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VESPER - Framework for VErifiable STI Personas
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Abstract

This document formalizes a profile and a framework for the use of delegate certificates and authority tokens to strengthen the association between telephone number assignments and the entities that have the authoritative right to use them. It defines a model in which the TNAuthList Authority Token serves as a trusted representation of telephone number assignment and right-to-use (RTU), anchored by a Notary Agent that logs these associations through verifiable transparency mechanisms. The framework also extends the use of authority tokens to support other PASSporT claims like Rich Call Data (RCD) by defining a role for JWTClaimConstraints Authority Tokens. These tokens are issued by authoritative or recognized and vetted claim agents within the ecosystem to assert information associated with the entity assigned a telephone number. The Notary Agent plays a critical role in recording these claims and their provenance, enhancing transparency and accountability. Delegate certificates encapsulate and incorporate both the telephone number and associated information validated via authority tokens to the certification authority issuing them, binding them to the authenticated telephone number of the calling party. These certificates are published to a certificate transparency log, enabling relying parties to independently verify the integrity and legitimacy of number use and related claims. The VESPER (Verifiable STI PERsona) approach utilizes STIR protocols and the ACME authority token to formalizing a verifiable, auditable, and privacy-conscious foundation for associating telephone numbers with vetted entities and validated assertion of associated metadata.

Status of This Memo

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

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1. Introduction

The Secure Telephone Identity (STI) architecture, based on STI certificates [RFC8226], PASSporTs [RFC8225], and the SIP Identity header field [RFC8224], define the foundational use of digital signatures and tokens to protect the integrity of calling information, particularly the telephone number, during a communications session. While these mechanisms help validate call signaling, they do not directly establish who is authorized to use a given telephone number. This document provides a profile of the STI architecture by formalizing the use of delegate certificates and authority tokens to more clearly and verifiably associate a telephone number with the entity-person or business-responsible for its use. This stronger linkage is especially important as misuse of telephone numbers by unauthorized parties continues to undermine trust in communications networks.

To address this, the VESPER framework introduces roles and interactions that mirror proven practices from other trust-based industries, such as Know Your Customer (KYC) and Know Your Business (KYB) procedures in finance. Through a defined process and as an adjunct to the telephone number assignment process involving Responsible Providers or Organizations and the Notary Agent, an Entity is issued a TNAuthList Authority Token defined in [RFC9448], establishing their right to use a telephone number. Additional information an entity would like to assert to a called party, such as Rich Call Data (RCD) [RFC9795], can be asserted and authorized using JWTClaimConstraints Authority Tokens [I-D.wendt-acme-authority-token-jwtclaimcon]. JWTClaimContraints have the interesting property that they can be used to assert either direct values or the integrity hashes of values (e.g., using "rcdi" claims defined in [RFC9795]) to enhance the ability to protect the privacy of information when desired or required. These tokens are used in challenges toward the issuance of delegate certificates which can be transparently recorded by a Notary Agent ecosystem role, which acts as a neutral registrar of these claims associated with telephone numbers without exposing underlying private data unless explicitly authorized or desired. Transparent declarations of claim assertions have the potential beneficial property of enhancing the trust of the asserted claims based on monitoring of these claims to avoid fraudulent impersonation that the STI framework is intended to solve.

In addition to supporting call authentication of the originating party, the VESPER framework can also extend to the validation of the called party through the use of connected identity as defined in [I-D.ietf-stir-rfc4916-update]. In this model, the same authority

token and delegate certificate mechanisms that bind an originating telephone number to a vetted entity can be applied in the reverse direction, enabling a called party to assert its validated identity via signed PASSporTs included in SIP responses. This optional capability broadens the scope of accountability and transparency to both ends of the communication session while maintaining the privacy-conscious design principles of VESPER.

This VESPER trust model and profile is enhanced using eco-system wide accountability. Transparency logs formalize the issuance of certificates and the relationship between telephone numbers, associated claims and their rightful users, helping detect and prevent fraudulent or conflicting claims by interested parties and auditing mechanisms. By shifting from implicit trust in digital signatures alone to an explicit framework of vetted identities and transparent claims, this approach builds a foundation for enhanced verifiable communications. It enables the responsible use of telephone numbers, discourages impersonation, and strengthens enforcement against abuse, ultimately fostering greater confidence in telephone number-based communications.

2. Conventions and Definitions

The key words "MUST", "MUST NOT", "REQUIRED", "SHALL", "SHALL NOT", "SHOULD", "SHOULD NOT", "RECOMMENDED", "NOT RECOMMENDED", "MAY", and "OPTIONAL" in this document are to be interpreted as described in BCP 14 [RFC2119] [RFC8174] when, and only when, they appear in all capitals, as shown here.

3. Overview

This document defines a framework for the authoritative association of telephone numbers to the entities responsible for their use, using delegate certificates and authority tokens. Within this framework, referred to as VESPER (VErifiable STI PERsonas), entities are represented through verifiable claims that establish their right to use a telephone number and, optionally, their asserted claim attributes such as Rich Call Data (RCD) or other claims defined via PASSporT type specifications. These claims are issued by trusted responsible parties and are anchored through transparency mechanisms to support trust, auditability, and privacy as appropriate.

The core premise is that a telephone number, when used as a communications identifier, must be explicitly bound to the real-world party authorized to use it. While telephone numbers have long served as identifiers in global communications, the absence of a strong binding between a number and a responsible party has allowed for abuse-most notably through number spoofing and impersonation fraud.

In many cases, bad actors exploit the lack of accountability to mislead call recipients, avoid traceability, or impersonate legitimate businesses and individuals. To address this, the VESPER framework introduces a standardized method for expressing and publishing the right-to-use (RTU) of a telephone number through the issuance of a TNAuthList Authority Token. This token is issued following the assignment or delegation of a number and is registered via a Notary Agent, which records the issuance event in a transparency log. This notarization provides independent verification of the association between a number and its rightful user, without requiring public disclosure of sensitive identity data.

JWTClaimConstraints [RFC8226] and EnhancedJWTClaimConstraints [RFC9118] play a critical role in delegate certificates issued under the VESPER framework. They provide a standardized mechanism for Certification Authorities to explicitly constrain the claims that a delegate certificate holder is permitted to assert in communications. This constraint mechanism ensures that even if a certificate is misused or presented outside its intended scope, the relying party can verify whether the claims presented are authorized. Certification Authorities derive these constraints from Authority Tokens issued by vetted Claim Agents, which serve as cryptographic proof of the claim validations. By limiting the scope of claims to those proven and approved during the certificate issuance process, using Authority Tokens provided by trusted Claim Agents, VESPER mitigates impersonation risks and preserves the integrity of the call authentication ecosystem.

Unlike prior models that rely on implicit trust in the caller or the STI signer, this approach provides an explicit, auditable, and standards-based path to associate communications with a known and authorized party. The VESPER framework does not define how vetting (e.g., KYC/KYB) is performed, nor does it prescribe specific policy requirements. Instead, it focuses on standardizing how vetted results and right-to-use associations are asserted, recorded, and presented within the STIR ecosystem.

By reinforcing the accountability of number usage and enabling the trusted presentation of related identity claims, this architecture enhances integrity, supports privacy, and enables enforcement mechanisms to deter misuse-ultimately restoring trust in telephone-based communications.

VESPER implementations MUST support short-lived certificates and SHOULD use "x5c" to convey certificates inline. Transparency logging remains required.

4. Vesper Architectural Overview

4.1. The VESPER Trust Framework Architecture

The VESPER Trust Model establishes a structured framework for asserting and verifying the association between a telephone number and the entity authorized to use it. This model supports a broad range of communications use cases, from fully attributed business communications with rich identity information to privacy-conscious scenarios that require only verification that the number is in legitimate use by a real validated entity.

At its core, the model is built on a trust structure with the following key roles:

1. Entities (e.g., individuals or organizations) seeking to assert their right to use a telephone number and assert claims about themselves or a set of communications,

2. Responsible providers and organizations that are authorized to allocate and assign numbers within a jurisdictional numbering plan,

3. Claim Agents that are authorized and recognized for validating and issuing claims about those entities, and

4. A Notary Agent that records claim issuance events and ensures transparency and traceability within the ecosystem.

Participation in this trust model requires a shared set of policies and standards governing how entities are vetted and how claims are created and validated. These policies define the requirements for asserting an entity’s identity, the right to use a telephone number, and, where applicable, additional claims and associated attributes (i.e. PASSporT type defined claims, like Rich Call Data). Claims are structured representations of verified information, issued by Claim Agents. Each claim type is standardized via PASSporT type specifications in the STIR working group, with clearly defined required and optional key-value pairs, ensuring interoperability and consistency across the ecosystem. Through this model, VESPER provides a scalable and transparent foundation for building trust in telephone-based communications, with the flexibility to support both fully attributed and privacy-respecting use cases.

4.2. Roles and Responsibilities in the VESPER Framework

The VESPER trust framework defines a set of roles that work together to assert and validate claims about telephone numbers and the entities authorized to use them. At the core of this ecosystem are two primary roles: Entities and Claim Agents. Entities are individuals or organizations that wish to establish their authority to use a telephone number and, optionally, present additional vetted identity attributes. Claim Agents are responsible for validating this information and issuing standardized, structured claims.

4.2.1. Entity

An Entity is the individual or organization seeking to assert its authority to use a specific telephone number and, optionally, to present additional vetted claims such as business name or purpose. The Entity is the central actor around which the claims and trust relationships are formed.

4.2.2. Responsible Provider or Responsible Organization

A Responsible Provider, sometimes called a Telephone Number Service Provider (TNSP), or Responsible Organization (RespOrg) plays both their traditional well-defined role in the allocation and assignment of telephone numbers in accordance with national or international numbering plans generally followed internationally via e.164 and e.164.1 but also a foundational role in the VESPER ecosystem by validation of the association of telephone number assignments to Entities. These entities operate under regulatory authority and are responsible for administering number resources associated with a specific country code or region.

Their responsibilities include:

* Number Assignment: Allocating telephone numbers to Entities under the rules of an authorized numbering plan.

* Entity Association: Establishing and maintaining a record that links each assigned telephone number to a specific, uniquely identified entity. This includes assigning a persistent identifier or account reference to the Entity to which a number is assigned providing an opaque identifier. This identifier can be used by the Entity to reference themselves in an opaque way for accessing assignment relevant information including TNAuthList Authority Tokens or also referenced during any disputes or disclosures when necessary.

The Responsible Provider or RespOrg coordinates with the Notary Agent to issue proof of assignment or participate in the claim transparency process, their role, even as it currently exists, is essential in grounding the trust framework in authoritative number assignment data. Other ecosystem participants, such as Claim Agents and Notary Agents, can and should reference assignment records governing the Right to Use (RTU) maintained by Responsible Providers or RespOrgs to validate issuance of delegate certificates to the valid Entities.

4.2.3. Claim Agent Responsibilities

Claim Agents are trusted parties in the ecosystem responsible for validating information about Entities and issuing authoritative or verified claims. These claims cover claims associated with PASSporT defined claims including identity details or Rich Call Data (RCD).

Each Claim Agent is uniquely identified within the VESPER ecosystem and should be registered with a Notary Agent (NA). Once a Claim Agent performs its vetting process, it issues signed JWTClaimConstraints Authority Tokens containing the validated claim information or integrity hashes for those claims for the Entity depending on privacy preferences.

4.2.4. Notary Agent Responsibilities

The Notary Agent (NA) serves as the ecosystem’s registrar and transparency authority. It performs three critical functions:

1. Registration of Responsible Providers and Responsible Organizations that correspond to the traditional roles in accordance with a national or international numbering plans.

2. Registration of Claim Agents, ensuring each is uniquely identifiable and authorized to issue specific types of claims.

3. Operation of a Transparency Log, which issues cryptographic receipts to confirm and timestamp the existence of each claim.

Notarization can be privacy-preserving, where only cryptographic hashes of claims are logged, or fully transparent, allowing public visibility of claim contents to detect conflicts or impersonation attempts. This optional public disclosure enables monitoring of duplicate or unauthorized claims across the ecosystem.

While this document does not define the dispute resolution process, any conflicts or misclaims discovered through transparency can be escalated through ecosystem-specific mechanisms, likely coordinated by the Notary Agent in communication with relevant Claim Agents.

4.3. Claim Agents and Claim Information Privacy

Privacy is a foundational principle of the VESPER trust model. Claim Agents are not required to expose or publish sensitive data about Subject Entities when recording claims. Instead, claims can be privacy-protected by logging only the cryptographic hashes of the claim content in the transparency log, preserving proof without revealing the underlying details.

4.3.1. Public vs. Private Disclosure

For claim information that is public by nature-such as business names, logos, or other branding elements-Claim Agents may choose to log the data in full within certificates for public visibility. This public transparency helps the ecosystem identify conflicting or fraudulent claims and reinforces trust through open scrutiny.

Conversely, for private or sensitive claims (e.g., internal identifiers or personally identifiable information), Claim Agents may choose to log only a hash of the data. This approach ensures that the claim’s authenticity can still be verified without compromising the Entity’s privacy. Disclosure of such claims remains at the discretion of the Entity or may occur in limited cases where legal or regulatory obligations apply.

4.4. Delegate Certificate Issuance Process

In the VESPER trust framework, the issuance of a delegate certificate to an Entity involves the multiple roles defined and referenced in this document, including the Responsible Provider or Responsible Organization, Claim Agents, the Notary Agent, and a trusted Certification Authority (CA) operating under the STIR eco-system certificate policy governing STIR certificates defined in [RFC8226].

The process begins when a Responsible Provider or Responsible Organization assigns a telephone number to an Entity. As part of that assignment, the Entity is formally associated with the number in the Notary Agent’s system via an opaque and unique identifier, establishing an auditable relationship between the number and the right-to-use holder. The opaque unique identifier helps to uphold the privacy of the eco-system as part of normal telephone number allocation and assignment has traditionally followed. When potential policy violations occur the Notary Agent systems using the Entity identifier provides an indisputable path to the corresponding Responsible Providers and Organizations and then to the Entities assigned the telephone number and delegated a certificate in question that can respond to policy and legal requests as part of their responsibilities to the STIR eco-system should govern.

Additionally, following this association, a TNAuthList Authority Token can be issued to the Entity. This token authoritatively represents the Entity’s Right-To-Use the telephone number and can serve as cryptographic proof of assignment.

In parallel, a Claim Agent may be used to validate additional attributes that the Entity wishes to assert when originating calls, such as Rich Call Data (RCD). These validated attributes are encoded in a JWTClaimConstraints Authority Token, which governs what claims the Entity is authorized to present in communications. The Claim Agent may also use the TNAuthList Authority Token as proof of assignment and the Right-to-Use the telephone numbers being asserted by the Entity. This should also be utilized to govern the constraint of the "orig" claim to only the valid associated numbers to the Entity.

Once both tokens have been obtained, the Entity initiates a Certificate Signing Request (CSR) to a CA authorized to issue certificates within the STIR ecosystem. As per the mechanisms outlined in [RFC9447], [RFC9448], and [I-D.wendt-acme-authority-token-jwtclaimcon], the TNAuthList and JWTClaimConstraints tokens are presented as ACME challenge responses to prove the Entity’s authority over the number and its validated claims.

Upon successful validation, the CA issues a delegate certificate to the Entity.

CAs SHOULD issue short-lived certificates with brief validity intervals. Entities SHOULD automate renewal to avoid service interruptions.

This certificate includes:

* A TNAuthList extension [RFC8226], representing the telephone number(s) the certificate holder is authorized to use.

* A JWTClaimConstraints extension [RFC8226] and/or EnhancedJWTClaimConstraints extension [RFC9118], representing the constraints on claims the certificate holder is permitted to assert.

The issued certificate is then submitted to a certificate transparency log. A corresponding transparency receipt is returned to the Entity and/or CA to provide verifiable proof of publication. This transparency mechanism enables ecosystem-wide monitoring and validation of certificate issuance and claim legitimacy.

4.5. VESPER Certificate Profile (Short-Lived & Inline Conveyance)

VESPER delegate certificates MUST support the short-lived certificate profile in [I-D.ietf-stir-certificates-shortlived]. PASSporTs SHOULD include the certificate chain using the "x5c" header. Verification Services SHOULD prefer "x5c" over "x5u", and MUST NOT dereference "x5u" if "x5c" is present and valid. Short-lived certificates reduce the need for revocation infrastructure and eliminate external certificate fetches.

4.6. Use of VESPER Delegate Certificates for Signing Communications

Once an Entity has received a delegate certificate containing validated right-to-use and claim constraints, it can use this certificate to sign communications associated with the authorized telephone number.

For example, when the Entity initiates a SIP call, it generates a PASSporT object containing session-specific details such as "orig", "dest", and "iat". The Entity then signs the PASSporT using its delegate certificate, which binds both the telephone number and any authorized claims (e.g., RCD elements) to the communication.

Critically, the JWTClaimConstraints extension in the certificate enforces the set of claims the Entity is permitted to assert, ensuring that claims cannot exceed those vetted and authorized by the corresponding Claim Agent.

The signed PASSporT is then attached to the SIP Identity header and transmitted with the call. The Verification Service (VS) on the receiving side performs STIR verification, checking:

* That the PASSporT signature is valid.

* That the delegate certificate is trusted, unexpired, and issued by a recognized CA.

* If the PASSporT includes an "x5c" header, the certificate chain must be validated from the inline header; "x5u" must not be dereferenced.

* If "x5c" is absent, "x5u" MAY be used to retrieve the certificate chain.

* That the certificate includes a valid TNAuthList extension for the telephone number in use in the "orig" claim.

* That any asserted claims conform to the JWTClaimConstraints and/or EnhancedJWTClaimConstraints in the certificate.

* That a corresponding transparency receipt exists, proving the certificate was publicly recorded.

Senders SHOULD include "x5c"; relying parties SHOULD prefer "x5c" when both are available.

If all verifications succeed, the relying party can trust that the call is both authorized and attributable, and that all claims have been validated by responsible participants in the ecosystem.

4.7. VESPER Authentication and Verification Procedures

This section outlines the expected behavior of Authentication Services (AS) and Verification Services (VS) in deployments utilizing VESPER delegate certificates. These procedures extend the baseline STIR authentication and verification models defined in [RFC8224], [RFC8225], and [RFC8226] by incorporating validation of transparency-backed delegate certificates and associated claims.

4.7.1. Authentication Service Behavior

When originating a call, the Authentication Service performs the following steps:

* Constructs a PASSporT for the session containing the required claims (e.g., orig, dest, iat), as well as any optional authorized claims (e.g., Rich Call Data).

* Signs the PASSporT using a VESPER delegate certificate that:

  - Contains a valid TNAuthList extension authorizing the orig telephone number.

  - Optionally includes JWTClaimConstraints or EnhancedJWTClaimConstraints extensions consistent with the asserted claims.

  - Is backed by a Signed Certificate Timestamp (SCT) from a transparency log.

* Attaches the signed PASSporT in a SIP Identity header using the "x5c" header parameter to convey the certificate chain inline.

* Ensures that the certificate is valid, unexpired, and issued by a CA compliant with the VESPER certificate issuance profile.

4.7.2. Verification Service Behavior

Upon receiving a SIP request containing an Identity header, the Verification Service:

* Validates the PASSporT signature and parses the included claims.
* Validates the VESPER delegate certificate by checking:
  - Trust chain validity and issuer compliance with STI and VESPER certificate policies.
  - The presence and accuracy of the TNAuthList extension corresponding to the orig telephone number.
  - The presence and SCT validation of the certificate’s transparency log inclusion.
  - Any JWTClaimConstraints [RFC8226] and EnhancedJWTClaimConstraints [RFC9118] extensions, ensuring claimed values conform to constraints.
* Rejects the PASSporT if any of the above validations fail.

This delineation ensures that only calls with properly issued and verifiable delegate certificates are authenticated and accepted under the VESPER framework, reinforcing accountability and integrity within the STIR ecosystem.

4.7.3. Connected Identity Authentication and Verification

A similar verification process applies when VESPER is used in deployments that support Connected Identity as defined in [I-D.ietf-stir-rfc4916-update]. In this model, the destination party may return a PASSporT of type rsp within a SIP response, signed using a delegate certificate authorized for the dest telephone number in the original call.

4.7.3.1. Authentication by the Destination Party

When acting as an Authentication Service, the destination party performs the following steps to generate and sign the rsp PASSporT:

* Constructs a PASSporT of type rsp including:
  - The original orig and dest values from the incoming call.
  - The iat claim representing the issuance time.

- Optionally, the attest claim to convey the attestation level of the identity relationship, if appropriate.

* Signs the PASSporT using a valid VESPER delegate certificate containing a TNAuthList extension authorizing use of the dest telephone number (i.e., the destination party’s number).

* Includes the "x5c" header in the PASSporT, conveying the certificate chain used for signing.

* Ensures the certificate is valid, unexpired, includes a valid SCT, and that the certificate corresponds to the dest claim.

* Attaches the signed PASSporT to a SIP 200 OK response using the Identity header as described in [I-D.ietf-stir-rfc4916-update].

4.7.3.2. Verification by the Originating Party

To verify the rsp PASSporT, the originating party (or an upstream Verification Service acting on its behalf) MUST perform the following checks:

* The rsp PASSporT MUST be signed using a valid VESPER delegate certificate with a TNAuthList value matching the dest number.

* The certificate MUST:

  - Be issued by a Certification Authority compliant with [RFC8226] and the VESPER profile;

  - Include a valid SCT and be within its validity period.

* The PASSporT signature MUST be validated using the provided x5c header.

* The orig and dest claims MUST match those of the original PASSporT that initiated the call.

* The iat claim MUST be within an acceptable freshness interval.

* The Verification Service SHOULD validate the certificate’s inclusion in a transparency log using the SCT.

These procedures confirm that the destination party has authenticated and cryptographically asserted its identity using a VESPER delegate certificate, extending mutual identity validation to the terminating side of the call. This process supports bi-directional trust, enhances accountability, and enables privacy-aware identity assertion.

5. Security Considerations

TBD

6. IANA Considerations

None

7. Acknowledgments

TODO acknowledge.

8. Normative References

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