**ATIS-0x0000x**

ATIS Standard on

**ATIS Technical Report on a Framework for SHAKEN Attestation and Origination Identifier**

**Alliance for Telecommunications Industry Solutions**

Approved Month DD, YYYY

**Abstract**

This technical report provides a framework for SHAKEN attestation and granularity of the Origination Identifier.

**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**

| **Date** | **Version** | **Description** | **Author** |
| --- | --- | --- | --- |
|  |  |  |  |

**Table of Contents**

[INSERT]

**Table of Figures**

[INSERT]

**Table of Tables**

[INSERT]

# Scope, Purpose, & Application

## Scope

This technical report provides a framework for SHAKEN attestation and granularity of the Origination Identifier.

## Purpose

The population of attestation indicator and origination identifier in the SHAKEN Identity header rely on decisions the originating service provider (originating SP) makes based on the type of interface at the ingress to its network, knowledge of the customer or SP entity it has received the call from, and knowledge or agreements as to the calling party telephone numbers (calling TNs) used on the interface. These determinations are made both through administrative and security management procedures as well as security services applied at call processing time. The resulting values are provided to the SHAKEN STI-AS function to be passed with the protected call data. This report documents the characteristics of the security services applied at the User-to-Network Interface or Network-to-Network Interface of an originating SP, and some guidelines for the population of SHAKEN attestation indicator and origination identifier based on these services.

The material and guidelines presented here should be considered informative, as practice and norms can be expected to evolve with deployment and industry experience.

.

# 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.

[Ref 1] ATIS-1000074, Signature-based Handling of Asserted Information using toKENs (SHAKEN)

[Ref 2] Signature-based Handling of Asserted information using toKENs (SHAKEN): Governance Model and Certificate Management

[Ref 3] ITU-T Recommendation X.811 (04/1995) | ISO/IEC 10181-2:1996, Information technology – Open Systems Interconnection – Security frameworks for open systems: Authentication framework

[Ref 4] ITU-T Recommendation X.815 (11/1995) | ISO/IEC 10181-6:1996, Information technology – Open Systems Interconnection – Security frameworks for open systems: Integrity framework

[Ref 5] Recommendation X.812 (11/1995) | ISO/IEC 10181-3:1996, Information technology – Open Systems Interconnection – Security Frameworks For Open Systems: Access Control Framework

[Ref 6] CCITT Recommendation X.800 (1991), Security architecture for Open Systems Interconnection for

CCITT applications.

# 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

**Caller identity:** The originating phone number included in call signalling used to identify the caller for call screening purposes.In some cases this may be the Calling Line Identification or Public User Identity. For the purposes of this study, the caller identity may be set to an identity other than the caller’s Calling Line Identification or Public User Identity.

## Acronyms & Abbreviations

|  |  |  |
| --- | --- | --- |
| ATIS | Alliance for Telecommunications Industry Solutions | |
| CSCF | | Call session control function |
| FQDN | | Fully qualified domain name |
| IMEI | | International Mobile Equipment Identity |
| IMSI | | International Mobile Subscriber Identity |
| NNI | | Network-to-network interface |
| MGCF | | Media gateway control function |
| SBC | | Session border controller |
| SGW | | Signaling gateway |
| SP | | Service provider |
| STI-AS | | Secure Telephone Identity – Authentication Service |
| STI-VS | | Secure Telephone Identity – Verification Service |
| TN | | Telephone number |
| UA | | User agent |
| UNI | | User-to-network interface |
| VASP | | Value-added service provider |
| VoIP | | Voice over IP |

# Architecture

## SHAKEN reference architecture

The figure below shows the SHAKEN reference architecture. This is a logical view of the architecture and doesn’t mandate any particular deployment and/or implementation. For reference, this architecture is specifically based on the 3GPP IMS architecture with an IMS application server, and is only provided as an example to set the context for the functionality described in this document. The diagram shows the two IMS instances that comprise the IMS half-call model; an originating IMS network hosted by Service Provider A, and a terminating IMS network hosted by Service Provider B.



**Figure 4.1 – SHAKEN Reference Architecture**

This SHAKEN reference architecture includes the following elements:

* SIP UA – The SIP User Agent that is authenticated by the service provider network and the calling party identity is known since it is under direct management by the telephone service provider. It initiates the SIP INVITE as the calling party.
* IMS/CSCF - This component represents the SIP registrar and routing function. It also has a SIP application server interface.
* IBCF/TrGW - This function is at the edge of the service provider network and represents the Network-to-Network Interface (NNI) or peering interconnection point between telephone service providers. It is the ingress and egress point for SIP calls between providers.
* Authentication Service (STI-AS) - The SIP application server that performs the function of the authentication service defined in 4474bis. It should either itself be highly secured and contain the Secure Key Store (SKS) of secret private key(s) or have an authenticated, Transport Layer Security (TLS)-encrypted interface to the SKS which stores the secret private key(s) used to create PASSporT signatures.
* Verification Service (STI-VS) - The SIP application server that performs the function of the verification service defined in 4474bis. It has an HTTPS interface to the Telephone Number Certificate Repository that is referenced in the Identity header field to retrieve the provider public key certificate
* Call Validation Treatment (CVT) - This is a logical function that could be an application server function or a third party application for applying anti-spoofing mitigation techniques once the signature is positively or negatively verified and then providing a response to signal the display response for the end user.
* SKS – The Secure Key Store is a logical highly secure element that stores secret private key(s) for the authentication service (STI-AS) to access.
* Certificate Provisioning Service – A logical service used to provision certificate(s) used for STI.
* Telephone Number Certificate Repository (TN-CR): This represents the publically accessible store for public key certificates. This should be an HTTPS web service that can be validated back to the owner of the public key certificate.

# XxxSHAKEN security services and attestation

The SHAKEN Identity header provides certain security services for call signaling information between an originating service provider (originating SP) and a terminating service provider (terminating SP) in the VoIP-based service provider network. It authenticates the originating service provider identity to the terminating service provider and it protects the integrity of call parameters populated by the originating SP. It is intended that the Identity header is populated via an STI-AS function by the first SP to receive the call in the VoIP-enabled SP network, a point in the VoIP-based SP network as close as possible to the ultimate source of the call, and is transmitted unchanged across any NNI and intermediate SP networks so that it can be verified by the terminating SP in its STI-VS function. The originating/signing SP identity, in the form of a Service Provider Code (SPC) is contained in the PKI certificate associated with the public/private key pair the SP uses to create the cryptographic signature in the Identity header, and the certificate can be validated against root CA certificates shared within a common governance and trust domain [Ref 2]. The signature also protects the integrity of the call parameters, including calling and called number, timestamp, “attestation indicator,” and “origination identifier.” The SP-level identity and authentication and call parameter integrity services support other security dimensions such as non-repudiation as defined in [Ref 6]. In the SHAKEN model, the Identity header protects this information across the NNIs through the SP networks but assuring the correctness of the parameters relies on other mechanisms and procedures the originating SP typically applies at the user-to-network interface (UNI).

## Attestation indicator

The SHAKEN Identity header does not convey a customer identity other than calling TN which may or may not uniquely identify the customer, nor does it convey authentication credentials for the customer entity that originated the call into the VoIP-based SP network. Instead, it contains an “attestation indicator” (the “attest” claim) which codes the extent to which the originating SP has itself identified and authenticated its customer and determined the customer’s “association” to the calling party telephone number. The initial set of attestation values are “A,” “B,” or “C” defined as follows (as excerpted from [Ref 1], Section 5.2.3):

**A.** **Full Attestation:** The signing provider shall satisfy all of the following conditions:

* Is responsible for the origination of the call onto the IP based service provider voice network.
* Has a direct authenticated relationship with the customer and can identify the customer.
* Has established a verified association with the telephone number used for the call.

…

**B. Partial Attestation:** The signing provider shall satisfy all of the following conditions:

* Is responsible for the origination of the call onto its IP-based voice network.
* Has a direct authenticated relationship with the customer and can identify the customer.
* Has NOT established a verified association with the telephone number being used for the call.

…

**C.** **Gateway Attestation:** The signing provider shall satisfy all of the following conditions:

* Is the entry point of the call into its VoIP network.
* Has no relationship with the initiator of the call (e.g., international gateways).

In terms of security services, the process of determining an attestation level equates to the application of UNI “identity,” “authentication,” and “access control” security services. The primary UNI “identity” is a user identity indicating the customer and not necessarily tied to the calling TN. The UNI “authentication” service refers to authenticating the customer/user again potentially irrespective of calling TN. Note that this UNI service is different from the SHAKEN “authentication” service (STI-AS) which generates the Identity header for propagation across the NNI. “Access control” in this instance pertains to determining whether the customer, once identified and authenticated, is authorized to utilize the calling TN (that is, the customer has a “verified association” to the TN as described in the attestation level definitions). A call that passes all three of these security services may be marked with the highest level of attestation (“A”), and a call that does not pass one or more of these should be passed with a reduced attestation level. Once the terminating SP’s “verification” function (STI-VS) has verified the integrity of the identity header through the received signature, the terminating SP network can use the received attestation indicator to make decisions about the validity of the calling TN for further analytics, call processing decisions, and conveying information to terminating user agents.

## UNI Model

In the VoIP-based service provider network, calls are place to originating SPs and received from terminating SPs over a signaling and media path that constitutes a UNI. The reference model (Section 4.1, above) covers one use case where the UA initiating the call at the UNI is under “direct management” of the originating SP. More generally, the initiating UA that signals the call to the originating SP is typically in the possession of or under the control of a “customer,” which is typically an entity that has a direct commercial relationship with the originating SP and may or may not be the ultimate source of the call. In addition to individuals or enterprises that can be considered direct end users of the originating SP’s service, other types of customers include communications resellers and value-added service providers (VASPs) that bundle communications capabilities with other services and provide those services to other entities. Resellers accept calls sourced from other parties (indirect users) and relay them into the VoIP-based SP network via their own UNI. A VASP may relay calls similar to a reseller or may itself originate calls from a call center or automated function on behalf of one or more customers. For the purposes of this report, the “UNI” will refer to the interface between the customer networks or devices and the originating SP network and not any upstream interfaces between the customer and any indirect users that may be the ultimate source of calls received by the originating SP. Note that there is a separate class of call flows where the “originating SP” for the purposes of SHAKEN Identity header population receives a call over an NNI from another service provider. This is discussed in section 5.3.

Figure 5-1: User-to-Network Interface in context of SHAKEN

### Customer identity

The primary user identity associated with a UNI is a “customer identity” used to determine the commercially responsible party for consumption of the service (the customer is the “principal” as that term is defined in [Ref 3]). In some cases an originating SP may rely on a TN-based identity for this purpose. In many cases a TN does not unambiguously identity the customer, making it an insufficient identifier for UNI authentication and authorization procedures. Other forms of user identity include account names or IDs, equipment identifiers (e.g. mobile IMSI or IMEI), physical connections or IP network addresses. One or more forms of user identity are inputs to an authentication process to verify the user and in some cases to an authorization process to determine what services the user is entitled to.

In the ideal case the originating SP establishes the real-world identity of the customer by personal name, business name, e-mail and physical home or business address, tax ID or other government-conferred identifiers, payment accounts and credit history, etc. This allows the SP to track the responsible party for placing or receiving calls for commercial purposes, policy enforcement and other legal purposes. The real-world customer identity is typically associated with user names, customer equipment IDs, and/or other identifiers used in protocols and procedures at the UNI.

### TN-based identity

The caller identity used across the NNI in general and in the SHAKEN Identity header specifically is a calling party TN in the form of a national or international E.164 number. While customer IDs other than TN may be used for authentication and authorization decisions at the UNI, non-TN identities are not typically delivered across the NNI or used directly in transit or terminating network processing (a “calling name” may be added by the terminating network using a database lookup against the calling TN received via the NNI). An origid claim sent in the Identity header may or may not be associated with individual customers, but the parameter is also intended to be an opaque value not specifically conveying identity.

A TN-based identity may be tied to other types of user identities that an originating SP utilizes to determine the source of the call for commercial purposes. In the simplest cases there is a one-to-one correspondence between a TN-based identity and a customer account ID so that either may be used by the originating SP for authentication, identification, and authorization purposes. In many cases there is not a one-to-one correspondence and the service provider will likely use an identity other than the TN to identify the customer at the UNI. Furthermore, in a number of use cases the real-world identity of the customer is not strongly established. A few possible scenarios for the use of TN-based identity at the UNI are included in Annex B, below.

### User authentication

Once a VoIP communications service customer has been identified, authentication is the means of verifying that they are the authorized entity to be using UNI resources and that the entity is responsible for the commercial and policy terms of placing or receiving calls to and from the SP network. User authentication can take a number of forms including transactions via equipment-resident or user-provided credentials, network location, and/or protected network paths. Some of these are described in Annex B, below.

### TN authorization and screening

For the purposes of SHAKEN attestation, once an originating SP has identified and authenticated the customer, the originating SP network determines whether a customer is authorized to utilize a calling TN (described in SHAKEN as the customer’s “association” with the TN). Authorizing and determining the authorization of a customer to utilize a TN resource are parts of the “access control” security dimension along with other authorizations to use the VoIP service itself. Authorizing the use of a TN with a service is largely an administrative process before the handling of the call, for instance by populating a subscriber record or populating a database for affirmative control of TNs, or by recording customer agreement to terms of use. If the originating SP network can determine that the customer is authorized to use a customer-asserted TN then it would presumably mark an “A” attestation in the Identity payload. Where it cannot determine the authorization it would mark a “B” attestation. One possible implementation would be for the originating SP and customer to agree that calling TNs will be “screened,” and any calls with TNs not explicitly authorized will be rejected. Only authorized calling TNs would be passed, including an “A” marking. Some possible means of determining authorization under different usage scenarios are described in Annex B, below.

## Identity header population and attestation for calls received at a network-to-network interface

Within a common governance and trust domain (e.g. U.S. service providers), the end goal of SHAKEN mechanism deployment is for all calls to be marked with an Identity header containing call parameters (SHAKEN claims) populated based on information determined directly at the customer’s UNI where they first enter the trust domain. Once the Identity header is created by the originating SP, it is to be passed across any downstream NNIs without modification. Calls may still arrive at an NNI without an Identity header for a number of reasons, and therefore the receiving gateway or intermediate SP might assume the role of “originating SP” for the purposes of SHAKEN call processing. This would result in the gateway/intermediate SP populating an Identity header using information they can determine across the NNI and signing it with its own credentials. The main use case for SHAKEN “authentication” for calls received at an NNI is an international gateway provider, where calls are received from entities outside the trust and governance domain, and therefore the source’s identity and adherence to the receiving SP’s country or regional policies may not be determined. Likewise, the SP populating the Identity header is not expected to have any knowledge of the identity, authenticity or authorization to use calling TNs of any customers homed on the interconnecting gateway SP’s network or other interconnecting parties behind that SP’s network. Any Identity header received at a gateway may not be verifiable (in the future, inter-governance-authority agreements and administration mechanisms may make this possible). A signature with the gateway provider’s credentials allows for traceability to a call’s entry point into the trust domain. The gateway provider should not populate attestation values (A or B) that rely on UNI security services that cannot be applied at the NNI.

 Figure 5-2: Network-to-Network Interface in context of SHAKEN

Another reason that a call might arrive at an NNI without an Identity header is that the NNI uses a non-SIP protocol (e.g. TDM/ISUP), so that capability is not available even if the carrier originating the TDM call leg is or could be covered under the governance and trust domain. The first SP that transits the call across a VoIP NNI may populate an Identity header using its own credentials, and as with the international gateway scenario it should not populate attestation values A or B that rely on UNI security services.

Especially during a transition phase where SHAKEN functions are not deployed in a substantial percentage of SP networks, it may be of some limited value for an intermediate SP to add an Identity header using its own credentials, to provide traceability to itself where it can provide information regarding an upstream SP. There is probably limited additional value for an intermediate provider to add an Identity header if one is present (created within the trust domain), and doing so may make it harder to determine at the verification function which header has the more authoritative information about the call parameters. As with the other NNI-origination use cases, the intermediate provider should not itself mark A or B attestation values.

## Guidelines

### Full Attestation

In order to mark a call with an Identity header containing the “full attestation” attest claim value (“A”), all the previously discussed UNI security services should be applied and passed. As a result, the following conditions should apply:

* The originating SP administrative functions should determine the real-world identity of the customer.
* The originating SP network should receive the call through an interface constituting a UNI.
* The customer should present its identity across the UNI interface as necessary for authentication purposes.
* The originating SP UNI security function should authenticate the customer’s identity through an authentication transaction, protected network path, or other means.
* The originating SP UNI security function should apply an access control procedure and determine that the customer is authorized to utilize the calling TN, or the originating SP should itself populate a known authorized calling TN.

Per SIP procedures, any calling TN populated by the originating SP should be passed in the SIP P-Asserted-Identity header, and that value will also be populated as the “orig” claim value of the SHAKEN PASSPorT token of the Identity header.

Note that the “customer” refers to the direct customer of the originating SP. Where the originating SP has assigned the calling TN or the customer has provided evidence that it has authorization to use the calling TN itself, the originating SP can mark an “A” attestation without reference to authorizations of any indirect users (for instance in a reseller or VASP scenario). In some other scenarios the TN assignments and/or authorizations apply to the indirect user or call-initiation functions executed on behalf of the reseller’s or VASP’s customer. In those cases the SP’s customer should provide assurances that they can trace the identity of an indirect end user and that user’s authorization to utilize a calling TN. The customer should be able to certify that only the authorized party (or calls originated on their behalf) will use the particular set of authorized TNs, and any traceback to the ultimate source will rely on the cooperation of the SP’s customer.

### Partial Attestation

In order to mark a call with an Identity header containing the “partial attestation” attest claim value (“B”), at a minimum the customer identity and authentication services should have been applied to the call. As a result, the following conditions should apply:

* The originating SP administrative functions should determine the real-world identity of the customer.
* The originating SP network should receive the call through an interface constituting a UNI.
* The customer should present its identity across the UNI interface as necessary for authentication purposes.
* The originating SP UNI security function should authenticate the customer’s identity through an authentication transaction, protected network path or other means.
* The originating SP UNI security function has not determined the customers authorization to utilize a calling TN, or it has applied an access control procedure and could not determine the customer’s authorization to use the presented calling TN.

### Gateway Attestation

An “originating SP” for the purposes of SHAKEN “authentication” processing s should mark a call with an Identity header containing the “gateway attestation” attest claim value (“C”) under the following circumstances:

* An SP (international gateway SP, intermediate SP) populating an Identity header for a call received through an NNI should mark the call with “gateway attestation.” Presumably this will be done only when an Identity header has not been received at the NNI and/or the interconnecting SP or other entity is outside the trust domain.
* An originating SP populating an Identity header for a call received through a UNI interface should populate “gateway attestation” when it is unable to identify and authenticate the customer initiating the call. Note that in most cases there should be an identifiable customer utilizing a UNI interface. The gateway marking may be used, for instance, if the real-world identity of the customer is not sufficiently determined.

### Other Attestation Values

In the future, additional attestation indicator values may be defined to take into account different security dimensions or levels of granularity.

# Origination Identifier

Per SHAKEN Framework, the unique origination identifier (“origid”) is defined as part of SHAKEN. This unique origination identifier should be a globally unique string corresponding to a UUID (RFC 4122).

The purpose of the unique origination identifier is to assign an opaque identifier corresponding to the service provider-initiated calls themselves, customers, classes of devices, or other groupings that a service provider might want to use for determining things like reputation or trace back identification of customers or gateways.

## Origid granularity

As an opaque identifier, the origid claim does not convey any SP or customer information in and of itself barring the sharing of origid decoding lists among SPs (not currently envisioned). It may be used in the originating SP network logging and call detail records to aid local traceback searches, and a terminating SP may include the value in traceback requests to help it determine a relationship between multiple calls from the same originating SP. The origid may also be used to signal traffic that can be correlated by terminating SP analysis functions.

The text of the SHAKEN standard ([Ref 1] 5.2.4) implies that for calls where both the customer and its TN authorization have been determined (‘A’ attestation level), the calling TN will provide sufficient correlation to the customer/traffic source that an origid at the granularity of a customer may not be needed. The implication for the other levels of attestation, where an explicit TN authorization lookup has not been applied or has not determined that there is authorization, then the origid should specifically be at the granularity of a customer or other identified traffic source (e.g. gateway peer or node). Note that in practice the origid and its granularity may be determined by the characteristics of a traffic source or point of origin in the SP network and not be dependent on a subsequently determined attestation value.

Over time, origid values populated at the granularity of individual customers for personal or small business service, when combined with calling patterns, could reveal information to other SPs and parties in the SHAKEN ecosystem regarding customer identity, personal relationships and/or business relationships that may not be obvious from calling/called numbers alone. The industry should consider whether or not this may raise privacy issues. One possible solution to this might be to use a persistent, but not permanently assigned value, such as for a 24-hour period or the length of a SIP registration, which may be long enough for an analytics function to make correlations without exposing a permanent reference to the individual customer.

There are possibly no such privacy issues for resellers, VASPs, and possibly larger enterprise customers with more diverse calling patterns and service usage. Private information leakage regarding individual customers should also not be an issue with international gateway or other NNI-originated calls marked at a peer or interconnecting SP level of granularity. Where a given SP marks calls with origids assigned at different levels of granularity (e.g., customer, peer, gateway, region) and for different purposes, it is unclear how these purposes would be sorted out by analytics in the terminating SP network to know the appropriate handling of calls correlated to a given origid.

## Guidelines

### Origid for calls received via an NNI

An SP populating an Identity header for calls received across an NNI should populate an origid claim value at the granularity of per peer SP or per peer NNI.

### Origid for calls received via a UNI

For customers or customer groups where an originating SP is directly assigning, populating, and/or otherwise controlling the calling TNs associated with calls received across the customers’ UNIs, the originating SP may populate the Identity header origid value at a granularity other than on a per-customer or per-UNI basis, as may be useful traceback purposes within the SPs own network.

For customers or customer groups where an originating SP allows the customer some discretion over the calling TN populated at the UNI, the originating SP should populate the Identity header origid value at a per-customer or per-UNI granularity.

Where origid is populated at the granularity of a customer or UNI that may be associated with an individual person, such as for a residential or small business service, the origid used should be a persistent but not permanent value. For example, the origid value may persist for the length of a SIP registration or a 24-hour period before being cycled.

# Conclusions

**Annex A**

(normative/informative)

1. Illustrative Examples

This annex will document supportive material



1. Use case examples for UNI Identity, Authentication, and Authorization in relation to SP use of SHAKEN

There are many possible use cases of UNI security services as inputs to SHAKEN processing. These should be thought of both in the management plane and in the transport and call processing planes. The process begins with establishing the customer real-world identity at on-boarding time and negotiating terms of use, establishing UNI authentication credentials and securing network paths, and establishing and maintaining TN authorization. In the service plane, it consists of authentication of the customer and determining TN authorization for each call to the extent that is part of the calling scenario. The process continues with monitoring of customer/TN usage patterns to enforce policy.

The scenarios are different, among other dimensions, based on whether the customer is the direct end user or the end user is behind a customer proxy/b2bua, which entity is assigned a TN, and whether or not the originating SP assigned the TN. The following is a discussion of some possible use cases for UNI security services in relation to determining an attestation value.

## Customer and TN identity use cases:

### Direct individual assignment

As part of establishing a new account, such as a landline VoIP or mobile account, an SP may directly assign a TN to the account for the customer’s use in placing and receiving calls. A TN can also be ported from another service provider and likewise be used to identify the individual user account. With typical post-paid service to individuals the account is more tightly associated to a particular user (e.g. by postal address and credit checks) to assure payment after consumption of the service. In many of these cases a TN-based identity can be used interchangeably with other forms of user identity.

### Prepaid account

In a prepaid mobile account, a TN is tied to an account and a prepaid mobile phone or SIM. The account is associated to the customer entity, who might be assumed to be an individual end user of the service, through a registration process. While the TN and prepaid account are strongly associated, the association to individually identified users may be looser than for post-paid accounts since the associated charges are collected in advance.

### Enterprise

An SP may directly assign or port TNs to an enterprise as they would for an individual account, and the TNs are used with the SPs service. Enterprise customers may utilize multiple SPs to originate calls, and they may mark calls with a TN (such as a main business number) across all their providers regardless of which SP assigned the TN. In such cases, an originating SP may choose to utilize other customer identifiers to determine the source of the call instead of relying on TNs that they did not assign. In many cases, any SP accepting calls originated from the enterprise will have business contact, location, and credit information for the enterprise so they can strongly identify the user entity. In some cases enterprise services may be offered on a prepaid basis with lesser user and credit verification requirements.

### Communications reseller

A communications reseller may interact with TN-based identities in various ways. The reseller may receive direct TN assignments from an SP or port assigned numbers to a particular SP, and then they may resell use of these TNs to individual or enterprise end-user entities in association with the communications services originated through the assigning SP. They may also provide service on a “bring-your-own-number” basis where the end user has received assignments from other SPs. The reseller may originate either of these types of numbers through multiple service providers, not just one who made an original TN assignment. In most reseller use cases, an originating SP does not know the identity of the ultimate end users and only identifies and authenticates the reseller customer. Identification of end users relies on the communications reseller to make any such determination, and further layers of indirection might obscure the ultimate source.

### Value-added service provider (VASP)

Some entities provide communications services ancillary to other services, for example a doctor’s office patient management platform with voice contact features. As with communications resellers, a value-added provider may arrange for TN assignments from an SP for use of a particular VASP customer or for the platform generally irrespective of customer, or customers may bring their own TN assignments and delegate their use to the VASP to originate calls on the end customer’s behalf. An end customer may utilize the same calling TN through their own direct services and for calls a VASP originates on their behalf. TNs assigned to either the VASP or the end-user entity may be used through different originating SPs. As with reseller scenarios, the originating SP typically knows the VASP customer and does not have direct knowledge of users of VASP call centers or platforms. Any determination of the identity of end-users and their TN authorizations would need to be traced through the VASP.

## User/customer authentication

### Device

In device-based authentication, the user identity and permanent cryptographic credentials are stored on the device and used in an authentication transaction with the network. For instance, in 3G/4G mobile networks an IMSI identity and authentication keys are stored on a SIM card, and these may be tied through registration to the mobile phone’s hardcoded ID (IMEI) and an associated TN (MSISDN). Access to the credentials for use in an authentication transaction may require further unlocking codes or other factors.

### Account

Devices and software that do not have permanent credential storage often use an account ID and credentials (passwords, pre-shared keys, private keys/certificates) that are manually entered by a user or populated through administrative procedures. For instance, a communications app may require an e-mail-address-based identity and user-entered or cached password credentials. A customer softswitch or SBC may authenticate at the transport layer (e.g. TLS), for instance using a customer FQDN or wildcard domain name in a PKI client certificate and stored private key. Barring other factors applied to the authentication process the account credentials may be moved between physical devices or software instances or re-entered in different apps or browser windows to gain access to the service.

### Network

Where the originating SP controls the customer connection point such as in a broadband access network or where customer equipment such as an enterprise PBX or reseller platform has a fixed network IP address, the originating SP may rely on physical interface or IP address to authenticate the customer over the UNI. The customer and originating SP may also set up protected network-layer tunnels (e.g. IPsec) between their networks to exclude traffic received outside the tunnels. These physical or network location characteristics may be a sole factor for authenticating a customer or it may be a second factor combined with device-stored credentials or other primary forms of authentication.

## Calling TN authorization and screening

### SP marking

An originating SP can determine the account ID and authenticate the customer and then mark or re-mark the call with a specific calling TN it has assigned to the customer. This is possible when there is a one-to-one correspondence between customer account and TN.

### Direct assignment

The originating SP may directly assign TNs to a customer and allow the customer to mark calls at the UNI with those TNs and receive an “A” marking. Any other TNs would receive a “B” marking unless authorization was determined through some other means.

### Contract relationship

The customer and originating SP may have contract terms that state the customer will only mark calls with authorized TNs. In this case there may be no explicit per-TN authorization step in the originating SP but misuse would be enforced under contract terms of use.

### Letter of Authorization (LOA)

A possible way to establish authorization would be for an SP that assigns TNs to provide some form of a “letter of authorization” (LOA) to the customer (an enterprise customer, reseller or value-added service provider) that the customer can present to other SPs it uses to originate calls. The LOA will presumably contain the assigning SP identity, customer identity that can be verified by the receiving SP (company name, address, and other verifiable characteristics) and a list of TNs the authorizing SP assigned or in-ported to its network. The receiving SP can, for example, add these TNs to an authorization database and use the list to drive an “A” marking for calls containing TNs in the list. Any such LOA would need to be periodically verified to determine that the TNs are still validly associated to the customer from the assigning SP, and if such a process is implemented with any volume of TNs there should be automated mechanisms to exchange LOA documents and re-verify TN assignments.

### Independent authorization check

A possible method for an originating service provider to independently verify the customers authorization to use a TN is by proving that the customer requesting authorization can use the TN, such as by calling the TN and giving a verbal code that the customer will be challenged to replay to the originating SP, or by sending a code in an SMS message. These methods would be most applicable in cases where the TN is used for a person-to-person service, terminating to an individual user.

### Indirect authorization

In a number of reseller/VASP scenarios the TN assignee will not be the customer with a direct relationship to the originating SP. The reseller/VASP may come up with a means to determine the TNs the end-user customer is assigned and then relay a request for originating SPs to accept those TNs from its UNI to receive “A” marking. The originating SP will likely not know the identity of the end user and would need to rely on enforcement of contract terms with the reseller or VASP.

### No validation

An originating SP may not have a process to determine authorization for customers to use TNs through a UNI. Presumably such an originating SP will always mark calls with a “B” attestation if the customer is known and authenticated or possibly “C” if the real-world identity of a customer is ambiguous. SPs may find, however, that customers will request that their traffic receives “full attestation” whether the customer is an individual, enterprise, reseller, etc. and under many legitimate use cases for calling number TN marking. The service quality need may drive SPs to initiate an authorization process where they are not currently doing so today.

## Example use case matrix

A way to represent the scenarios is a matrix of the customer and end-user type, UNI or NNI security services applied, and a possible SHAKEN attestation result. Below are some examples:

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **End user** | **Customer/ Inter-connecting entity** | **TN assigned to** | **TN assigned by** | **Identity established by** | **Authentication type** | **Authorization established by** | **Attestation result** |
| Mobile subscriber | Same as end user | Subscriber | Originating SP | Customer name/address/credit checks | Device | Direct assignment | A |
| Enterprise PBX | Same as end user | Enterprise customer | Other SP | Customer name/address/credit checks | Customer ID/pre-shared key, IP network ACL | Letter of Authorization | A |
| Individual or enterprise | VASP | VASP | Originating SP | Customer name/address/credit checks, end-user traced through customer | Customer ID/IP network ACL | Direct assignment, terms of use (customer responsible for end use) | A |
| Non-domestic entity | Gateway provider | End user | Non-domestic provider/not determined | Not determined (gateway provider not the originating SP) | Network interconnection | Not determined | C |
| Individual or enterprise | Reseller | End user | Other SP | Customer name/address/credit checks, end-user traced through customer | Network interconnection | Terms of use | A or B based on terms enforcement |
| … |  |  |  |  |  |  |  |