark Issuer
Sirtfi v1 & v2	https://refeds.org/sirtfi https://refeds.org/sirtfi2	REFEDS / Sirtfi	National Identity Federation
REFEDS DP CoCo v2	https://refeds.org/category/code-of-conduct/v2	REFEDS	self-issued
Security Operational Baseline	https://aarc-community.org/guidelines/aarc-g084/	AEGIS	self-issued
WISE Baseline AUP	https://wise-community.org/wise-baseline-aup/v1/	WISE SCI-WG	self-issued
REFEDS Assurance Framework v2	https://refeds.org/assurance	REFEDS	self-issued
Snctfi	https://aarc-community.org/snctfi	AARC	self-issued

A.2 Example of a (decoded) Subordinate Statement Including Metadata Policies

```
{
  "exp": 1757495867,
  "iat": 1757409467,
  "iss": "https://ta.g100.2.example.com",
  "sub": "https://proxy.ri.example.org",
  "jwks": {
    "keys": [
      {
        "kid": "abc123",
        "kty": "RSA",
        "alg": "RS256",
        "use": "sig",
        "n": "....",
        "e": "AQAB"
      }
```

```
    ]
  },
  "metadata_policy": {
    "federation_entity": {
      "contacts": {
        "essential": true
      },
      "display_name": {
        "essential": true
      },
      "organization_name": {
        "essential": true
      },
      "policy_uri": {
        "essential": true
      }
    },
    "openid_provider": {
      "client_registration_types_supported": {
        "essential": true,
        "superset_of": [
          "automatic"
        ]
      },
      "id_token_signing_alg_values_supported": {
        "subset_of": [
          "RS256",
          "ES256",
          "ES512"
        ]
      },
      "scope": {
        "essential": true,
        "superset_of": [
          "openid",
          "profile",
          "email"
        ]
      },
      "subject_type_supported": {
        "essential": true,
        "superset_of": [
          "public"
        ]
      },
      "userinfo_signing_alg_values_supported": {
        "subset_of": [
          "RS256",
          "ES256",
          "ES512"
        ]
```

```
      }
    }
  },
}
```

Appendix B - Example Entity Configurations (decoded)

B.1 Trust Authority

```
{
  "exp": 1757495867,
  "iat": 1757409467,
  "iss": "https://ta.g100.2.example.com",
  "jwks": {
    "keys": [
      {
        "alg": "ES256",
        "crv": "P-256",
        "kid": "xFYuOlyKBlMghUMke-x-fvKm17Pub3LowiWe-szNsa8",
        "kty": "EC",
        "use": "sig",
        "x": "SqpIPSH6n7RcY4ZWco8_i5XMeoGh8LrWoTmxfASEfFM",
        "y": "rPiFQrTLPfaLk1zG4zxUgVm-ZptAZEYBp6Rfoc2H6Rc"
      }
    ]
  },
  "metadata": {
    "federation_entity": {
      "display_name": "AARC G100.2 Example TA",
      "federation_fetch_endpoint": "https://ta.g100.2.example.com/fetch",
      "federation_list_endpoint": "https://ta.g100.2.example.com/list",
                                                "federation_resolve_endpoint":
"https://ta.g100.2.example.com/resolve",
      "organization_name": "Example Organization"
    }
  },
  "sub": "https://ta.g100.2.example.com",
  "trust_mark_issuers": {
    "https://refeds.org/sirtfi": [
      "https://tmi.example.com"
    ],
    "https://refeds.org/sirtfi2": [
      "https://tmi.example.com"
    ]
  }
}
```

B.2 Trust Mark Issuer


```
{
  "authority_hints": [
    "https://ta.g100.2.example.com"
  ],
  "exp": 1757574701,
  "iat": 1757488301,
  "iss": "https://tmi.example.com",
  "jwks": {
    "keys": [
      {
        "alg": "ES256",
        "crv": "P-256",
        "kid": "njbnIq34F9BLD2jAGnZV4J0-IPwFu7dEq0CAEM05qOo",
        "kty": "EC",
        "use": "sig",
        "x": "dx4wzrVuWN9GpSKhIzz1kXq5YzFfFTL5syp3Y4IR9CU",
        "y": "rGVM5yYgg8PnSXauuX1VACXzOWDDXx0OKJBHf4m7BOs"
      }
    ]
  },
  "metadata": {
    "federation_entity": {
      "display_name": "Trust Mark Issuer",
                                              "federation_trust_mark_endpoint":
"https://tmi.example.com/trustmark",
                                        "federation_trust_mark_list_endpoint":
"https://tmi.example.com/trustmark/list",
                                     "federation_trust_mark_status_endpoint":
"https://tmi.example.com/trustmark/status",
      "organization_name": "Example Organization"
    }
  },
  "sub": "https://tmi.example.com"
}
```


B.3 Proxy with OP and RP roles


```
{
  "iss": "https://proxy.ri.example.org",
  "sub": "https://proxy.ri.example.org",
  "iat": 1756375124,
  "exp": 1756461524,
  "jwks": {
    "keys": [
      {
        "kid": "abc123",
        "kty": "RSA",
        "alg": "RS256",
```

```
      "use": "sig",
      "n": "....",
      "e": "AQAB"
    }
  ]
},
"metadata": {
  "openid_provider": {
    "issuer": "https://proxy.ri.example.org",
    "authorization_endpoint": "https://proxy.ri.example.org/oidc/auth",
    "token_endpoint": "https://proxy.ri.example.org/oidc/token",
    "userinfo_endpoint": "https://proxy.ri.example.org/oidc/userinfo",
    "jwks_uri": "https://proxy.ri.example.org/oidc/jwks",

    "response_types_supported": [
      "code",
      "id_token",
      "code id_token"
    ],
    "subject_types_supported": ["public", "pairwise"],
    "id_token_signing_alg_values_supported": ["RS256"],

    "scopes_supported": [
      "openid",
      "profile",
      "email",
      "offline_access",
      "entitlements",
      "voperson_external_affiliation",
      "schac_home_organization"
    ],

    "claims_supported": [
      "sub",
      "name",
      "given_name",
      "family_name",
      "preferred_username",
      "email",
      "email_verified",
      "acr",
      "eduperson_assurance",
      "entitlements",
      "voperson_id",
      "voperson_external_affiliation",
      "schac_home_organization"
    ],

    "client_registration_types_supported": [
      "automatic",
      "explicit"
```

```
      ],
                                          "federation_registration_endpoint":
"https://proxy.ri.example.org/openid-federatio/register"
    },
    "openid_relying_party": {
      "application_type": "web",
      "redirect_uris": [
        "https://proxy.ri.example.org/callback",
        "https://proxy.ri.example.org/callback2"
      ],
      "client_name": "Example RI",
      "client_uri": "https://proxy.ri.example.org",
      "jwks_uri": "https://proxy.ri.example.org/oidc/jwks",
      "response_types": ["code"],
      "grant_types": [
        "authorization_code",
        "refresh_token"
      ],
      "token_endpoint_auth_method": "client_secret_post",
      "id_token_signed_response_alg": "RS256",
      "scope": "openid profile email entitlements",
      "client_registration_types": [
        "explicit"
      ],
      "tos_uri": "https://proxy.ri.example.org/aup"
    },
    "federation_entity": {
      "contacts": ["aai-support@ri.example.org"],
      "organization_name": "Example RI",
      "logo_uri": "https://proxy.ri.example.org/assets/logo.png",
      "policy_uri": "https://proxy.ri.example.org/privacy"
    }
  },
  "authority_hints": [
    "https://interm1.example.org",
    "https://ta1.example.net"
  ]
}
```

Appendix C. Summary of required Features

Participant Role/Feature	**Entity Configuration**	**Client Registration**	**Trust Marks**	**Metadata Policies**	Endpoints	Other
Trust Authority	MUST publish `federation_entity`	N/A	[G100.2] MUST list accepted issuers	[G100.2] MAY enforce via subordinate statements	• [REQ] Subordinate Listing • [REQ] Fetch • [OPT] Resolve	MUST define an onboarding process
Trust Mark Issuer	MUST publish `federation_entity`	N/A	MUST issue Trust Marks; MAY publish status	N/A	• [REQ] Trust Mark • [OPT] Trust Mark Status • [OPT] Trust Marked Entities Listing	
Proxy (OP role)	MUST publish `openid_provider`	MUST support Automatic and Explicit [§5.4]	[G100.2] MUST validate Trust Marks	[G100.2] MUST apply during trust chain resolution	• [REQ] Federation Registration	
Proxy (RP role)	MUST publish `openid_relying_party`	MUST implement at least one method required by federation policy (SHOULD support both)	[G100.2] MUST validate Trust Marks	[G100.2] MUST apply during trust chain resolution		
Proxy (AS role)	MUSTMAY publish `oauth_authorization_server`	MUST support Automatic and Explicit [§5.4]N/A	[G100.2] MUST validate Trust Marks	[G100.2] MUST apply during trust chain resolution		
Proxy (Client / Resource)	MUSTMAY publish `oauth_client`, `oauth_resource`	MUST implement at least one method (SHOULD support both)N/A	N/A	N/A		

Table 8.x: Features by Participant Role