**ATIS-0x0000x**

ATIS Standard on

**Signature-Based Handling of Asserted Information Using Tokens (SHAKEN): Delegate Certificates**

**Alliance for Telecommunications Industry Solutions**

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**Abstract**

The base-SHAKEN framework enables a VoIP Service Provider to deliver cryptographic proof to a called user that the calling user is authorized to use the calling telephone number. This specification extends the base-SHAKEN framework to provide a number of additional capabilities, including the ability to provide cryptographic proof of human readable calling user information such as calling name, the ability for SHAKEN-authorized TN Providers to delegate SHAKEN signing authority to their non-SHAKEN customers, plus a number of additional enhancements.

**Foreword**

The Alliance for Telecommunications Industry Solutions (ATIS) serves the public through improved understanding between carriers, customers, and manufacturers. The [**COMMITTEE NAME**] Committee [**INSERT MISSION**]. [**INSERT SCOPE**].

The mandatory requirements are designated by the word *shall* and recommendations by the word *should*. Where both a mandatory requirement and a recommendation are specified for the same criterion, the recommendation represents a goal currently identifiable as having distinct compatibility or performance advantages. The word *may* denotes a optional capability that could augment the standard. The standard is fully functional without the incorporation of this optional capability.

Suggestions for improvement of this document are welcome. They should be sent to the Alliance for Telecommunications Industry Solutions, [**COMMITTEE NAME**], 1200 G Street NW, Suite 500, Washington, DC 20005.

At the time of consensus on this document, [**COMMITTEE NAME**], which was responsible for its development, had the following leadership:

[**LEADERSHIP LIST**]

The **[SUBCOMMITTEE NAME]** Subcommittee was responsible for the development of this document.

**Revision History**

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# Scope, Purpose, & Application

## Scope

This specification extends the SHAKEN certificate management framework to enable a telephone number provider to create telephone number or telephone block specific certificates for entities that do not having direct ownership of those telephone number resources. The mechanisms described in this specification are based on the STI delegate certificate procedures defined in [draft-peterson-stir-cert-delegation]. In order to manage the security and integrity of the overall SHAKEN ecosystem, this specification defines both the procedures for the entity with authority over a set of telephone number(s) to create and manage delegated certificates scoped only to the specific set of TNs assigned to the delegate certificate owner and, in addition, the use of those credentials to create end-entity delegate certificates for authenticated customers to directly sign telephone calls.

## Purpose

The purpose of the SHAKEN framework is to provide an end-to-end set of tools to authenticate the telephone identity of the caller. [ATIS-1000074-E], the SHAKEN protocol specification describes a mechanism where the originating service provider can “attest” their association to the telephone number associated with a call. The three conditions that must exist in order for a SHAKEN authentication service to fully attest, or attestation level “A”, that an originating customer can legitimately use the calling TN:

1. The signing provider must be responsible for the origination of the call onto the IP based service provider voice network.
2. The signing provider must have a direct authenticated relationship with the customer and can identify the customer.
3. The signing provider must have established a verified association with the calling telephone number

Conditions 1 and 2 are relatively unambiguous; the originating provider is the signing provider, and the originating provider typically authenticates the calling user.

Condition 3 is satisfied for the case where the originating provider has authority over the calling TN, has assigned the calling TN to the originating customer, and has directly authenticated the customer before the call. However, there are a number of legitimate real-world call scenarios where this is not the case; i.e., where the originating SP does not have direct knowledge of the set of TNs the calling user is authorized to use. Example scenarios include the following (note, list is not exhaustive):

* A SIP-PBX obtains originating call service from multiple providers (e.g., for redundancy or least cost routing). In this case, the PBX can legitimately originate a call via one provider from a calling TN that it obtained from a different provider.
* An enterprise wants to display a toll-free callback number for B2C calls, and the 800-number provider (RespOrg) and the originating provider are two separate entities.
* A “legitimate spoofing” service displays the subscriber’s work TN for calls originated by the user’s home phone.
* An outbound dialing service that automatically initiates calls on behalf of a business or other entity, and displays the business TN to the called users (e.g., school announces weather-related school closings to students, or airline sends flight information updates to its passengers).
* Wholesale TNs used by reseller SPs, Cloud Communication Providers, and others when they originate calls
* A contact center serving multiple enterprises from various locations originates calls using the unique calling TN specified by each enterprise.

The SHAKEN specification provides guidance to originating SPs on how they can satisfy the TN-legitimacy condition in order to provide full attestation for call scenarios where the originating provider is not the TN provider. For example, the originating SP could establish the legitimacy of the calling TN as part of the service level agreement with the customer, or it could obtain the necessary TN assignment information from the TN provider using some “out-of-band” mechanism. However, these mechanisms often have shortcomings. The service level agreement approach may be unworkable in practice due to a low level of trust between originating provider and customer. Or the originating provider may have no relationship with or knowledge of the TN provider. And finally, the ad-hoc and non-automated nature of these mechanisms incurs a large administrative overhead for the participating parties (e.g., the overhead required to establish relationships between otherwise unrelated providers), and could make full attestation non-viable in the majority of enterprise scenarios.

The delegate mechanism defined in this specification addresses these shortcomings by providing an automated, protocol-based mechanism that enables a telephone number provider customer the ability to directly sign calls using a set of credentials that are specific to the telephone number resources that customer is responsible for in the form of delegate certificates.

# Normative References

The following standards contain provisions which, through reference in this text, constitute provisions of this Standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this Standard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below.

ATIS-1000074, *Signature-based Handling of Asserted Information using Tokens (SHAKEN).*

ATIS-1000080, *SHAKEN: Governance Model and Certificate Management,*

IETF RFC 3261, *SIP: Session Initiation Protocol.*1

IETF RFC 3325, *Private Extensions to SIP for Asserted Identity within Trusted Networks.*1

RFC 4122, *A Universally Unique IDentifier (UUID) URN Namespace.*1

RFC 4949, *Internet Security Glossary, Version 2.*1

RFC 5806, *Diversion Indication in SIP*. 1

RFC 7044, *An Extension to the Session Initiation Protocol (SIP) for Request History Information*. 1

RFC 8224, *Authenticated Identity Management in the Session Initiation Protocol.*1

RFC 8225, *Personal Assertion Token.*[[1]](#footnote-1)

RFC 8226, *Secure Telephone Identity Credentials: Certificates.*1

draft-ietf-stir-passport-shaken, *PASSporT SHAKEN Extension.* 1

draft-ietf-stir-passport-divert, *PASSporT Extension for Diverted Calls.* 1

draft-ietf-acme-authority-token, *ACME Challenges Using an Authority Token.* 1

draft-ietf-acme-authority-token-tnauthlist, *TNAuthList profile of ACME Authority Token.* 1

TS 24.229, IP multimedia call control protocol based on Session Initiation Protocol (SIP) and Session Description Protocol (SDP). [[2]](#footnote-2)

# Definitions, Acronyms, & Abbreviations

For a list of common communications terms and definitions, please visit the *ATIS Telecom Glossary*, which is located at < <http://www.atis.org/glossary> >.

## Definitions

The following provides some key definitions used in this document.

**Caller ID:** The originating or calling party’s telephone number used to identify the caller carried either in the P-Asserted-Identity or From header fields in the Session Initiation Protocol (SIP) [RFC 3261] messages.

**(Digital) Certificate:** Binds a public key to a Subject (e.g., the end-entity). A certificate document in the form of a digital data object (a data object used by a computer) to which is appended a computed digital signature value that depends on the data object [RFC 4949]. See also STI Certificate.

**Certification Authority (CA):** An entity that issues digital certificates (especially X.509 certificates) and vouches for the binding between the data items in a certificate [RFC 4949].

**Certificate Chain:** See Certification Path.

**Certification Path:** A linked sequence of one or more public-key certificates, or one or more public-key certificates and one attribute certificate, that enables a certificate user to verify the signature on the last certificate in the path, and thus enables the user to obtain (from that last certificate) a certified public key, or certified attributes, of the system entity that is the subject of that last certificate. Synonym for Certificate Chain [RFC 4949].

**Certificate Revocation List (CRL):** A data structure that enumerates digital certificates that have been invalidated by their issuer prior to when they were scheduled to expire [RFC 4949].

**Certificate Signing Request (CSR):** A CSR is sent to a CA to request a certificate. A CSR contains a Public Key of the end-entity that is requesting the certificate.

**Chain of Trust:** Deprecated term referring to the chain of certificates to a Trust Anchor. Synonym for Certification Path or Certificate Chain [RFC 4949].

**Certificate Validation:** An act or process by which a certificate user established that the assertions made by a certificate can be trusted [RFC 4949].

**Company Code:** A unique four-character alphanumeric code (NXXX) assigned to all Service Providers [ATIS-0300251].

**Cross-certificate:** A CA certificate where the issuer and subject are different entities; i.e., a CA certificate that has been issued from one CA to another CA, where the receiving CA uses the private key of the certificate for issuing new certificates [RFC 5280].

**Cross-certification:** The process whereby a CA delegates authority to another CA by issuing a cross-certificate to the delegate CA [RFC 5280].

**End-Entity:** An entity that participates in the Public Key Infrastructure (PKI). Usually a Server, Service, Router, or a Person. In the context of this document, an end-entity is a Service Provider, TN Provider, or Customer AF.

**Fingerprint:** A hash result ("key fingerprint") used to authenticate a public key or other data [RFC 4949].

**Identity:** Either a canonical Address-of-Record (AoR) SIP Uniform Resource Identifier (URI) employed to reach a user (such as ’sip:alice@atlanta.example.com’), or a telephone number, which commonly appears in either a TEL URI [RFC 3966] or as the user portion of a SIP URI. See also Caller ID [RFC 8224].

**National/Regional Regulatory Authority (NRRA):** A governmental entity responsible for the oversight/regulation of the telecommunication networks within a specific country or region.

NOTE: Region is not intended to be a region within a country (e.g., a region is not a state within the US).

**Online Certificate Status Protocol (OCSP):** An Internet protocol used by a client to obtain the revocation status of a certificate from a server.

**Private Key:** In asymmetric cryptography, the private key is kept secret by the end-entity. The private key can be used for both encryption and decryption [RFC 4949].

**Public Key:** The publicly disclosable component of a pair of cryptographic keys used for asymmetric cryptography [RFC 4949].

**Public Key Infrastructure (PKI):** The set of hardware, software, personnel, policy, and procedures used by a CA to issue and manage certificates [RFC 4949].

**Root CA:** A CA that is directly trusted by an end-entity. See also Trust Anchor CA and Trusted CA [RFC 4949].

**Secure Telephone Identity (STI) Certificate:** A public key certificate used by a service provider to sign and verify the PASSporT.

**Service Provider Code:** In the context of this document, this term refers to any unique identifier that is allocated by a Regulatory and/or administrative entity to a service provider. In the US and Canada this would be a Company Code as defined in [ATIS-0300251].

**Signature:** Created by signing the message using the private key. It ensures the identity of the sender and the integrity of the data [RFC 4949].

**Telephone Identity:** An identifier associated with an originator of a telephone call. In the context of the SHAKEN framework, this is a SIP identity (e.g., a SIP URI or a TEL URI) from which a telephone number can be derived.

**Trust Anchor:** An established point of trust (usually based on the authority of some person, office, or organization) from which a certificate user begins the validation of a certification path. The trust anchor is a combination of a trusted public key and the name of the entity to which the corresponding private key belongs [RFC 4949].

**Trust Anchor CA:** A CA that is the subject of a trust anchor certificate or otherwise establishes a trust anchor key. See also Root CA and Trusted CA [RFC 4949].

**Trusted CA:** A CA upon which a certificate user relies for issuing valid certificates; especially a CA that is used as a trust anchor CA [RFC 4949].

**Trust Model:** Describes how trust is distributed from Trust Anchors.

## Acronyms & Abbreviations

|  |  |
| --- | --- |
| 3GPP | 3rd Generation Partnership Project |
| ATIS | Alliance for Telecommunications Industry Solutions |
| B2BUA | Back-to-Back User Agent |
| CRL | Certificate Revocation List |
| CSCF | Call Session Control Function |
| CVT | Call Validation Treatment |
| HTTPS | Hypertext Transfer Protocol Secure |
| IBCF | Interconnection Border Control Function |
| IETF | Internet Engineering Task Force |
| IMS | IP Multimedia Subsystem |
| IP | Internet Protocol |
| JSON | JavaScript Object Notation |
| JWS | JSON Web Signature |
| NNI | Network-to-Network Interface |
| OCSP | Online Certificate Status Protocol |
| PASSporT | Persona Assertion Token |
| PBX | Private Branch Exchange |
| PKI | Public Key Infrastructure |
| SHAKEN | Signature-based Handling of Asserted information using toKENs |
| SIP | Session Initiation Protocol |
| SKS | Secure Key Store |
| SPID | Service Provider Identifier |
| STI | Secure Telephone Identity |
| STI-AS | Secure Telephone Identity Authentication Service |
| STI-CA | Secure Telephone Identity Certification Authority |
| STI-CR | Secure Telephone Identity Certificate Repository |
| STI-VS | Secure Telephone Identity Verification Service |
| STIR | Secure Telephone Identity Revisited |
| TLS | Transport Layer Security |
| TN | Telephone Number |
| TN-PoP | TN Proof-of-Possession |
| TrGW | Transition Gateway |
| UA | User Agent |
| URI | Uniform Resource Identifier |
| UUID | Universally Unique Identifier |
| VoIP | Voice over Internet Protocol  |

# Overview

The delegate certificate management framework defines two new entities:

1. Telephone Number Provider (TN Provider):
	* An entity that is authoritative over a set of telephone numbers, and that can delegate a subset of those telephone numbers to another entity to attest for signing. In the context of this document, a TN Provider is an STI Service Provider as defined in the base SHAKEN specification (i.e., a TN Provider is authorized by the STI-PA to obtain end-user certificates from an STI-CA).
	* Ultimately the entities entitled to obtain STI Certificates will be defined by the STI-GA, but the initial definition is Service Providers that have an OCN (Operating Carrier Number) and are eligible to directly obtain TNs.
2. Customer Application Function (Customer AF):
	* A non-STI-authorized entity that purchases (or otherwise obtains) delegated telephone numbers from a Telephone Number Provider.
	* Examples include an Enterprise PBX, Contact Center, Cloud Communication Provider, a legitimate spoofing application, or an automated outbound dialing service.

## Certificate Authority Delegation

Figure 1 shows the high-level overview of the certificate management process for issuing delegate end-entity certificates to a VoIP Entity using the STIR certificate delegation procedures defined in [draft-peterson-stir-cert-delegation]. The VoIP Entity is any X.509 End Entity that requires certificate credentials for signing STI PASSporTs; for example:

* A SHAKEN Service Provider as defined in [ATIS-1000074-E],
* A Customer Application Function (e.g., PBX, Call Center, etc.) as defined in section [add ref]

The general process is as follows:

1. The Subordinate CA obtains a delegate CA certificate from the STI-CA. The delegate CA certificate chains (possibly via one or more STI-CA intermediate certificates) to an STI-CA trusted root certificate. The delegate CA certificate contains a TNAuthList that identifies the scope of the delegate CA certificate, and which therefore identifies the scope of authority of the Subordinate CA to issue delegate end-entity certificates.
2. Once it has obtained a delegate CA certificate from an STI-CA, the Subordinate CA can issue delegate end-entity certificates to VoIP Entities, within the scope of the delegate CA certificate; i.e., the TNAuthList of the delegate end-entity certificate must be equal to or a subset of the TNAuthList of the parent delegate CA certificate. The delegate end-entity certificates are chained via the delegate CA certificate to the STI-CA’s trusted root certificate.

 

Figure 1. STI-CA delegates authority to a Subordinate CA

# Delegate Certificate Management

This section describes the architecture, functional entities, interfaces, and procedures to issue delegate end-entity certificates to a VoIP Entity.

## Certificate Management Architecture

Figure 2 shows how the SHAKEN certificate management architecture is extended to provide delegate end-entity certificates to a VoIP Entity. The Subordinate CA plays the role of a SHAKEN Service Provider defined in [ATIS-1000080-E] to obtain delegate CA certificates from the STI-CA. The Subordinate CA in turn plays the role of a CA in issuing delegate end-entity certificates to the VoIP Entity. The Subordinate CA has a relationship with a Service Provider; i.e., the STI-PA recognizes that the Subordinate CA has authority for the SPC value and TNs assigned to the Service Provider. As specified in section 6, the Subordinate CA can be hosted by the Service Provider it serves, or hosted by a separate entity. The VoIP entity is an entity that provides SIP-based VoIP services. The VoIP Entity can either be a service provider with direct responsibility for telephone resources and is the originator of the call, or a VoIP provider or enterprise customer that has purchased telephone resources for use in Customer AFs.

 

Figure 2. Delegate Certificate Management Architecture

## Certificate Management Interfaces

The Subordinate CA obtains delegate CA certificates from the STI-CA using interfaces 1), 2), and 3) of Figure 2. Aside from the minor exceptions noted here, the procedures are identical to the certificate management procedures defined by ATIS-1000080-E.

1. The Subordinate CA obtains a fresh SPC Token from the STI-PA that authorizes the Subordinate CA to obtain delegate CA certificates from the STI-CA. The procedure is as specified in [ATIS-1000080-E], with the exception that the SPC Token has TN-level scope, and the token “ca” boolean is set to ‘true’.
2. Once the Subordinate CA has obtained a valid SPC Token, it can order a delegate CA certificate from the STI-CA using the ACME protocol as specified in [ATIS-1000080-E].
3. During the authorization phase of the certificate ordering process, the STI-CA obtains the STI-PA certificate referenced by the SPC Token in order to verify the SPC Token signature, as specified in [ATIS-1000080-E].

At this point, the Subordinate CA stores the issued delegate CA certificate in preparation for issuing delegate end-entity certificates to the VoIP Entities that it serves. The VoIP Entity procedure to order a delegate end-entity certificate is similar to the STI end-entity certificate ordering procedure defined in ATIS-1000080-E, except that the ACME account can be pre-authorized by leveraging the already-established security association between VoIP Entity and Subordinate CA. This simplifies the ordering process, since the VoIP Entity does not have to obtain an SPC Token, and it does not have to respond to an ACME authorization challenge.

1. Following the procedures defined in [ATIS-1000080-E], the VoIP Entity KMS generates two public/private key pairs; one for the ACME account, and one for the delegate end-entity certificate. It stores the private keys in its SKS.
2. The VoIP Entity orders a new delegate end-entity certificate using the certificate ordering procedure specified in [ATIS-1000080-E], minus the ACME authorization challenge/response steps (since the ACME account is pre-authorized). The Subordinate CA signs the newly issued end-entity certificate with the private key of the delegate CA certificate, and returns the STI-CR URI where the certificate is stored to the VoIP.
3. As part of step-5, the Subordinate CA stores the newly issued delegate end-entity certificate in the STI-CR.

As an alternative within steps 5) and 6), the VoIP Entity could download the newly issued end-entity certificate and store it in an STI-CR hosted by the VoIP Entity.

## Certificate Management Procedures

### Subordinate CA obtains an SPC Token from STI-PA

The Subordinate CA shall obtain an SPC Token as described in [ATIS-1000080-E] with the exceptions noted in this section.

As specified by [ATIS-1000080-E], the SPC Token request contains the “atc” JASON object defined in [draft-ietf-acme-authority-token-tnauthlist]. The “atc” object identifies the type and scope of certificates authorized by the SPC Token. (Essentially, the Subordinate CA is asking the STI-PA to issue an SPC Token that contains this same “atc” object.) In order to obtain an SPC Token that authorizes delegate CA certificates, the token request “atc” object “ca” boolean shall be set to ‘true’. To authorize a specific scope for the delegate CA certificates, the token request “atc” object TNAuthList shall contain a single SPC value and the set (or a specific subset) of TNs assigned to the Subordinate CA. Since SPC Tokens authorizing delegate CA certificates are required have TN-granularity, the TNAuthList must contain at least one TN. Otherwise, the token request “atc” object is populated as specified in [ATIS-1000080-E].

An example of a request for an SPC Token sent by the Subordinate CA to the STI-PA is as follows:

 POST /at/account/:id/token HTTP/1.1

 Host: authority.example.com

 Content-Type: application/json

 {

 "atc":{"TNAuthList":"F83n2a...avn27DN3==",

 "ca":true,

 "fingerprint":"SHA256 56:3E:CF:AE:83:CA:4D:15:B0:29:FF:1B:71:D3 \

 :BA:B9:19:81:F8:50:9B:DF:4A:D4:39:72:E2:B1:F0:B9:38:E3"}

 }

On receiving the above token request, the STI-PA shall verify that the requesting Subordinate CA is authorized to obtain delegate CA certificates, and also that the requesting Subordinate CA has authority over the SPC value identified in the received TNAuthList. It shall also verify that the TNAuthList identifies one or more TNs and/or TN ranges, and that the identified TNs are assigned to the requesting Subordinate CA. If these verification checks pass, then the STI-CA shall construct an SPC Token containing the received “atc” object, as shown in the following example:

 { "typ":"JWT",

 "alg":"ES256",

 "x5u":https://authority.example.org/cert

 }

 {

 "iss":"https://authority.example.org/authz",

 "exp":1300819380,

 "jti":"id6098364921",

 "atc":{"TnAuthList":"F83n2a...avn27DN3==",

 "ca":true,

 "fingerprint":"SHA256

 56:3E:CF:AE:83:CA:4D:15:B0:29:FF:1B:71:D3:BA:B9:19:81:F8:50:

 9B:DF:4A:D4:39:72:E2:B1:F0:B9:38:E3"}

 }

The STI-PA shall sign the SPC Token with the private key of the STI-PA certificate referenced by the token’s “x5u” parameter, and return the token to the Subordinate CA in a 200 OK response, as shown in the following example:

 HTTP/1.1 200 OK

 Content-Type: application/json

 {"token": "DGyRejmCefe7v4N...vb29HhjjLPSggwiE"}

### Subordinate CA obtains a Delegate CA Certificate from STI-CA

The Subordinate CA shall create an ACME account and order a new delegate CA certificate from the STI-CA using the ACME procedures defined in [ATIS-1000080-E], with the exceptions noted in this section.

During the finalize step of the ACME certificate ordering process, the Subordinate CA shall request a delegate CA certificate by including a BasicConstraints object in the CSR with the cA boolean set to ‘true’. When the STI-CA receives a CSR containing a BasicConstraints object with a cA boolean of ‘true’, it shall verify that the requesting Subordinate CA is authorized to obtain delegate CA certificates by checking that the SPC Token received in the challenge response contains a “ca” boolean with a value of ‘true’. If the Subordinate CA is authorized to receive delegate CA certificates, then the STI-CA shall issue a certificate containing a BasicConstraints object with a cA Boolean of ‘true’. The STI-CA shall populate both the delegate CA certificate, and its direct parent certificate, with the TNAuthList identifier received in the ACME new-order request, as specified in [draft-ietf-acme-delegate-certificate]. (Note, as part of normal SHAKEN procedures, the STI-CA shall verify that the new-order TNAuthList and the CSR TNAuthList both match the TNAuthList in the SPC Token challenge response.)

Once it has downloaded the newly issued delegate CA certificate, the Subordinate CA shall store the certificate locally (i.e., unlike end-entity certificates, the delegate CA certificate is not stored in the STI-CR).

### VoIP Entity obtains a Delegate End-Entity Certificate from Subordinate CA

The procedure to obtain a delegate end-entity certificate is a simplified version of the ACME certificate ordering procedures defined in [ATIS-1000080-E] where the VoIP Entity KMS plays the role of the SP-KMS, and the Subordinate CA plays the role of STI-CA.

#### Initial Conditions

As a pre-requisite to issuing delegate certificates, the Subordinate CA must configure the VoIP Entity with the URL of the Subordinate CA ACME directory resource, and the scope of delegate end-entity certificates that the VoIP Entity is authorized to obtain from the Subordinate CA. The scope must not exceed the scope of the delegate CA certificate that will serve as the parent to end-entity certificates issued by the Subordinate CA to this VoIP Entity. Specifically, the SPC value must match the SPC value of the delegate CA certificate, and the assigned set of TNs must either match, or be a subset of, the TNs of the delegate CA certificate. The Subordinate CA shall also provision the VoIP Entity with the “origid” claim value that it must use when signing PASSporTs with the private key of any delegate end-entity certificates it obtains from the Subordinate CA.

#### Creating an ACME Account with the Subordinate CA

The VoIP Entity KMS and Subordinate CA shall support the ACME account creation process defined in [ATIS-1000080-E].

The account creation process is identical to that specified by [ATIS-1000080-E]. The VoIP Entity KMS shall generate a public/private key pair using the ES256 algorithm, to serve as credentials for the account, and shall send an HTTP POST request to the “newAccount” resource to create the ACME account, as shown in the following example:

POST /acme/new-account HTTP/1.1

Host: subordinate-ca.com

Content-Type: application/jose+json

{

 "protected": base64url({

 "alg": "ES256",

 "jwk": /\* ACME account public key \*/,

 "nonce": "6S8IqOGY7eL2lsGoTZYifg",

 "url": "https:/subordinate-ca.com/acme/new-account"

 })

 "payload": base64url({

 "contact": [

 "mailto:cert-admin-kms01@voip-entity.com",

 "tel:+12155551212"

 ]

 }),

 "signature": /\* signed using ACME account private key \*/

}

If the account already exists for the specified account key, then the Subordinate CA shall send a “200 OK” response to the POST request. Otherwise, the Subordinate CA shall create an account object and send a “201 Created” response, as shown in the following example:

HTTP/1.1 201 Created

Content-Type: application/json

Replay-Nonce: D8s4D2mLs8Vn-goWuPQeKA

Location: https://subordinate-ca.com/acme/acct/1

Link: <https://subordinate-ca.com/acme/some-directory>;rel="index"

{

 "status": "valid",

 "contact": [

 "mailto:cert-admin-kms01@voip-entity.com",

 "tel:+12155551212"

 ]

 "orders": "https://subordinate-ca.com/acme/acct/1/orders"

}

#### Pre-authorizing the ACME Account

The Subordinate CA shall pre-authorize the new ACME account based on a security association with the VoIP Entity that was previously established via procedures outside the scope of this document. The Subordinate CA shall provision an authorization object with a “status” of “valid”, with an empty set of challenges, and containing an “identifier” field of type “TNAuthList” with the ASN.1 encoding of the SPC value and TN list pre-authorized for the VoIP Entity.

The Subordinate CA shall advertise the URL of the authorization object in the “newAuthz” field of the directory object.

An example of the authorization object is as follows:

 {

 "status": "valid",

 "expires": "2018-03-01T14:09:00Z",

 "identifier": {

 "type":"TNAuthList",

 "value": "F83n2a...avn27DN3=="

 },

 "challenges": []

 }

#### Obtaining a new Delegate End-Entity Certificate from Subordinate CA

The VoIP Entity KMS and Subordinate CA shall support the pre-authorization certificate ordering and issuance process defined in [draft-ietf-acme-acme].

**1) Ordering the Certificate**

As the first step in applying for a new certificate, the VOIP Entity KMS shall provide an “identifiers” field in the new-order POST request of “type” of “TNAuthList”. The TNAuthList value shall identify the SPC, and the set (or a subset) of the TNs that were pre-provisioned by the Subordinate CA (see 5.3.3.1). The TNAuthList must identify at least one TN.

Note, as an alternative, the VOIP Entity KMS could simply use the TNAuthList contained in the authorization object (see section 5.3.3.3).

An example of the new-order POST request is as follows:

POST /acme/new-order HTTP/1.1

 Host: subordinate-ca.com

 Content-Type: application/jose+json

 {

 "protected": base64url({

 "alg": "ES256",

 "kid": " https://subordinate-ca.com/acme/acct/1",

 "nonce": "5XJ1L3lEkMG7tR6pA00clA",

 "url": " https://subordinate-ca.com/acme/new-order"

 })

 "payload": base64url({

 "identifiers": [{"type:"TNAuthList","value":"F83n2a...avn27DN3=="}],

 "notBefore": "2018-01-01T00:00:00Z",

 "notAfter": "2018-01-08T00:00:00Z"

 }),

 "signature": /\* signed using ACME account private key \*/

}

**2) Verifying the order**

The Subordinate CA shall verify that the “Identifiers” field in the new-order request is authorized by the “identifier” field of the pre-provisioned authorization object described in section 5.3.3.3 (i.e., SPC must match pre-authorized SPC, TNs must either match or be subset of pre-authorized TNs, and there must be at least one requested TN).

If the request is valid, then the Subordinate CA shall send a “201 Created” response containing the newly created order object, as shown in the following example:

 HTTP/1.1 201 Created

   Content-Type: application/json

 Replay-Nonce: MYAuvOpaoIiywTezizk5vw

 Location: https://subordinate-ca.com/acme/order/asdf

 {

 "status": "ready",

 "expires": "2016-01-01T00:00:00Z",

 "notBefore": "2016-01-01T00:00:00Z",

 "notAfter": "2016-01-08T00:00:00Z",

 "identifiers": [{"type:"TNAuthList","value":"F83n2a...avn27DN3=="}],

 "authorizations": [

 "https://subordinate-ca.com/acme/authz/1234"

 ],

 "finalize": "https://subordinate-ca.com/acme/order/asdf/finalize"

 }

The “authorizations” field contains the URL to the pre-provisioned authorization object described in section 5.3.3.3. The “finalize” field contains the URL that the CAF-URL will use to finalize the order.

**3) Finalizing the order**

The VOIP Entity KMS knows that that the account is pre-authorized to issue the requested certificate based on the returned order object status of “ready”, and therefore shall proceed to finalize the order. (As an option, the VOIP Entity KMS may verify that the ACME account has been pre-authorized by performing an HTTP GET for the URL contained in the “authorizations” field in step-2, and check that the returned authorization object has a status of “valid”.)

To finalize the order, the VOIP Entity KMS shall create a CSR as specified in [ATIS-1000080-E], but containing an “identifier” field identical to the “identifiers” field of the new-order request in step-1. The VOIP Entity KMS shall then finalize the order by sending an HTTP POST request to the “finalize” URL received in step-2, as shown in the following example:

 POST /acme/order/asdf/finalize HTTP/1.1

 Host: subordinate-ca.com

 Content-Type: application/jose+json

 {

 "protected": base64url({

 "alg": "ES256",

 "kid": "https://subordinate-ca.com/acme/acct/1",

 "nonce": "MSF2j2nawWHPxxkE3ZJtKQ",

 "url": "https://subordinaate-ca.tn-provider.com/acme/order/asdf/finalize"

 }),

 "payload": base64url({

 "csr": "5jNudRx6Ye4HzKEqT5...FS6aKdZeGsysoCo4H9P",

 }),

 "signature": /\* signed using ACME account private key \*/

 }

The Subordinate CA shall respond to the finalize request with a “200 OK” response containing the order object, as shown in the following example:

 HTTP/1.1 200 OK

   Content-Type: application/json

 Replay-Nonce: MYAuvOpaoIiywTezizk5vw

 Location: https://subordinate-ca.com/acme/order/asdf

 {

 "status": "processing",

 "expires": "2018-01-01T00:00:00Z",

 "notBefore": "2018-01-01T00:00:00Z",

 "notAfter": "2018-01-08T00:00:00Z",

 "identifiers": [{"type:"TNAuthList","value":"F83n2a...avn27DN3=="}],

 "authorizations": [

 "https://subordinate-ca.com/acme/authz/1234"

 ],

 "finalize": "https://subordinate-ca.com/acme/order/asdf/finalize"

 }

At this point in the process, the Subordinate CA shall execute the order by constructing a certificate containing the requested TNAuthList, and signed with the private key of the Subordinate CA’s delegate CA certificate. While the Subordinate CA is filling the order, it shall maintain an order object status of “processing”.

**4) Polling for the certificate**

Once it has finalized the certificate order with the Subordinate CA, the VOIP Entity KMS shall periodically poll the order object resource with a POST-as-GET request, as specified in [ATIS-1000080-E]. When the order has been filled, the Subordinate CA shall store the newly issued certificate in the STI-CR, and shall indicate to the VOIP Entity KMS that the certificate is available by responding to the next poll as shown in the following example:

   POST /acme/order/asdf HTTP/1.1

   Host: subordinate-ca.com

 Content-Type: application/jose+json

 {

 "protected": base64url({

 "alg": "ES256",

 "kid": "https://subordinate-ca.com/acme/acct/1",

 "nonce": "uQpSjlRb4vQVCjVYAyyUWg",

 "url": "https://subordinate-ca.com/acme/new-order"

 }),

 "payload": "",

 "signature": "nuSDISbWG8mMgE7H...QyVUL68yzf3Zawps"

 }

 HTTP/1.1 200 OK

   Content-Type: application/json

 Replay-Nonce: MYAuvOpaoIiywTezizk5vw

 Location: https://subordinate-ca.com/acme/order/asdf

 {

 "status": "valid",

 "expires": "2018-01-01T00:00:00Z",

 "notBefore": "2018-01-01T00:00:00Z",

 "notAfter": "2018-01-08T00:00:00Z",

 "identifiers": [{"type:"TNAuthList","value":"F83n2a...avn27DN3=="}],

 "authorizations": [

 "https://subordinate-ca.com/acme/authz/1234"

 ],

 "finalize": [https://subordinate-ca.com/acme/order/asdf/finalize](https://subordinate-ca.tn-provider.com/acme/order/asdf/finalize)

 "certificate": "https://sti-cr.tn-provider.com/cert-1"

 }

Based on a pre-established agreement between the Subordinate CA and VoIP Entity , the newly issued delegate end-entity certificate shall be stored in the STI-CR either by the Subordinate CA or the VoIP Entity. If the Subordinate CA stores the certificate in the STI-CR, then the VoIP Entity does not need to download the actual certificate. Instead, it can simply use the URI identified in the “certificate” field of the step-4 response to populate the “x5u” field in the PASSportT token created during STI authentication.

### Obtaining a new Delegate End-Entity Certificate from STI-CA

A SHAKEN Service Provider can obtain delegate end-entity certificates directly from the STI-CA, as shown in Figure 3. This would apply to the case where the Service Provider wants to sign a PASSporT that requires delegate end-entity certificate credentials (e.g., the “rcd” PASSporT extension).



Figure 3. Service Provider obtains delegate end-entity certificate directly from STI-CA

The procedure for obtaining an SPC Token in this case is the same as that described in section 5.3.1, except that in order to obtain an SPC Token that authorizes delegate end-entity certificates, the token request “atc” object “ca” boolean shall be set to ‘false’. As specified in section 5.3.1, the TNAuthList in the token request “atc” object must identify at least one TN.

The procedure to create an ACME account and order a delegate end-entity certificate from the STI-CA is the same as that described in section 5.3.2, except that during the finalize step of the ACME certificate ordering process, the Service Provider shall request a delegate end-entity certificate by either omitting the BasicConstraints object in the CSR, or including a BasicConstraints object in the CSR with the cA boolean set to ‘false’. When the STI-CA receives a CSR containing no BasicConstraints object, or a BasicConstraints object with a cA boolean of ‘false’, and a TNAuthList that identifies at least one TN (and the TNAuthList is authorized by the received SPC Token), then it shall issue a delegate end-entity certificate by populating both the end-entity certificate and its direct parent certificate with the TNAuthList identifier received in the ACME new-order request, as specified in [draft-ietf-acme-delegate-certificate].

# Delegate Certificate Deployment Models

This section describes different delegate certificate deployment models. The diagram entities labeled “Service Provider” represent both VoIP Service Providers and TN Providers; i.e., entities that are assigned OCN(s) and TN(s), and that are able to obtain SPC Tokens from the STI-PA.

## Service Provider Hosts Subordinate CA to serve Customer AF

Figure 4 shows the case where a Service Provider hosts a Subordinate CA in order to provide delegate end-entity certificates to its Customer AFs.

1. The Subordinate CA shall obtain an SPC Token as described in section 5.3.1.
2. The Subordinate CA shall obtain a delegate CA certificate as described in section 5.3.2.
3. The Customer AF shall obtain a delegate end-entity certificate as described in section 5.3.3, where the Customer AF is playing the role of the VoIP Entity.
4. Either the Customer AF/KMS (as shown), or the Subordinate CA shall store the delegate end-entity certificate in the STI-CR.



Figure 4. Service Provider Hosts Subordinate CA to serve Customer AF

## Service Provider Hosts Subordinate CA to serve Itself

Figure 5 shows the case where a Service Provider hosts a Subordinate CA in order to obtain delegate ent-entity certificates for its own use (e.g., to sign “rcd” PASSporTs). This deployment model could be combined with the deployment model described in section 6.1.

1. The Subordinate CA shall obtain an SPC Token as described in section 5.3.1.
2. The Subordinate CA shall obtain a delegate CA certificate as described in section 5.3.2.
3. The KMS obtains a delegate end-entity certificate from the Subordinate CA via proprietary mechanisms. Since this interface is internal to the Service Provider, the procedure does not need to be specified. However, the procedure specified in section 5.3.3, where the KMS plays the role of VoIP Entity, could be used for this interface.
4. The KMS can also obtain SHAKEN end-entity certificates from the STI-CA as specified in [ATIS-1000080-E].
5. The KMS stores the newly issued end-entity certificates in the STI-CR.



Figure 5. Service Provider Hosts Subordinate CA to serve itself

## Service Provider obtains Delegate End-Entity Certificates from STI-CA

Figure 6 shows the case where a Service Provider obtains delegate end-entity certificates directly from the STI-CA. The Service Provider KMS shall obtain SHAKEN end-entity certificates via interfaces 1) and 2) as described in [ATIS-1000080-E], and shall obtain delegate end-entity certificates via interfaces 1) and 3) as described in section 5.3.4. The KMS shall store the certificates in the STI-CR via interface 4).



Figure 6. Service Provider obtains delegate end-entity certs from STI-CA

## Service Provider obtains Delegate End-Entity Certificates from 3rd-party

Figure 7 shows the case where a Service Provider obtains delegate end-entity certificates from a Subordinate CA that is hosted by a 3rd party (for example, where the 3rd party is another Service Provider). This case assumes that there is a security association established between the Service Provider and 3rd party entity, and that the STI-PA recognizes that the 3rd party is authorized to request CA-level SPC Tokens for the Service Provider’s SPC(s) and TN(s).

1. The Subordinate CA shall obtain an SPC Token as described in section 5.3.1.
2. The Subordinate CA shall obtain a delegate CA certificate as described in section 5.3.2.
3. The Service Provider KMS shall obtain a delegate CA certificate as described in section 5.3.3, where the KMS is playing the role of the VoIP Entity.
4. Either the Service Provider (as shown) or the 3rd party shall store the delegate end-entity certificate in the STI-CR.



Figure 7. Service Provider obtains Delegate End-Entity Certificates from 3rd-party

## Customer AF Hosts Subordinate CA

Figure 8 shows the case where a Service Provider hosts a Subordinate CA that provides delegate CA certificates to a second Subordinate CA hosted by a Customer AF. This model enables the Customer AF to obtain a delegate CA certificate from a Service Provider, and then use that CA certificate to issue multiple delegate end-entity certificates to other internal or external VoIP Entities that need to sign PASSporTs that require delegate certificate credentials. Figure 8 shows the case where a Customer AF as an Enterprise has delegated a subset of its assigned TNs to a Call Center that it has contracted to make calls on its behalf.

1. Subordinate CA 1 shall obtain an SPC Token as described in section 5.3.1.
2. Subordinate CA 1 shall obtain a delegate CA certificate from the STI-CA as described in section 5.3.2.
3. Enterprise Subordinate CA 2 shall obtain a delegate CA certificate from Subordinate CA 1 as described in section 5.3.3, except that during the finalize step of the new-order process, Subordinate CA 2 shall populate the CSR with a BasicConstraints object containing a cA boolean having a value of ‘true’.
4. The Call Center KMS shall obtain a delegate end-entity certificate as specified in section 5.3.3.
5. Either the Call Center KMS (as shown), or Enterprise Subordinate CA 2 shall store the delegate end-entity certificate in the STI-CR.



Figure 8. Customer AF Hosts Subordinate CA

# A Annex Title

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1. Available from the Internet Engineering Task Force (IETF) at: < <https://www.ietf.org/> >. [↑](#footnote-ref-1)
2. Available from 3rd Generation Partnership Project (3GPP) at: < [https://www.3gpp.org](http://www.3gpp.org) > [↑](#footnote-ref-2)