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An Architecture and Information Model for Telephone-Related Information  
(TeRI)  
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#### Abstract

As telephone services migrate to the Internet, Internet applications require tools to access and manage information about telephone numbers. This document specifies a protocol-independent framework and information model for managing service and administration data related to telephone numbers.

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**1. Terminology**

In this document, the key words "MAY", "MUST", "MUST NOT", "SHOULD", and "SHOULD NOT", are to be interpreted as described in [\[RFC2119\]](#). This document also incorporates the terminology of the MODERN Framework [\[I-D.ietf-modern-problem-framework\]](#).

**2. Motivation**

Telephone numbers remain the worldwide standard identifier for routing calls and text messages over the Public Switched Telephone Network (PSTN). Increasingly, real-time communications is migrating to the Internet, and bringing telephone numbers with it. As identifiers, however, telephone numbers differ fundamentally from those commonly used by Internet applications. Email, the web and native Voice over IP (VoIP) systems such as SIP ([\[RFC3261\]](#)) use identifiers that rely on the Domain Name System (DNS) to resolve a domain portion of the identifier to a particular IP address; commonly, Uniform Resource Indicators (URIs) with a user and host



component serve this purpose. SIP, for example, quickly developed a convention for using a TEL URI in the user part of its URIs. To help telephone numbers work similarly on the Internet, a number of efforts have specified mechanisms to manage and retrieve information about telephone numbers via network services.

The ENUM ([\[RFC6116\]](#)) effort originally specified a public DNS profile for translating telephone numbers into URIs. Due to the difficulty of coordinating the public administration of telephone numbers in the DNS, this work transitioned to "infrastructure" ENUM ([\[RFC5067\]](#)), which assumed private DNS implementations, each of which could give a different answer to the same request to translate a telephone number depending on who asked, or other internal factors. The framework of the SPEERMINT working group ([\[RFC6406\]](#)), expanding on these requirements, differentiated the mapping of a telephone number to a target network (the "Look-up Function") from the mapping made by the originating network to the proper next-hop to reach such a target network (the "Location Routing Function"). To provision the data associated with telephone numbers, the DRINKS working group ([\[RFC6461\]](#)) designed systems for uploading back-end data to the services that would answer ENUM queries.

None of the preceding efforts, however, encompassed the entire lifecycle of a telephone number as an Internet identifier. They focused largely on service data, on how to "resolve" a telephone number to a location on the Internet, rather than on administrative questions of how numbers are acquired, how the entities associated with telephone numbers are authorized to provision data, and what kinds of systems need to be in place to allow a diverse community of devices, applications and users to rely on telephone numbers. Early considerations were moreover based on overlapping, but not entirely consistent, information models: intrinsic limitations in the DNS kept the queries and responses of ENUM relatively simple, whereas the DRINKS provisioning system considered a much richer syntax.

The need for solutions in this space is pressing, as many carriers worldwide contemplate migrating their entire PSTN infrastructure onto the Internet within the next decade. Further pressures come from emerging Internet communications providers who never invested in PSTN infrastructure in the first place, but want access to services related to telephone numbers. This includes devices, services, and applications on the Internet that make use of telephone numbers and need to distribute and manage numbering inventory: for example, an Internet-enabled PBX that might want to automate the process for allowing new connected phones to acquire numbers and provision contact information for their users. Ultimately, the resources identified by telephone numbers must also be reachable on the Internet, and different applications might want to use different



protocols to retrieve information about numbers. In some environments, there are performance constraints that would require a very lightweight binary protocol; in others, applications might prefer human-readable markup languages suitable for interfacing with existing APIs. The use cases associated with these functions are detailed in [[I-D.ietf-modern-problem-framework](#)].

Therefore, this document proposes a reconsideration of telephone service and administration data on the Internet, based on an information model that allows records associated with telephone number to be created, modified and accessed through network interfaces. This document specifies no particular syntax or encoding for queries or responses, but instead describes an extensible information model for the semantics of provisioning and querying operations associated with a telephone number.

### **3. The Information Model**

The fundamental building block of the TeRI model is the Record. A Record is created by an Authority who has authority over a particular telephone number or a set of numbers. There may be more than one Authority who is authorized to create Records for a particular telephone number, and a TeRI service may have multiple Records corresponding to a single telephone number, including potentially overlapping Records associated with a range of numbers that encompasses a particular telephone number. Under various circumstances detailed in [Section 5](#), participants in the numbering ecosystem may create, read, update, and modify Records.

Records contain Elements that hold data about the telephone number. Elements in this information model have a Name, which may optionally be associated with a Type and Value. Records are divided into two broad categories: Administrative Records and Service Records. Administrative Records hold data about how records have been allocated that is typically generated by a Registrar or similar entity that distributes numbers; they include information on the administrative contacts for telephone numbers, and so on. Service Records hold data required to initiate communication with the resources reachable at a telephone number; these Records are typically generated by an assignee or delegate such as a CSP.

The distinction between Administrative and Service Records exists because different parties might only need access to one sort of information instead of another: moreover, some actors may be authorized to view Service Records for a particular telephone number but not Administrative Records, or vice versa. In practice, a Record may contain both Administrative and Service Elements, but the creators of Records may find it useful to keep the two types of





information separate. If a Record contains both Administrative and Service Elements, it may be returned in a Retrieval Query for either, provided the Client is authorized to receive the Elements within.

### **3.1. Record Elements**

A Record is made up of Elements, which may contain Service or Administrative Data. All Records can contain the following generic Elements.

#### **3.1.1. Identifier**

Every Record has an Identifier, which is a globally unique identifier of the Record. The Identifier will typically be created at the same time as the Record itself, at a time when an assignment or delegation has occurred (as described in [[I-D.ietf-modern-problem-framework](#)]).

#### **3.1.2. Authority**

Every Record contains an Authority Element indicating the source of the data: either the entity that provisioned the data with the Service, or the external source from which the Service collected the data. The Authority element ideally gives a logical identity of the source of the data. A public key value may also be associated with an Authority element.

#### **3.1.3. Access**

Every Record contains an Access Element indicating the conditions under which Retrieval Requests can acquire the Record. The Access Element is set by the Authority generating the Record.

#### **3.1.4. Subject**

Every Record has a Subject. As TeRI Records concern telephone numbers, the Subject of a Record is an array of either a telephone number type or a telephone number range type. The simplest Record Subject is an array with one element consisting of a single telephone number.

#### **3.1.5. Signature**

Optionally, a Record contains a Signature element. The Signature element contains a signature over the concatenation of the other elements given the Record. Signatures are provided by the Authority responsible for the Record.

[Syntax TBD]



### **3.1.6. Administrative Elements**

Records that contain Administrative Elements are Administrative Records. The baseline TeRI specification sets only one Administrative Element, the Contact.

#### **3.1.6.1. Contact**

Every Administrative Record has at least one Contact. The Contact contains administrative data about the assignee of the telephone number, though additionally Contacts may contain information about delegates (as defined in [[I-D.ietf-modern-problem-framework](#)]). Typically, this information would be set by the Registrar; policies outside the scope of this specification dictate the sorts of entities that may be designated as Contacts in Records.

### **3.1.7. Service Elements**

Records that contain a Service Element are Service Records. The most important Service Element is simply called Service, and it contains an identifier for a communications resource reachable through a telephone number. More than one Service Element can appear in a given Record. Other Service Elements may be defined by later specifications.

#### **3.1.7.1. Service**

Records optionally have one or more Service entries. A Service may be of any Service Type, as given in [Section 3.2.1](#). Optionally, subelements modify how a Service Element should be retained.

##### **3.1.7.1.1. Priority**

Optionally, a Service may specify a weighted Priority associated with a Record. Priorities are between 0 and 1, with a value of 1 having the highest priority.

##### **3.1.7.1.2. Expiration**

Optionally, a Service may specify an absolute time at which a Record will no longer be valid, should a client or intermediary wish to cache a Record. In the absence of an Expiration element, Records may be cached for a maximum of twenty-four hours.



## **3.2. Element Value Types**

The remainder of a Record is made up of Elements. Elements types are specified in this section. Every Element Type has a Type Code. A Type Code is used as a short form for the Element in a Record.

### **3.2.1. Service Types**

#### **3.2.1.1. Telephone Number Type**

The telephone number type conforms to the telephone number syntax given in [\[RFC3966\] Section 3](#), in the ABNF for "telephone-subscriber."

Type Code: T

[TBD - need for subtying? E.164, Service Code, Short Code, Prefix, Nationally-Specific and Unknown. ]

##### **3.2.1.1.1. TN Range Type**

The TN range type consists of a prefix of a telephone number (per [\[RFC3966\]](#) "telephone-subscriber"), and is semantically equivalent to all syntactically-valid telephone numbers below that prefix. For example, in the North American Numbering plan, the prefix 157143454 would be equivalent to all numbers ranging from 15714345400 to 15714345499.

[TBD - identify alternative ways of specifying ranges, potentially as separate element types]

Type Code: R

##### **3.2.1.1.2. Domain Name Type**

The domain name type conforms to the syntax of [RFC1034 Section 3.5](#) and [Section 2.1 of \[RFC1123\]](#).

Type Code: D

##### **3.2.1.1.3. Uniform Resource Indicator (URI) Type**

The Uniform Resource Indicator (URI) type conforms to the syntax for URIs given in [\[RFC3986\]](#) (see [Section 3](#)).

Type Code: U



#### **3.2.1.4. Internet Protocol (IP) Address Type**

The IP Address type conforms to the ABNF syntax of either the IPv4address given in [RFC3986](#) (Appendix A) or the IPv6reference of [RFC5954](#).

Type Code: I

#### **3.2.1.5. Trunk Group Type**

The trunk group type conforms to the "trunk-group-label" ABNF given in [RFC4904](#) ([Section 5](#)).

Type Code: G

#### **3.2.1.6. Service Provider Identifier (SPID) Type**

The SPID type consists of a four-digit number.

[TBD - introduce other elements for alternative SPID syntaxes]

Type Code: ?

#### **3.2.2. Public Key Type**

The Credential type consists of a public key [encoding TBD].

Type Code: C

#### **3.2.3. Contact Type**

The contact type follows the conventions of jCard [\[RFC7095\]](#).

Type Code: C

#### **3.2.4. Access Type**

The access type consists of a string, which is set to the values "Public," "Semi-restricted" or "Restricted." If either "Semi-restricted" or "Restricted" appears as the access type, the Element will need to be accompanied by a Permissions Element. [TBD - work to be done here]

Type Code: A





### **[3.2.5.](#) Expiry Type**

The Expiry type is an absolute time conformant to the syntax of [\[RFC3339\]](#).

Type Code: E

### **[3.2.6.](#) Priority Type**

The Priority type contains a number between 0 and 1, conforming to the specification of the "q" parameter of the Contact header field in [\[RFC3261\]](#).

Type Code: P

### **[3.2.7.](#) Record Identifier Type**

The Record Identifier Type consists of a unique identifier for a record [format TBD].

Type Code: U

### **[3.2.8.](#) Signature**

[Syntax TBD]

Type Code: S

### **[3.2.9.](#) Extension Type**

This code is reserved for future use.

Type Code: X

## **[4.](#) Relationship to the MODERN Framework**

The MODERN Framework [\[I-D.ietf-modern-problem-framework\]](#) enumerates a series of actors and use cases related to telephone number administration on the Internet. In terms of actors, it details interactions between Users, Communications Service Providers (CSPs), Registries, Registrars, and Government Entities. These actors acquire, manage, or retrieve telephone numbers, implementing various interfaces in support of different use cases. Registries in MODERN may be centralized or decentralized. The TeRI Operations discussed in this document pertain largely to centralized Registries: the creation and propagation of Records for decentralized Registries is outside the scope of this document. For centralized Registries, client-server operations are conducted to acquire, manage, and



retrieve telephone numbers with TeRI. Typically, Users, CSPs, and Government Entities act as TeRI Clients, and CSPs, Registries, and Registrars act as TeRI Services.

In the MODERN framework, the lifecycle of a number begins with a Registry. Registrars acquire telephone numbers from Registries, and make those numbers available for allocation. Thus, an Acquisition Operation is used by a Registrar that acquires numbers from a Registry, and this Request, if successful, will result in the creation of a Record that is returned in the Response. That Record renders the Registrar an Authority for the telephone numbers in question, but that Record will contain exclusively Administrative Data, with no Service Data.

In some cases, that Registrar will also fulfil the role of a CSP, and as a CSP, it will allocate those numbers to Users and generate any associated Records itself. Alternatively, a Registrar that does not act as a CSP may in turn act as a TeRI Service to which CSPs, and potentially Users, will send Acquisition Requests to acquire number blocks or individual numbers. Through that process, CSPs and Users can also become Authorities for telephone numbers. New Records containing Administrative Data indicating the contact information and so forth of the CSP or the User will be generated when that allocation occurs; those Records will be stored at the Registrar. The Registrar may also house a "glue" Record of Service Data that indicates the servicing CSP for the telephone number, and in particular the Retrieval interface of that CSP where Records with further Service Data can be found.

The Authorities who create and propagate Records of Service Data are typically CSPs and Users. Most commonly, CSPs will store these Service Data Records, and make them accessible through a Retrieval interface. CSPs may also propagate these Records to various external directories; the signature of the CSP and expiry data in the Record will prove its integrity and freshness to any relying party. It is envisioned that multiple Authorities may create Records for different services that are associated with a given telephone number.

Finally, CSPs and Users may query a Retrieval interface at a CSP to acquire Records containing Service Data that will enable them to route communications. The Retrieval interface will enable Clients to ask for Records associated with particular services, though Retrieval can present Clients with a number of service options. Entities may also query the Retrieval Interface of Registrars to acquire Administrative Data about a telephone number, though it is likely that authorization policies will restrict access to that data. Government Entities may have legal relationships with Registrars that



grant them authorization privileges with regard to Administrative Data.

## 5. TeRI Client-Server Operations

In TeRI, Clients use Operations to acquire, manage, or retrieve Records, which are typically stored at Services. Every Operation consists of a Request and a Response. Requests may pass directly from a Client to a Service, or they may pass through one or more Request Intermediaries; Request Intermediaries can modify Requests and Responses in transit. A Response will contain a Response Code indicating the status of the requested Operation. Both Requests and Responses can, in certain Operations, carry Records. TeRI does not specify any specific data format or underlying protocol to instantiate Requests, Responses, or Records: TeRI is an abstract architecture that must be implemented with concrete bindings and encodings (see [Section 5.6](#)).

The TeRI information model (see [Section 3](#)) specifies the baseline contents of Records, though Records are designed to be extended by future specifications for particular use cases or environments. Records provide information related to telephone numbers; a Record may apply to one telephone number, a block of numbers, or several discrete blocks of numbers. There may be multiple Records stored at a Service which cover a single telephone number: this may include multiple Records that apply only to that one telephone number, which probably have been provisioned by different Authorities, as well as Records applying to a telephone number range which contains that one telephone number. Authorities sign Records, and Clients typically have a trust relationship with those Authorities.

The three TeRI Operations are as follows:

The Acquisition Operation enables a Client to request the allocation of unallocated telephone numbers that are held by a Service on behalf of an Authority. A Service makes an authorization decision before allocating the telephone number(s) in accordance with the policy of the Authority. One or more new Records may be created as a result of a successful Acquisition Operation, and the Service will pass any such Record(s) to the acquiring Client as well as retaining them locally at the Service. As a result of a successful Acquisition Operation, the administrative entity operating the Client will typically become a new Authority for the allocated telephone numbers.

The Management Operation enables a Client to push new values for a Record to a Service. In the baseline Operation described in this document, the Client pushes the entire value of the Record to the



Service. The Service then makes an authorization decision to determine whether or not the Client is permitted to upload the Record in question. The policy behind those authorization decisions is outside the scope of this document, though at a high-level, the Client must be an Authority for a telephone number in order to publish and modify Records associated with that number. However, outside of hierarchical Authorities, Clients will not be able to modify or delete Records related to that number that have been provisioned by other Authorities.

The Retrieval Operation enables a Client to request one or more Records that are stored at a Service. Some Records may contain public information, and some may contain information that requires an authorization decision to be made before it is shared with a Client. Note that Services may have trust relationships with Request Intermediaries, and that the Response may depend on that trust relationship rather than on the Service's trust relationship with the Client. Although a Client acquires Records from a Service, a Client need not have a trust relationship with it - typically, the Client trusts the Record because it trusts the Authority which signed the Record rather than the Service that holds or delivers the Record.

All entities that act as TeRI Services will offer at least the Management and Retrieval interfaces, and some will also offer the Acquisition interface. All entities that act as TeRI Clients will implement at least the Retrieval Operation; others may implement the client side of one or both of the Management and Acquisition Interfaces.

## **5.1. Elements Common to All Operations**

All Operations in the TeRI model consist of Requests and Responses. A Request from a TeRI Client to a Service may attempt to create, read, update, or delete TeRI Records. Requests may use Restrictions to focus only on particular parts of a TeRI Record. A Response gives the result of the Operation back to the Client, which may indicate success or failure.

### **5.1.1. Requests**

All TeRI Requests have a Source, a Subject, and optionally a set of Restrictions which further specify the nature of the Request. Some Requests will contain the Identifier of the Record they concern; others will query for all Records matching a given Subject.





#### **5.1.1.1. Source**

The Source is a required element in all Requests. In this specification, two categories of Sources are defined: Request Source and Request Intermediary. At least one of these Sources must be present in a Retrieval Request, and multiple Sources are permitted. Responses do not contain a Source.

Future specifications may extend the set of Source types.

##### **5.1.1.1.1. Request Source**

Every Request generated by a Client has a Request Source, which identifies the originator of the Request. This represents the logical identity of the user or service provider who first sent the Request, rather than the identity of any Intermediate entity. This field is provided in the Source to authenticate the poser of the Request, so that the Service can make any necessary authorization decisions as it formulates a Response.

In some service deployments, an Intermediary may wish to mask the Request's Source from a Service. The removal of the Request's Source by an Intermediary is permitted by TeRI, but any Intermediary that removes the Request Source must provide a Request Intermediary for the Source element.

A Request Source element has a Type, which indicates how the logical identity of the originator of the Request has been represented. The Type field of the Request Source is extensible. Initial values include a domain name, a URI and a telephone number.

The Type element of the Request Source is followed by a Value, which contains the identity. The format of the identity is determined by the Type.

##### **5.1.1.1.2. Request Intermediary**

Optionally, Requests may contain one or more Request Intermediary elements in the Source. A Request Intermediary resides between the originator of the Request (the Client) and the Service, where it may aggregate queries, proxy them, transcode them, or provide any related relay function to assist the delivery of Requests to the Service.

The Request Intermediary element, like the Request Source, contains the logical identity of the service that relayed the Request. This field is provided in the Source for those deployments in which the Service makes an authorization decision based on the identity of the Intermediary rather than a Request Source.



A Request Intermediary element has a Type, which indicates how the logical identity of the Intermediary has been represented. The Type element of the Request Intermediary is extensible. Initial values include a domain name, an X.509 certificate subject, or a URI.

The Type of the Request Intermediary element is followed by a Value, which contains the identity. The format of the identity is determined by the Type.

#### **5.1.1.2. Subject**

All Requests have a Subject. The Subject identifies the resource that the Request concerns. Responses only contain a Subject if the Subject of the Response differs from that of the original Request, which may occur when (for example) the Subject contains a broad range, and the Service replies with a more narrow Subject. Future specifications, including Profiles, may define alternative Subject elements.

##### **5.1.1.2.1. Request Restrictions**

TeRI Request Restrictions consist of a Name with an optional Type and an Optional Value. Most Restrictions are specific to the Operation.

#### **5.1.2. Responses**

All TeRI Responses will have a Response Code, and may contain one or more Records.

##### **5.1.2.1. Response Code**

All Responses contain a Response Code.

Response Codes defined by this document include: Success, Subject Does Not Exist, Subject Conflict, No Suitable Records Exist for Subject, Subject Syntax Error, No Suitable Records Exist for Restriction, Unauthorized Source, Route Source Topology Unavailable.

[TBD]

#### **5.2. The Acquisition Operation**

An Acquisition Request has a Source and a Subject, and may have one or more Restrictions. An Acquisition Response has a Response Code, and will contain one Record if it is successful.

The Subject of an Acquisition Request always specifies a Telephone Number Type or a Telephone Number Range Type. If the Subject



contains a particular telephone number, then the Acquisition Request is a Request to acquire that particular telephone number. If it is a range, the Acquisition Request should be considered to be for the entire range, but future Restrictions defined for this the Request might limit the scope of the resources requested. The Service will determine whether or not the Client is authorized to acquire the resources in question based on the Source of the Acquisition Request.

The Response to an Acquisition Request will contain a Success Response Code if the resource can be allocated. The Subject of a Success Response will always contain the Telephone Number Type or Telephone Number Range that has been allocated. A successful Acquisition Response must contain a Record with a Identifier Element; that Record may also contain an Element containing tokens or other material that the Client might use to acquire credentials from a Credential Authority (see [[I-D.ietf-modern-problem-framework](#)]). By default, this Record will contain only Administrative Elements, without Service Elements. If a requested telephone number (or range) is already allocated, or a telephone number in the specified range is not available, then a Subject Conflict Response Code is returned.

### **5.3. The Management Operation**

A Management Request comprises a Source, a Subject, and one or more Records; it also may contain one or more Restrictions. A Management Response contains a Response Code, and optionally may contain a Record.

The Subject of a Management Request always specifies a Telephone Number Type or a Telephone Number Range Type. In almost all circumstances, however, the Service will locate that Record(s) that a Management Request modifies through the Identifier Restriction on each Record in the Management Request.

A Management Request contains at least one Record; it may contain multiple Records. Each Record in the Management Request must contain a Record Identifier Element which designates the Record that the Client is requesting that the Service provision as or replace with the Record included in the Management Request. The Service will authorize whether or not the Client is authorized to modify the Record in question via the Source of the Management Request.

The Management Operation not only provisions Records at a Service, but also provisions at the Service any information needed by the Service to make authorization and policy decisions when responding to Retrieval Requests. This information is tied to the Access Element of the Record.



### **5.3.1. Service-to-Service Record Distribution**

TeRI Records contain the signature of the Authority who generated them, and as such, a relying party trusts a Record based on that signature rather than based on the Service from which a Record was retrieved. This permits architectures that allow a Records to be duplicated across a distributed Service. Distribution protocols are left to future specifications.

### **5.4. The Retrieval Operation**

Every Retrieval Request comprises a Source and a Subject, and may have one or more Restrictions. A Retrieval Response has a Response Code, optionally one or more Records, and optionally a Subject, if the Subject differs from that of the Request.

Retrieval Requests optionally contain Restrictions; a Request with no specified Restrictions requests that the Service return any Records associated with the Subject. In a Request, the presence of one or more Restrictions limits the scope of the Request to Records about the Subject containing those Elements, or the Restrictions otherwise qualify the Request. Typically a Restriction will specify a Service or Service Type that the Client seeks Records for.

Successful Retrieval Responses always contain one or more Records; unsuccessful Responses never contain Records.

### **5.5. Common Restrictions**

Restrictions are broadly structured around Elements, typically the Service, Contact, and Identifier Elements. A TeRI Request may contain a Restriction based on any Element, be it a baseline Element or a Service or Administrative Element, including Elements that are defined in future specifications. Semantically, a Restriction may target Records that contain a particular Element, or only Elements with a particular subtype or even value. Multiple Restrictions may appear in a Request, and Restrictions are always additive, which is to say that Restriction always narrow then target of a Request.

Restrictions may either name a target Element, or both an Element and a value. For example, a Management Request replacing an existing Record must name as its target with a Restriction both the Identifier Element and the value, which is the identifier for the Record. A Retrieval Request for a particular Subject might restrict itself to Service elements, or even Service elements that have a particular subtype, such as a URI.





### **5.5.1. Route Source**

Optionally, Retrieval Requests may contain a Route Source which functions in much the same way as a Restriction. A Route Source identifies a reference point in the network from which any Service Elements in the response should be calculated. It therefore always designates a network element, though depending on the circumstances, it may be an endpoint, a gateway, a border device, or any other agent that makes forwarding decisions for telephone calls and related services. A Route Source is a subelement of the Source element.

A Route Source element has a Type, which indicates how the network element has been represented. The Type field of the Request Source is extensible. Initial values include a domain name, an IP address or a trunk group.

The Type of the Route Source element is followed by a Value, which designates the network element. The format of the identity is determined by the Type.

## **5.6. Implementing Operations**

This framework specifies an abstract Request/Response protocol that enables a Client to send Requests to a Service about telephone numbers or related telephone services. Requests may pass through one or more Intermediaries on their way from a Client to a Service; for example, through aggregators or service bureaus. A Client establishes the Subject of a Request, and optionally includes one or more Restrictions to focus the scope of the Request. When a Service receives a Request, it performs any necessary authorization and policy decisions based on the Source. If policy permits, the Service generates a Response, which will consist of a Response Code and one or more Records associated with the Subject. The Service then sends the Response through the same path that the Request followed; transactional identifiers set by the Client and Service correlate the Request to the Response and assist any intermediary routing.

### **5.6.1. Transport Independence**

The information model provided for Requests and Responses in this framework is independent of any underlying transport or encoding. Future specifications will define Bindings that specify particular transports and Encodings for Requests and Responses. In some deployment environments, for example, a binary encoding and lightweight transport might be more appropriate than the use of a web protocol. This specification provides a template of requirements that must be addressed by any encoding scheme.



It is a design goal of this work that the semantics of Requests and Responses survive interworking through translations from one encoding to another; for example, when an Intermediary receives a binary Request from a Client, it should be able to transcode it to an XML format to send to a Service without discarding any of the original semantics.

### **5.6.2. Bindings**

A TeRI Binding is an underlying protocol that carries Requests and Responses. Future specifications may define Bindings in accordance with the procedures in the IANA Considerations sections of this document.

By underlying protocol, this specification means both transport-layer protocols as well as any application-layer protocols that the Binding requires. Thus an example Binding might specify a combination of TCP, TLS, HTTP and SOAP as the underlying transport for TeRI. Alternatively, it might only specify a very lightweight underlying protocol like UDP. A Binding may be specific to a particular Encoding, or it may be independent of any Encoding.

Bindings must specify whether they are continuous, transactional or non-transactional. A continuous Binding creates a persistent connection between two TeRI entities over which many, potentially unrelated, Requests and Responses might flow. Many Bindings defined for use between an Intermediary and a Service will have this property, as Intermediaries may aggregate on behalf of many Clients, and opening a separate transport-layer connection for each new Request would be inefficient. A transactional Binding creates a temporary connection between two TeRI entities for the purpose of fulfilling a single Request; any Responses to the Request will use the same connection to return to the sender of the Request. Finally, a non-transactional Binding does not rely on any sort of connection semantics: the senders of Requests and Responses will always initiate a new instance of the Binding to send a message.

This document makes no provision for discovering the Bindings supported by a TeRI Client, Intermediary or Service. Intermediaries may transcode between Bindings if necessary when acting to connect a Client and a Service, especially if the Client and Service support no Bindings in common.

A Binding specification must enumerate all categories of metadata required to establish a connection using a Binding. For some Bindings, this might comprise solely an IP address and a port; for other Bindings, this might instead require higher-layer application identifiers like a URI. This metadata includes any identifiers



necessary for correlating Requests to Responses in a continuous or non-transactional Binding; any Encoding making use of these Bindings must specify how it carries those elements.

Bindings must also describe the security services they make available. Bindings must have a means of providing mutual authentication, integrity and confidentiality between Clients, Intermediaries and Services. If a Binding supports TLS, for example, these features can be provided by using TLS in an appropriate deployment environment.

### **5.6.3. Encodings**

A TeRI Encoding specifies how the Request and Response are constructed syntactically. An Encoding may be specific to a particular Binding, or it may be specified independently of any Binding.

An Encoding may define an object format; for example, an XML or JSON object, described with any appropriate schemas, or an ABNF description. An Encoding might alternatively specify a mapping of the semantic elements of Requests and Responses on to the existing fields of headers of a protocol, especially when that protocol has been defined as an underlying protocol Binding. Encodings must also define whether or not they provide a bundling feature that allows multiple Requests to be carried within particular objects or mappings.

Every Encoding must specify how each semantic Element Type of a Request and Response will be represented. For all baseline TeRI Restrictions and Element Types, the Encoding specifies whether values will be text or binary, how they will be encoded. Many baseline Element Types (such as telephone numbers) can appear in different places in a TeRI message; Encodings need only specify these common element types once. Due to the extensibility of TeRI, however, future specifications might define Element Types that an Encoding does not address. Profiles using those extensions and Encodings must explain their interaction.

Encodings must also describe the security services they make available. In particular, encodings must describe a means of providing authentication of the Sources and Authorities of Requests and Responses respectively, as well as an integrity check over critical elements including the Subject of Requests and the Record of Responses.



[TBD - we may define more about the computation of this signature, including canonicalization of elements, in this framework, and make it a requirement for encodings to support this mechanism]

#### **5.6.4. Profiles and Extension Elements**

For particular deployment environments, only one Binding, Encoding and set of Restrictions or other extended elements may be meaningful. Future specifications may therefore define TeRI Profiles, which describe a particular deployment environment and the Binding, Encoding and set of Elements and Restrictions it requires.

Profiles may encompass extensions to baseline TeRI, and any new Elements or Restrictions necessary may be defined within the Profile. It is not necessary for a TeRI Service to understand extension Elements that appear in Records or as Restrictions in a Query: if a Service receives a Query with a Restriction, it can search Records with the target Subject for Elements matching the Restriction and return only those that apply. As such there is no formal capability negotiation for extensions in the TeRI model: a Record may contain Elements beyond baseline TeRI that a particular Client does not understand and must ignore; similarly, a Service may receive a Query with a Restriction that applies to no Records collected at the Service, in which case the Service returns a "No Suitable Records Exist for Restriction" Response Code.

### **6. Security Considerations**

The framework of this document differs from previous efforts to manage telephone numbers on the Internet largely by offering a much richer set of security services. In particular, it requires that three entities be capable of authenticating themselves to one another at the layer of a binding: Clients, Intermediaries and Services. It furthermore requires object security at the encoding layer so that Sources and Authorities can sign data in order to authenticate Requests and Responses that may pass through Intermediaries, and moreover so that Authorities can prove to Clients that their Records are authoritative even when the Authority does not operate the Service. The requirements that bindings and encodings must satisfy to meet these security needs are specified in [Section 5.6.1](#).

[TBD - more]

### **7. IANA Considerations**

This specification defines several registries: A registry of Elements, a registry of Element Types, and a registry of Response Codes.





This document creates a registry of Elements for use with this framework. This registry is extensible, with an IANA Registration policy of Specification Required. Any new Element registered must supply the name of the Element, the name of the parent Element in the information model, and a code point. [TBD]

This specification pre-provisions the Element Types registry with the entries given in [Section 6](#). These elements are indexed by their Type Code. This registry is extensible, with an IANA Registration policy of Specification Required. Any new Element Type registered must supply the name of the Element Type, the name of the parent element in the information model, and a Type Code.

This document furthermore creates a registry of Response Codes. This registry is pre-provisioned with the values given in [Section 5.5](#). [TBD]

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