ENUM Study Group

Report

May 23, 2003

1. Introduction

ENUM is a mechanism through which users can identify Internet services using name spaces with telephone numbers. The study and standardization of its specifications are being performed by the IETF ENUM Working Group, and its model of operations is being studied by the ITU-T as well.

ENUM is a mechanism that obtains one or more applications corresponding to an E.164 number in URI format by looking up the DNS. It does this by using a telephone number based on the E.164 Recommendation, an international agreement created by the ITU-T regarding telephone numbers, as a key.

For example, ENUM is effective when terminal equipment (i.e., telephone sets and facsimiles) connected to the existing telephone network communicates with terminal equipment on the Internet. Telephone equipment can only use telephone numbers, which are sequences of numbers, to identify other equipments. ENUM can associate one telephone number with one or more applications available on the Internet. ENUM is drawing attention for this function, or as a means of name (telephone number) resolution when connecting from an existing telephone to an Internet telephone.

The ENUM Study Group (hereinafter referred to as the Study Group) has been established to study and discuss possibilities of and issues related to ENUM from a technical viewpoint and to clarify and organize these technical issues.

The background of the formation of the Study Group is as follows:

- The technical standard associated with ENUM in the IETF is made clear.
- The ITU-T publishes its international operation policy as a supplement.
- The ENUM trial environment is created around IAB, RIPE NCC and ITU-T.
- The Internet telephone becomes popular in Japan and assignment of IP telephone numbers beginning with 050 begins.

In this background, prompt action is urgently required to deepen understanding of ENUM and study future possibilities.

This report summarizes the results of discussions made by the Study Group.

- ENUM Overview
- Issues that can be resolved by ENUM
- ENUM Registration Model
- Personal information protection and security in ENUM

1.1 Purposes and Targets of Discussions by the Study Group

The study purposes of the Study Group are as follows:

- To understand ENUM technology
- To observe the ENUM implementation method, operation method and related studies
- To extract legal and institutional issues in ENUM implementation and operation
- To study other technical issues associated with ENUM
- To clarify effects and problems when ENUM is introduced

To achieve these purposes, the Study Group is mainly studying ENUM technology and other related technologies (DNS, URL, DDDS, etc.).

1.2 Terms and Definitions

This section defines terms required to understand the contents of this report.

1.2.1 ENUM Terms (General Definitions) of the ITU, IETF, etc.

AUS : Application Unique String

- The first character string input in a DDDS application.
- An input to URI conversion service (RFC3263).

DDDS : Dynamic Delegation Discovery System

- A mechanism that converts character strings by applying dynamic rewriting rules repeatedly (RFC3401 to 3405).

ENUM : Telephone Number Mapping

- Architecture and protocol that associate E.164 numbers with domain names and registers URIs corresponding to the telecommunications numbers in the DNS.
- Defined in RFC2916.
- The IETF and ITU-T are working collaboratively for its standardization (the IETF ENUM WG charter).

E.164 number

- A decimal numeric string (telephone number) that has three characteristics – structure, length and uniqueness – which are specified in Appendix A of the ITU-T E.164 Supplement . Example: +81-3-5297-2571 (ITU-T E.164 Supplement)
- International public telecommunication numbers are specified by the ITU-T E.164 Supplement . These numbers can also be used to receive calls from other countries and each number can be up to 15 digits long, including the country code. (Report made by the "Study Group Concerning IP Network Technology" of the Ministry of Public Management, Home Affairs, Posts and Telecommunications (MPHPT))

E.164 Country Code

- A code specified by E.164 (ITU-T E.164) that is unique to a geographical area. Example: 81 is the country code assigned to Japan.

NAPTR : Naming Authority Pointer

- A DNS resource record for identification of possible domain labels and URIs
- Defined in RFC2915 and redefined in RFC3403 as part of a DDDS (RFC2915, RFC3403).

Number Portability

- The same telephone number can be used even when services, providers (telephone companies) or locations are changed.

1.2.2 ENUM Terms (Original Definitions for This Report)

ENUM application

- An application in which both the sender and receiver function use ENUM. Example: Telephone, SIP, H.323, facsimile, electronic mail, instant messenger

ENUM client

- A client application that makes ENUM look-ups.
- For Operator ENUM: Equipment and terminal in the network.
- For User ENUM: Application on a user computer connected to the Internet.

IP telephone

- (Narrow definition) A voice telephone service that uses managed IP networks to guarantee quality and generally tends to have a higher service quality than Internet telephony. (This report uses the term "IP telephone" in this sense)
- (Extensive definition) A voice telephone service that is provided using IP network technologies. It includes both Internet telephone and the above-mentioned “IP telephone”. The "IP telephone" carries this meaning when used in reports regarding the "Study Group Concerning IP Network Technology"__published by the Ministry of Public Management, Home Affairs, Posts and Telecommunications.

Tier 0

- Located at the top of the ENUM DNS layer, it is currently managed by the IAB (Internet Architecture Board), and “e164.arpa” is now being used experimentally .

Tier 1

- An ENUM DNS layer corresponding to E.164 country codes. In the case of Japan, it is 1.8.e164.arpa.

Tier 2

- An ENUM DNS layer that contains NAPTR resource records.

Internet telephone

- A best-effort type audio telephone service that uses the Internet and whose service quality changes depending on network conditions.

Operator ENUM, Infrastructure ENUM

- A form of ENUM that is used by ISPs and telephone operators to control routes in or between operators.

Managed IP network

- An IP network whose traffic is controlled by using techniques such as bandwidth reservation.

User ENUM

- A form of ENUM in which the user can specify the relationship between his telephone number and service.
- In some cases, Internet telephone operators use it for call termination from the Internet regarding customer telephone numbers.

DNS : Domain Name System

- A mechanism that provides information, such as domain names and IP addresses mappings of computers connected to the Internet.

EPP : Extensible Provisioning Protocol

- A communication protocol between registries and registrars in various types of registration which meets GRRP requirements, is extensively based on XML, and is currently being standardized.

GRRP Requirements : Generic Registry-Registrar Protocol Requirements

- Generic requirements of communication protocol between registries and registrars documented in RFC3375 as Informational RFC.

H.323

- Protocols for multimedia communication used on networks, such as the Internet and LAN, which are standardized by the ITU-T.

IP network: IP-based network

- A network using Internet protocol as a network layer protocol.

IP address

- A number that identifies a computer or device connected to the Internet.

RTP : Real Transport Protocol

- Protocol that transfers image and audio data in real time, dividing image and audio data into packets, and adding packet sequences and timestamps as packet headers for transfer (RFC1889).

SIP : Session Initiation Protocol

- A signaling protocol used to establish multimedia sessions on IP networks, such as the Internet and LAN, and is standardized by the IETF. It was prepared as RFC2543 in 1999 and revised as RFC3261 in June 2002.

SIP server

- A server that mediates processes, such as session establishment required for SIP conversation in IP networks.
- There are three types of SIP servers: proxy, redirect and registration servers.
- Proxy server: Transfers SIP requests and sends data by proxy.
- Redirect server: Receives SIP requests and returns the current address of the receiver to the sender. Unlike proxy servers, redirect servers do not transfer SIP requests.
- Registration server (Registrar): Receives requests (REGISTER requests) to register the current location of UA, and updates data registered on location servers, etc.

SOA : Start of authority

- Information that indicates zone authority and also indicates the beginning of data.

TCP : Transmission Control Protocol

- A transport layer connection type protocol defined in RFC793,

TLS : Transport Layer Security Protocol

- Protocol that provides confidentiality and security to communications

between applications and that is located above the existing reliable transport layer protocols, such as TCP.

- Defined in RFC2246.
- It has been standardized by the IETF based on the SSL (Secure Socket Layer) protocol developed by Netscape.

TRIP : Telephony Routing over IP

- Protocol (RFC3219) that exchanges information (attributes) for finding VoIP signaling paths (Next Hop Servers) that can be used by telephone terminals belonging to a specified number space from a telephone number area between providers (ITAD: Internet Telephony Administrative Domains).

UDP : User Datagram Protocol

- Transport layer connectionless protocol defined in RFC768.

URL : Uniform Resource Locator

- A description (RFC1738) that specifies means (protocol) and locations for accessing various information resources on the Internet.

URI : Uniform Resource Identifier

- A simple character string that identifies abstract resources or resources specified by locations and descriptions that extend URLs (RFC 2396).

VoIP : Voiceover IP

- Technology that implements voice conversation through IP networks, such as the Internet or intranet.

Zone

- Part of the information of a name space consists domain. This zone information is stored as a zone file.

Resource Record (RR)

- The elements (records) of the DNS database. NAPTR is one resource record.

2. Example of how ENUM works

ENUM is a mechanism that obtains one or more applications corresponding to an E.164 number in URI format by looking up the DNS using a telephone number based on the E.164 Recommendation, an international agreement by ITU-T regarding telephone numbers, as a key. This chapter gives an overview of ENUM.

Note: This chapter describes ENUM technologies based on RFCs, Internet drafts and discussions made by the IETF as of the publication of this report (May 2003). The items introduced here, including the typing and writing method of applications associated with ENUM and ENUM technical specifications, may be subject to change at a later date.

2.1. ENUM Overview

This section explains how ENUM works by giving the example of looking for the telephone number "03-5297-2311" in the ENUM DNS.

1) Convert the telephone number to an E.164 number with a country code.

   +81-3-5297-2311

2) Delete all characters, except the + sign at the beginning and the numbers. This is the character string AUS for ENUM DDDS look-ups (see the DDDS section).

   +81352972311

3) Delete all characters except the numbers.

   81352972311

4) Place a dot (".") between the numbers.

   8.1.3.5.2.9.7.2.3.1.1

5) Reverse the order of the numbers.
   1.1.3.2.7.9.2.5.3.1.8

6) Add the character string ".e164.arpa" to the end.

1.1.3.2.7.9.2.5.3.1.8.e164.arpa

Using this character string as a domain name, queries a NAPTR resource record to the DNS. If it is registered properly, the URI corresponding to this number can be obtained.

''e164.arpa'' has been proposed as a domain name for ENUM in RFC2916 and is currently used for trials. A formal domain name is now being discussed at the ITU-T and IETF.

If the following NAPTR record has been registered as the domain name on the DNS:

```
$ORIGIN 1.1.3.2.7.9.2.5.3.1.8.e164.arpa
   IN NAPTR 100 10 "u" "E2U+sip" "!^ .*$!sip:info@sip.nic.ad.jp!",
```

the following URI is obtained:

sip:info@sip.nic.ad.jp.

An application program will recognize that it can establish a session for sip:info@sip.nic.ad.jp by using SIP.

H.323, Internet fax, Web and electronic mail addresses can be specified for telephone numbers by rewriting E2U+sip on and conversion rule of URI part on the NAPTR line described above. Details will be described later.

The DDDS is a system that gets results such as URIs by applying rewriting rules stored in a database constructed on DNS to unique identifying character strings (AUS) in an application (RFC3401 to RFC3405).

The basic algorithm is as follows:

1. When an AUS is given, a key for looking up databases is made by the first conversion specified by each application.

2. A DDDS database is looked up based on the key to obtain conversion rules.

3. The conversion rules are applied to the AUS. If the conversion rules do not produce the final result, return to step 2 with the conversion result as a key.

4. The final result of conversion is the production of output. A URL, a domain name or an address is then obtained.

The DNS is used as a DDDS database, a domain name is used as a key for database look-ups, and a resource record called NAPTR for data accumulation is defined in RFC3403 and RFC3404. The format of a NAPTR resource record is as follows:

IN NAPTR order pref flags service regexp replacement

Order 16bit unsigned integer. Priority is ascending order. (higher priority than preference)

Preference 16bit unsigned integer. Priority is ascending order.

flags Characters "S", "A", "U", P"; replacement/interpretation control

S: Final result Then look for SRV.
A: Final result Then look for A,AAAA.
U: Final result URI output.
P: Protocol dependent
None: Repeat searching the database to obtain further results.

service Character string; protocol [+service]
Specify protocol and service to which this entry is applied.

regexp Replacement character string (by regular expression)

replacement If a literal domain name is returned, specify a domain name here instead of regexp.

If there are several NAPTR resource records for a single key, the one with a small in “order” is selected. If there are several records with the same order, the one with a small in “preference” is used. If there are several valid resource records for the same order value, and the resource record with a small preference is evaluated but then failed, the next resource record is processed. If all resource records with a certain value fail, no resource records with larger in “order” values are evaluated and an error is returned.

In the service field, enter a service for this NAPTR resource record. If several NAPTR resource records exist, this field should be checked first.

In the regexp field, conversion rules from AUS with regular expression is described.

In the replacement field, “.” Is written if there is a regexp field.

The NAPTR resource field is also used to specify SIP server information as well as ENUM (RFC3263).

2.2 ENUM as a DDDS Application

ENUM is being redefined as a DDDS Application.

E2U (ENUM to URI) is defined as a protocol that uses DDDS for ENUM.
Sip, h323, ifax, tel, enum, mailto and http are expected as service(s) in it.

Examples of expected service protocols, NAPTR service fields and URI schemes are listed below. Formally, after RFC2916bis is issued as RFC, functions such as service fields and URIs for each service are defined as RFCs and registered in IANA.

Service protocol	service field	URI scheme
SIP	sip	sip:info@sip.nic.ad.jp
H.323	h323	h323:info@h323.nic.ad.jp
H.323 telephone	E2U+voice:h323	h323:info@nic.ad.jp
Internet fax	E2U+ifax	mailto:info-fax@nic.ad.jp
Existing telephone service	E2U+voice:tel	tel:+81352972311;svc=voice
Telephone fax	E2U+tel	tel:+81352972311;svc=fax
Electronic mail	E2U+message:mailto	mailto:info@nic.ad.jp
WEB	E2U+message:http	http://www.nic.ad.jp/

The E.164 telephone number beginning with + becomes an AUS for ENUM as described in ENUM Overview. The first known conversion is a rule for converting the above-described telephone number to a domain under the e164.arpa domain.

Currently, only "U" is defined as a NAPTR flag for ENUM. Like resource records for another DNS, several NAPTR resource records (DDDS databases) can be defined for a single domain name (look-up key).

```
$ORIGIN 1.1.3.2.7.9.2.5.3.1.8.e164.arpa
  IN NAPTR 100 10 "u" "E2U+sip" "!^ .*$!sip:info@sip.nic.ad.jp!"
  IN NAPTR 102 10 "u" "E2U+message:mailto" "!^ .*$!mailto:info@nic.ad.jp.!"
  IN NAPTR 104 10 "u" "E2U+tel" "!^ (.*$)$!tel:¥1!"
```

In this example, connection by SIP is given priority. Then, it is followed by electronic mail by SMTP and, finally, telephone connection (using the existing telephone network connected to this terminal or the media gateway of a contracted IP telephone company).

The third resource record means the following URI according to NAPTR character replacement rules:

tel:+81352972311

If all four digits following the dialing code +8135297 are expected to be processed by a single SIP server, a URI like sip:nnnn@sip-server.jp (nnnn: 4-digit number) can be

used by replacing with DNS wild card and regular expressions.

Assume　AUS is +8135297nnnn.

```
$ORIGIN 7.9.2.5.3.1.8.e164.arpa
  * IN NAPTR 100 10 "u" "E2U+sip" "!^+8135297(.*)$!sip:¥1@sip-server.jp!"
```

If +81352972311 is looked for, sip:2311@sip-server.jp is obtained.

As shown, by Using DDDS in this way, applications that can be represented by URI can be associated with E.164 numbers.

2.3 ENUM Specifications

The ENUM specifications are defined in a series of RFCs. The primary RFCs are shown below.

- RFC2916 (E.164 number and DNS) specifies basic specifications of ENUM. It is currently being revised with the title "The E.164 to URI DDDS Application".

  ☞ draft-ietf-enum-rfc2916bis-06.txt

- RFC2806 (URLs for Telephone Calls) specifies URIs that indicate connections with the existing telephone network, tel:, fax:, modem:. Currently, it has the title "The tel URL for Telephone Calls" and specifies only tel: based on the present consensus that URIs do not show any service type.

  ☞ draft-antti-enum-rfc2806bis-08.txt

- RFC3401 to RFC3405 (Dynamic Delegation Discovery System - DDDS) specify DNS look-up, NAPTR resource records and a series of rewriting rules used by ENUM.

Related RFCs

2141 URN Syntax. R. Moats. May 1997. (Format: TXT=14077 bytes)
(Status: PROPOSED STANDARD)

2168 Resolution of Uniform Resource Identifiers using the Domain Name System. R. Daniel、M. Mealling. June 1997. (Format: TXT=46528 bytes) (Obsoleted by RFC3401、RFC3402、RFC3403、RFC3404) (Updated by RFC2915) (Status: EXPERIMENTAL)

2169 A Trivial Convention for using HTTP in URN Resolution. R. Daniel. June 1997. (Format: TXT=17763 bytes) (Status: EXPERIMENTAL)

2276 Architectural Principles of Uniform Resource Name Resolution. K.Sollins. January 1998. (Format: TXT=64811 bytes) (Updated by RFC3401) (Status: INFORMATIONAL)

2303 Minimal PSTN address format in Internet Mail. C. Allocchio. March 1998.

(Format: TXT=14625 bytes) (Obsoleted by RFC3191) (Status:PROPOSED STANDARD)

2304 Minimal FAX address format in Internet Mail. C. Allocchio. March 1998.
(Format: TXT=13236 bytes) (Obsoleted by RFC3192) (Status:PROPOSED STANDARD)

2396 Uniform Resource Identifiers (URI): Generic Syntax. T.Berners-Lee、R. Fielding、
L. Masinter. August 1998. (Format:TXT=83639 bytes) (Updates RFC1808、RFC1738)
(Status: DRAFT STANDARD)

2483 URI Resolution Services Necessary for URN Resolution. M.Mealling、R. Daniel.
January 1999. (Format: TXT=30518 bytes) (Status:EXPERIMENTAL)

2806 URLs for Telephone Calls. A. Vaha-Sipila. April 2000. (Format:TXT=50647 bytes)
(Status: PROPOSED STANDARD)

2915 The Naming Authority Pointer (NAPTR) DNS Resource Record. M.Mealling、
R. Daniel. September 2000. (Format: TXT=41521 bytes)
(Obsoleted by RFC3401、RFC3402、RFC3403、RFC3404) (Updates RFC2168)
(Status: PROPOSED STANDARD)

2916 E.164 number and DNS. P. Faltstrom. September 2000. (Format:TXT=18159 bytes)
(Status: PROPOSED STANDARD)

3191 Minimal GSTN address format in Internet Mail. C. Allocchio.October 2001.
(Format: TXT=24235 bytes) (Obsoletes RFC2303) (Updates RFC2846)
(Status: DRAFT STANDARD)

3192 Minimal FAX address format in Internet Mail. C. Allocchio.October 2001.
(Format: TXT=18813 bytes) (Obsoletes RFC2304) (Updates RFC2846)
(Status: DRAFT STANDARD)

3401 Dynamic Delegation Discovery System (DDDS) Part One: The Comprehensive DDDS.
M. Mealling. October 2002. (Format: TXT=10172 bytes) (Obsoletes RFC2915、RFC2168)
(Updates RFC2276) (Status: INFORMATIONAL)

3402 Dynamic Delegation Discovery System (DDDS) Part Two: The Algorithm. M. Mealling.
October 2002. (Format: TXT=38925 bytes)(Obsoletes RFC2915、RFC2168)
(Status: PROPOSED STANDARD)

3403 Dynamic Delegation Discovery System (DDDS) Part Three: The Domain Name System
(DNS) Database. M. Mealling. October 2002. (Format: TXT=31058 bytes)
(Obsoletes RFC2915、RFC2168) (Status: PROPOSED STANDARD)
3404 Dynamic Delegation Discovery System (DDDS) Part Four: The Uniform Resource
Identifiers (URI). M. Mealling. October 2002. (Format: TXT=40124 bytes)
(Obsoletes RFC2915、RFC2168) (Status: PROPOSED STANDARD)

3405 Dynamic Delegation Discovery System (DDDS) Part Five: URI.ARPA Assignment
Procedures. M. Mealling. October 2002. (Format: TXT=19469 bytes) (Also BCP0065)
(Status: BEST CURRENT PRACTICE)

2.4 ENUM Tier Structure and DNS Zone Structure

ENUM Tier and DNS Zone Structures are determined by each country's circumstances. The structures in use in Japan require discussions. This section describes several patterns and ideas concerning the structures.

2.4.1 Tier Structures

In Japan, a country code 81 is used for a single country, it is considered appropriate to make the boundary between Tier 0 and Tier 1 a domain 1.8.e164.arpa, which corresponds with the country code.

There are several patterns regarding the boundary between Tier 1 and Tier 2. Some typical patterns are described below.

(1) Unit of assigned telephone numbers to telecom operators

Telephone numbers (telecommunication numbers based on telecommunication number rules that are an ordinance of the Ministry of Public Management, Home Affairs, Posts and Telecommunications in Japan) are assigned to each telecom operator as local area codes (0ABCDE for 03-5297) for fixed telephones and in units of 050-CDEF for IP telephones. The level corresponding to this unit can be considered the boundary between Tier 1 and Tier 2 (Figure 2.2 (3)).

Telephone numbers have been managed efficiently by hierarchical management by the governmental numbering plan office and telecommunications carriers, and efficient management will be achieved in the same way by matching this assignment unit with the boundary between Tier 1 and Tier 2.

If carriers assigned telephone numbers are the Tier 2 registries, getting consistency of both service users with telephone numbers and ENUM users can be made easily. In this case, if inter-carrier number portability is in service, it will be considered appropriate that an NS resource record pointing to another Tier 2 provider is described in the DNS zone of Tier 2 instead of a NAPTR resource record.

(2) If whole telephone number digits are held in Tier 1

If a NAPTR resource record is awaited in the Tier 1 registry without separating Tier 2 (Figure 2-1 (1)), and Tier 2 is specified from Tier 1 in an NS resource record for each telephone number by separating Tier 2 (Figure 2-1 (2)).

In Figure 2-1 (1), it can be resolved by the Tier 1 registry only and the scope of responsibility for Tier 1 is large. In Figure 2-1 (2), a Tier 2 provider can be specified for each number, and models in which the user selects Tier 2 providers freely can be implemented.

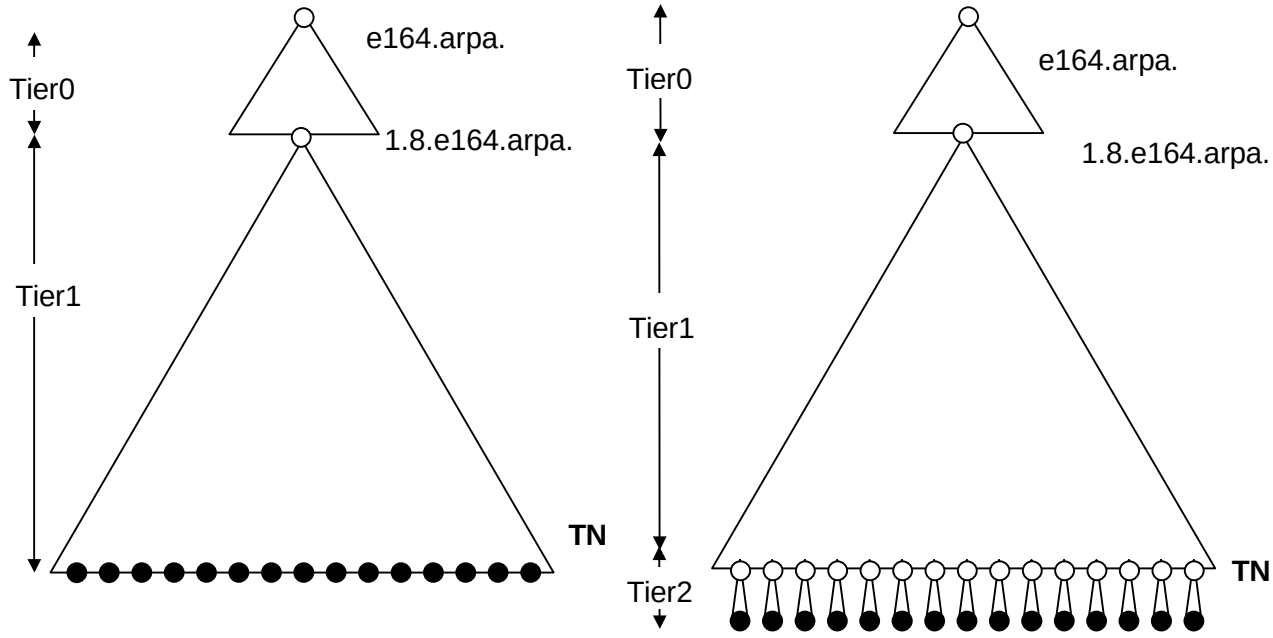
(3) Tier 1 division

A method that makes a boundary at a certain level in Tier 1 and divides it into several Tier 1 registries can be considered (Example: Figure 2.2 (4)). For example, Tier 1 is divided into upper and lower parts in some units, such as IP telephone 050, fixed telephone 03 area, etc., and these are handled by different carriers.

This method is expected to be used to select a policy of increasing opportunities for those participating in Tier 1 registry enterprises.

(Note: Japan's telephone numbers include 0A0 (telephone type) and 0AB0 (high-level service), and if numbers are divided in units of A like 03, a fixed telephone and other services are mixed. To divide them by telephone type or by service, it is necessary to divide Tier 1 at the digit place C of 0ABC.)

Tier Structure Figure 2.1

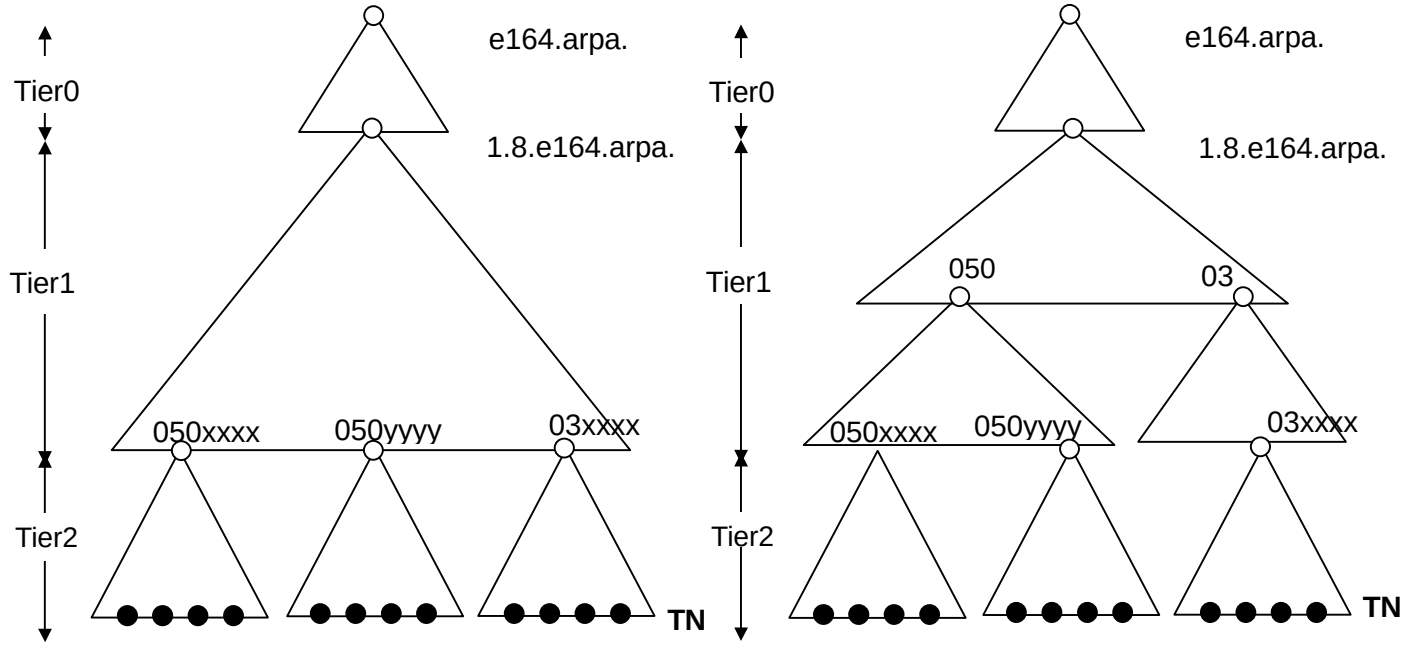


(1) **(2)**

○ : NS Record

● : NAPTR Record

Tier Structure Figure 2.2



○ : NS Record

● : NAPTR Record

2.4.2 ENUM DNS Zone Structure

Operations with one or more zones are expected for each tier described in the previous section. The decision of whether to divide a zone is left to the manager or operator for that zone, and it is determined according to operational requirements, such as ease of management and performance.

The registrar acceptance range of telephone numbers and the zone structure can be managed independently of each other. It is considered necessary to check record change authority by a registrar for each zone if matched or for each telephone number if not matched.

2.4.3 Communications between ENUM Registry and Registrar

If an ENUM DNS is operated, ENUM registries are required to manage DNS registrations.

For conventional domain name spaces of gTLD and ccTLD (e.g., .jp), there is one registry and multiple registrars for making registrations. Domain names registration and registered data can be changed through registrars. Registries generate DNS zones and provide DNS service based on the contents of registration.

So far, each registry has used its own communication protocol between registry and registrar, but the IETF PROVREG WG has established to standardize a general-purpose communication protocol between registry and registrar and has published the GRRP (General Registry Registrar Protocol) as RFC3375 for requirements for communication between registry and registrar. The EPP (Extensible Provisioning Protocol) that satisfies GRRP requirements is currently being developed. If it is standardized, many registries will be encouraged to support EPP.

EPP is designed as an extensible protocol based on XML and defines the following commands. These commands are combined as command sequences to operate registry databases. Each transaction begins with a login and ends with a logout. EPP stipulates a framework for communications, and communication transport and objects are separately defined.

login	Performs authorization and starts communication with an EPP server.
logout	Ends communication with an EPP server.
check	Checks ability to handle objects.
info	Displays information on existing objects.
poll	Requests messages queued for the user.
create	Creates objects (domain name registration).
delete	Deletes existing objects.
transfer	Changes registrar that manage existing objects.
update	Updates registration information of existing objects.

☞draft-ietf-provreg-epp-09.txt

Methods that use TCP (TLS), BEEP, SOAP and MAIL are proposed as transport for communication used for EPP.

☞draft-ietf-provreg-epp-tcp-06.txt
☞draft-ietf-provreg-epp-beep-03.txt
☞draft-liu-epp-soap-00.txt
☞draft-brunner-epp-smtp-00.txt

Handling of domain names, host information and contact information for objects to be registered are under discussion.

☞draft-ietf-provreg-epp-domain-07.txt
☞draft-ietf-provreg-epp-host-07.txt
☞draft-ietf-provreg-epp-contact-07.txt

ENUM is proposed in the form of an extension to domain name registries.

☞draft-ietf-enum-epp-e164-02.txt

This draft defines functions required for ENUM, which do not exist in gTLD domain name registries. Specifically, they are E.164 domain name and NAPTR field values. This definition enables the handling of communications between registry and registrar for Tier 1 and Tier 2 respectively.

2.5 Related Organizations and Their Activities

This section provides an overview of international organizations and their activities related to ENUM.

2.5.1 IETF

Overview of Activities

The IETF is an organization that standardizes technologies used for the Internet, such as TCP/IP. It is a subordinate organization of the IAB that manages standardization of Internet architecture and the smooth operation of the Internet. Technical specifications prepared by the IETF are published as RFCs.

Status

ENUM-WG was established in October 1999. The IETF joined the "IP-Telecoms Interworking Workshop" sponsored by the ITU in January 2000 and participated in collaborative work with the ITU-T. An ENUM protocol was designated as an RFC (RFC2916) in September 2000.

Currently, the ENUM Working Group is discussing an RFC to obsolete by modifying RFC2916 and has agreed upon draft-ietf-enum-rfc2916bis-06.txt.

Related URLs

- http://www.ietf.org/ (IETF)
- http://www.ietf.org/html.charters/77enum-charter.html (Telephone Number Mapping (ENUM) WG)

2.5.2 ITU

Overview of Activities

The ITU, headquartered in Geneva, Switzerland, is a subordinate organization of the United Nations that sets the international standards for telecommunications. The ITU adopted opinions (declarations) for the worldwide development, implementation and promotion of IP telephony in the third WTPF: World Telecommunication Policy Forum 2001 (March 2001).

Status

The ITU began working together with the IETF in the "IP-Telecoms Interworking Workshop" in January 2000. At the ITU-T SG2 WP1 meeting held in October 2000, it was determined that the E.164 number management procedure set in ENUM DNS would be prepared as a guideline.

In the "ITU ENUM Workshop" held in January 2001, the concerned parties of various countries exchanged views on administrative issues related to operational deployment of the ENUM protocol. After meetings of ITU-TSG2 in January and September, the ENUM Supplement of country codes assigned to geographic areas, networks and so on was adopted in May 2002.

Related URLs

- `http://www.itu.int/home/index.html (ITU)`
- `http://www.itu.int/osg/spu/enum/index.html (ITU ENUM)`

2.5.3 ENUM Forum

Overview of Activities

The ENUM Forum was established in August 2001 to create a framework for adopting the mechanism of RFC2916, based on the DNS structure using E.164 numbers with e164.arpa (tentatively) as a root, in North America under the influence of the NANP (North American Numbering Plan).

Status

The ENUM Forum released the "Unified Document" listing the requirements concerning Tier 1 and Tier 2 in November 2002. The "Unified Document" refers to the provisioning process of ENUM, including security, privacy and so on, as well as the roles of Tier 1 and Tier 2 and their connectivity.

Related URLs

- http://www.enum-forum.org/ (ENUM Forum)
- http://www.enum-forum.org/documents.html (The ENUM Forum - documents)

2.5.4 UKEG

Overview of Activities

The UKEG was formed in September 2001 to study operational and administrative issues on the implementation of ENUM in the United Kingdom and their solutions from the viewpoint of the industry, and to make recommendations to the DTI (Department of Trade and Industry).

Status

A preliminary report that proposed "a preferred framework that would facilitate ENUM implementation within the UK " was released in April 2002. In September, a formal announcement was released to call for participation in trials.

Related URLs

- http://www.dti.gov.uk/cii/regulatory/enum/index.shtml (DTI ENUM)
- http://www.dti.gov.uk/cii/regulatory/enum/egp_report.shtml (UKEG Preliminary Report on ENUM April 02)
- http://www.dti.gov.uk/industries/ecommunications/key_dti_contacts.html (ENUM-related contact)

2.5.5 ETSI

Overview of Activities

ETSI is the organization that sets the telecommunications standards in Europe. While the ITU is an international organization formed by representatives of governments, ETSI is a regional standardization organization (including outside Europe) focusing on standardizing activities.
ETSI is establishing EN (European Standard), which is related to telecommunications, and ETS (European Telecommunication Standards).

Status

The TIPHON (Telecommunications and Internet Protocol Harmonization Over Networks) project has been set up to discuss the preparation of united requirements for implementing commercial services for voice conversation and multimedia communication on IP networks. It proposed also minimum requirements for ENUM connectivity in Europe in October 2002.

Related URLs

- http://www.etsi.org/ (ETSI)
- http://www.etsi.org/frameset/home.htm?/tiphonweb/ (TIPHON)
- http://portal.etsi.org/tiphon (TIPHON portal site)

2.5.6 Activities of Other Countries

In order to make trials of ENUM, each country must request the "country code.e164.arpa" domain, delegated by contacting the RIPE NCC.

- http://www.ripe.net/enum/request-archives/ (RIPE)
- http://www.itu.int/itudoc/itu-t/enum/enum-app.html (ITU-T)

The following E.164 country codes received approval till May 5, 2003.

E.164 country code	Country name	Delegee	Date of TSB Approval
246	Diego Garcia	Government	‘02/08/12
247	Ascension	Government	‘02/08/12
290	Saint Helena	Government	‘02/08/12
31	Netherlands	Ministry	‘02/05/23
36	Hungary	CHIP/IszT	‘02/07/15
43	Austria	Regulator	‘02/06/11
44	UK	DTI/Nominum	‘02/05/16
48	Poland	NASK	‘02/07/18
49	Germany	DENIC	‘02/05/16
55	Brazil	Brazilian Internet Registry	‘02/07/19
86	China(c)	CNNIC	‘02/09/02
878 10	(a)	VISIONng	‘02/05/16
991 001	(b)	NeuStar	‘01/02/02

Notes:

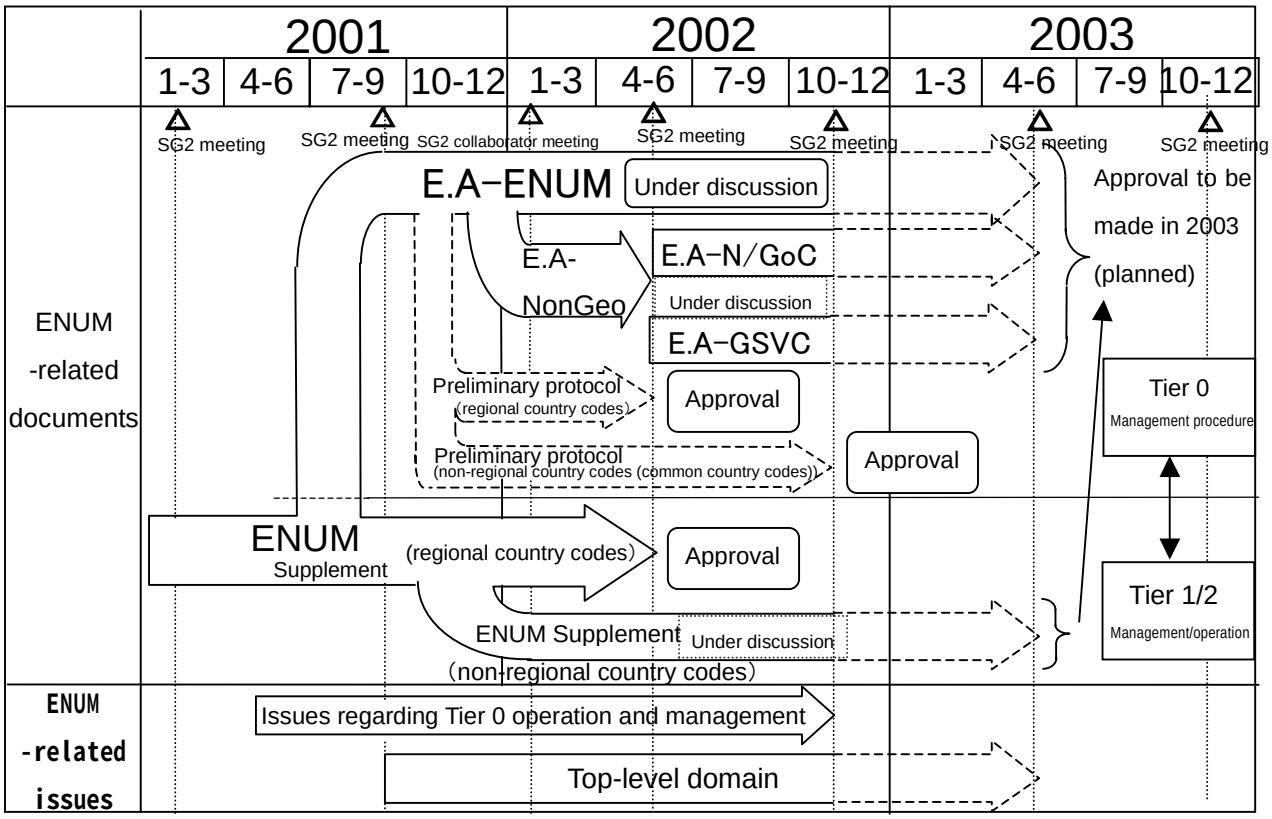
(a) UPT code (UPT: Universal Personal Telephony)

(b) The trial will expire on November 2, 2003.

(c) The trial will expire on June 30, 2003.

2.5.7 Transition of Recommendations Concerned with ENUM

The transition of ENUM recommendations (centering on the ITU-T)include the following::



3. User ENUM and Operator ENUM

This study group classifies ENUMs into two types: User ENUM and Operator ENUM.

The ENUM in which a user of the communication service identified by an E.164 number registers applications to as an ENUM record for that number by her/himself is called a "User ENUM".

The ENUM in which a service provider who is assigned E.164 numbers sets an ENUM records to implement the service identified by the telephone numbers is called an "Operator ENUM".

Note: The Operator ENUM is also called an infrastructure ENUM as in the UKEG report.

In actual systems, intermediate ENUMs between the two are possible, but they can be considered as combinations of the two types of ENUMs.

The ENUMs that are generally being discussed by the IETF, UKEG, ENUM Forum and others, are User ENUM. In Japan, there is an interest in ENUM in relation to the IP telephone. If IP telephone operators use an ENUM as a means of implementing IP telephone service, it is an "Operator ENUM".

The User ENUM is very different from the Operator ENUM in terms of the managing entity, as well as management policy, method and requirements.

For example, as to managing entities, in the User ENUM end users manage DNS record data corresponding to E.164 numbers, and in the Operator ENUM operators manage record data that correspond to applications for services provided in the network.

For ENUM DNS access, end users (i.e., their applications) access it on the Internet with the normal DNS protocol for the User ENUM. For a typical Operator ENUM, network equipment and operator terminals (provided by operators) use them for call connection and end users need not to be aware of DNS access.

The Study Group discusses both the User ENUM and Operator ENUM.

3.1 User ENUM

This section provides an example of a typical User ENUM and discusses its conditions.

The User ENUM must be operated as a public resource common to operators if they are to participate, though each operator assigned telephone numbers may make the decision whether to participate or not. It is therefore necessary to study details when the User ENUM is introduced.

☐ Purpose

- To publish reachable applications specified by E.164 number users (users who receive telecommunication services identified by E.164 numbers).
- To obtain an access method to E.164 number users by voice service.
- To obtain an access method other than voice (Web, mail) owned by E.164 number users.

☐ Registrant

- An E.164 number user.

☐ ENUM client

- An application on a user computer connected to the Internet.
- Gateway, proxy, etc.

☐ Requirements

- Provision of openness and fairness to users
- Privacy and security level requested by E.164 users
- Privacy and security level requested by ENUM client
- Registration based on the intention of registrants (opt-in)

☐ DNS configuration (tier structure)

- Global configuration

☐ Security issues

- Authorization of E.164 number users and validity of registered data during registration

☐ Number management

Since basically, individual users set URIs corresponding to numbers by themselves, it is necessary to clarify the relationship of the ENUM with the existing telephone number management.

★When URIs are shared with existing telephone numbers

If telephone numbers assigned to existing operators are also used as User ENUM numbers, it is required that those who use E.164 numbers for ENUM confirm that they indeed receive the services identified by the E.164 numbers from operators. If users receive the telecommunication services identified by the E.164 numbers, confusion should be avoided by taking measures to prevent inconsistency between the services provided by the operator and ENUM records registered by users.

In this case, for example, the following measures are considered:

- Restriction on priorities of the record
- Validation of the record by operators when users register
- Registration by operators based on user‘s application

★Telephone number space for the User ENUM

If an exculsive ENUM number is assigned, it is not necessary to consider consistency with management of the existing telephone numbers.

However, since telephone numbers are limited and must be effectively used, it is required that the necessity of the assignment of new telephone numbers will be discussed from several aspects including regulations.

3.2 Operator ENUM

If, for example, IP telephone operators implement communications with E.164 numbers internal to their IP telephone networks using ENUM technology containing proprietary information, it is an Operator ENUM.

If networks of several operators are interconnected, a common scheme for the operators can be provided based on a prior agreement between them concerning conversion of E.164 numbers to IP addresses and management of the conversion information. The Operator ENUM can be used as this scheme.

Some operators use ENUM as a shared database for inter-operator portability. In this case, it is also an Operator ENUM.

An Operator ENUM is introduced for each operator assigned telephone numbers or a group of operators that have a prior mutual agreement, and its implementation method is under the decision of each operator or each group.

This section provides an example of a typical Operator ENUM and discusses its conditions.

☐ Purpose

- Call connection in operators
- Call connection between operators
- Call connection from existing telephone networks to multiple IP telephone networks

☐ Registrant

- The operators that manage networks register corresponding numbers

- The operators that manage networks register DNS records for all telephone numbers in networks.

☐ ENUM client

- Equipment and operator terminal in the network.

☐ Requirements

- Exhaustivity and completeness of entries to guarantee address resolution for any call connections.
- Performance, reliability and scalability required for quality of service of operators.
- Query access restriction (inhibits DNS access by anyone other than a group of operators that have a prior mutual agreement).

☐ DNS configuration (tier structure)

- Corresponds to operator structure.
- Local/private configuration in some cases.

☐ Security issues

- Query access restriction (inhibits DNS access by anyone other than a group of operators that have a prior mutual agreement).

☐ Number management

- Number management corresponds to the assignment of numbers to operators.

3.3 Comparison Table

	User ENUM	Operator ENUM
Registrant	User	Operator (Service Provider)
Purpose	Publicizes services specified by users (registrants).	Publicizes operator-implemented services.
Registered URI type	Various Types of URIs that can be registered may be limited due to the relationship with the operator assigned to the telephone number.	URI to identify services provided by operators. Telephone service is limited to SIP/H323/TEL, etc.
Applicable number space	If existing telephone numbers are used, it depends on regulations or policies. If an ENUM-dedicated number is assigned, its space is used.	Number space assigned to operators.
Matching of telephone number assigner and registrant by the Japanese current regulation.	Unmatch. Regulations issues must be solved.	Match. Consistent with the current regulation.
Responsibility of number management	It must be specified by the user and operator.	Operator
Entity which performs lookups	Internet user	Operator service user, network device, operator terminal
DNS server performance/quality	Internet quality	The operator reinforces it as required.

Terminal which performs lookups	General-purpose user terminal that uses ordinary Internet applications.	Terminal shown on the left, network device, or operator terminal

(Continued)

	User ENUM	Operator ENUM
Registration contents comprehension	Since users make registrations at their discretion, registration is selective by opt-in.	Since it is used to implement operator services, they are registered comprehensively within the range of numbers assigned to operators.
Architecture	Similar to normal DNS service on the Internet. Homogeneous.	It may depend on the operator's choices. Complex and various with them in mind. Chimera If an individual event is an operator matter, the common part is simple.
Tier structure Global tree inevitability	2.1(2) Needs discussion because it changes case by case. Yes	2.2(3)>2.2(4)>2.1(2) Needs discussion because it changes case by case. In some cases, an ENUM-like service with a local tree can be used. It does not need to be global if it is only used as a database between specific operators. If look up is unlimited , it must be global.

(Continued)

	User ENUM	Operator ENUM
Troubles concerning registered RR/URI Many	problems may occur because it depends on user registration details	There may be fewerproblems because operators register RR/URIs. Those who solve problems are clearly identified.
Service problems and solutions	There are several entities related to service, so it may be difficult to solve problems.	Entities related to service are clear. Procedure for solution may be simple.
Extent of damage when a problem occurs	May be limited to users.	May affect the entire service of operators.
Registration/update frequency / Changes	Many (though it depends on the number of users)	Update frequency is lower because it occurs during a new number assignment or configuration change, but the amount of change is large.
Effort required to change registration (see authorization/accounting items)	Great	Small (can be simplified)

(Continued)

	User ENUM	Operator ENUM
Registrar authorization target (=registrant)	User	Operator
Number of registrar authorization targets	Large	Small
Effort required for registrar authorization	Great	Small
Registrar = Registrant possibility	No	Yes
Registrar accounting	User	Operator
Registrar charging effort	Great	Small
Registrar risk of unpaid charges	Yes	Low (Example: Closing of operators)
WHOIS/Privacy	Rules are required to handle and protect user identification information.	Policies made by operators can protect user information.
Privacy problem	Serious	Simple (possible)
Security	Internet level	Operators can reinforce security as required.
Protection target	General	General
Registrar, registrant interface	Simple interface (typical), such as Web	Transaction interface (typical), such as EPP

4. Items Expected from ENUM Introduction (Issues Expected To Be Solved)

This section discusses what is expected from the introduction of ENUM. The implementation and operation methods and managing entities may differ depending on forthcoming details.

The items expected from the introduction of ENUM are classified as follows:

(1) As a means of identification of applications with E.164 numbers.
(2) As a means of resolution from existing telephone number to Internet telephone number.
(3) As a means of resolution from Internet telephone number to existing telephone number.
(4) As means of number resolution of existing telephone networks (including IP telephone networks).

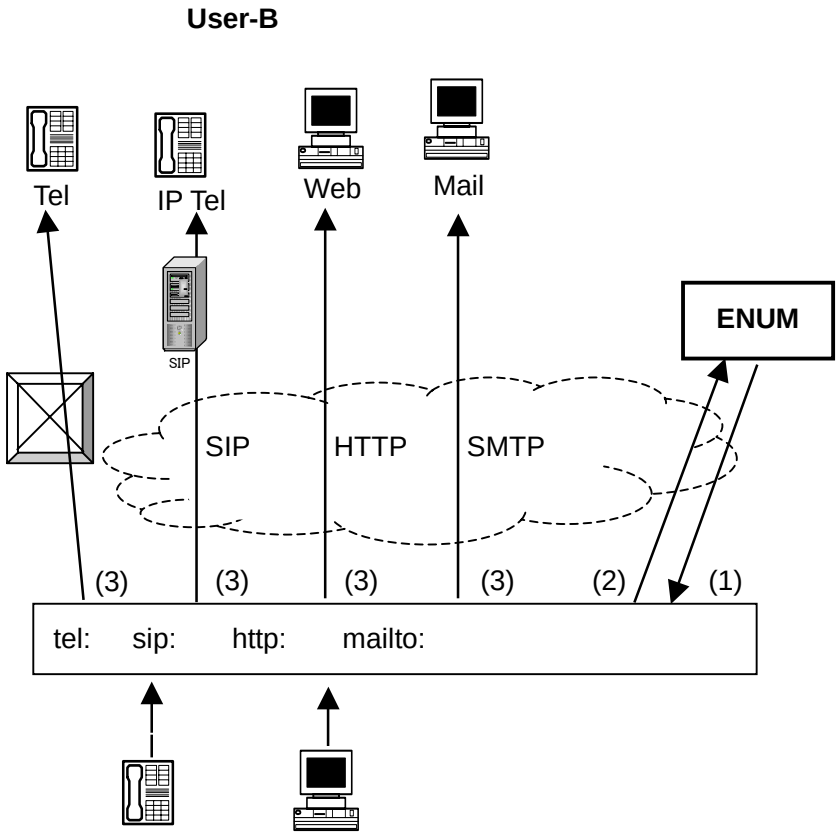
(1) is a typical purpose expected from the User ENUM. (4) is a typical purpose expected from the Operator ENUM. In (2) and (3), a user ENUM is used, an operator ENUM is used, or both are mixed according to Internet telephone operation methods.

(1) As a means of identification of applications with E.164 numbers:

ENUM allows one E.164 number to be associated with one or more applications available on the Internet. Therefore, by using an E.164 number, the means of communication other than by telephone can be provided integrally to the user of that E.164 number (the user who receives telecommunication service identified by the E.164 number).

There are several advantages, such as that applications are only ever identified by numbers and so can be entered through terminal interfaces with only numeric keys, like a telephone keypad for example.

End user B can reference a NAPTR resource record registered by end user A with an E.164 number, invoke the corresponding application on the end user B terminal and communicate with end user A. Applications may include telephone, facsimile, Internet telephone, electronic mail and WWW.



(1) Query to ENUM DNS

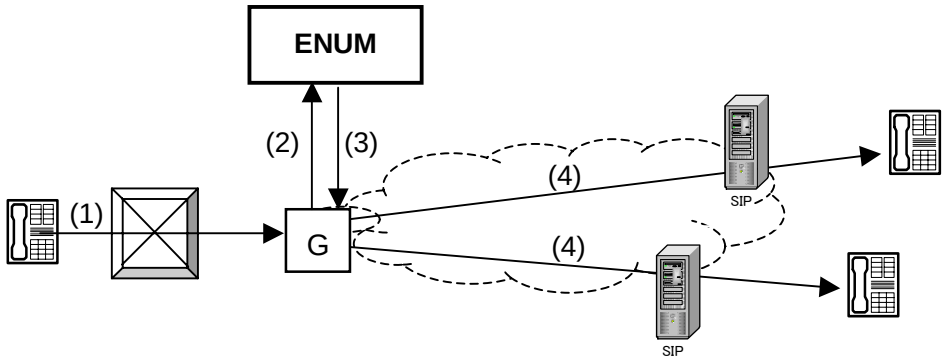
(2) Response from ENUM DNS

(3) Select and connect to destination based on response results

(2) As a means of resolution from the existing telephone number to an Internet telephone number:

When a applicantapplicant of the existing telephone network accesses an Internet telephone applicantapplicant, the relationship between the URI corresponding to the Internet telephone applicantapplicant and the corresponding E.164 number must be resolved. ENUM is a promising candidate as a means to resolve this.

An E.164 number is assigned to the Internet telephone applicantapplicant and a pair of that number and URI is registered in ENUM DNS as a NAPTR resource record. A gateway from the telephone network to the IP network looks up the DNS with an E.164 number as a key when a connection is made. If the corresponding IP telephone applicant can be connected by SIP, the corresponding SIP URI is obtained and a call is established according to that URI.



(1) Telephone calls IP telephone
(2) The gateway queries ENUM DNS
(3) Response from ENUM DNS
(4) Select and connect to SIP gateway based on response results

In this case, access can be made without using ENUM if the gateway has information on the SIP server corresponding to the E.164 number. However, using ENUM has advantages, such as look-up interface integration and scalability.

H.323 may be used instead of SIP as an Internet telephone protocol. In this case, an H.323 URI scheme is in the response.

(3) As a means of resolution from an Internet telephone number to the existing telephone number:

It is not always necessary to access ENUM when an Internet telephone applicant is attempting to connect to an existing telephone applicant. If the Internet telephone is an ordinary computer with a keyboard, the other party can be specified using a domain name through a gateway.

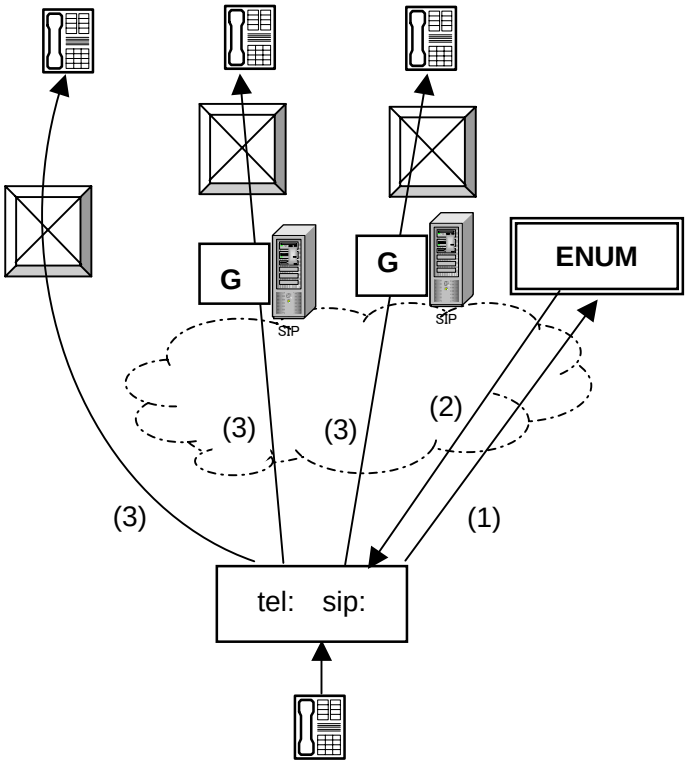
However, if ENUM is used, an integrated interface can be used for management as stated in (2).

An Internet telephone can be connected to an existing telephone by a method of using URI scheme tel: or using an IP telephone scheme (e.g., sip:).
tel: is a URI scheme that indicates a telephone number, such as:

tel:+81352972311

If a terminal gets this URI through ENUM, it can try to connect through the telephone network, without using the Internet network, if it is connected directly to the telephone network. This connection does not use the Internet.

If a gateway is installed between the existing telephone network and the Internet, and its connection is managed by a SIP server, an existing telephone applicant can be accessed from an Internet telephone applicant by SIP if the SIP server is specified by the URI.



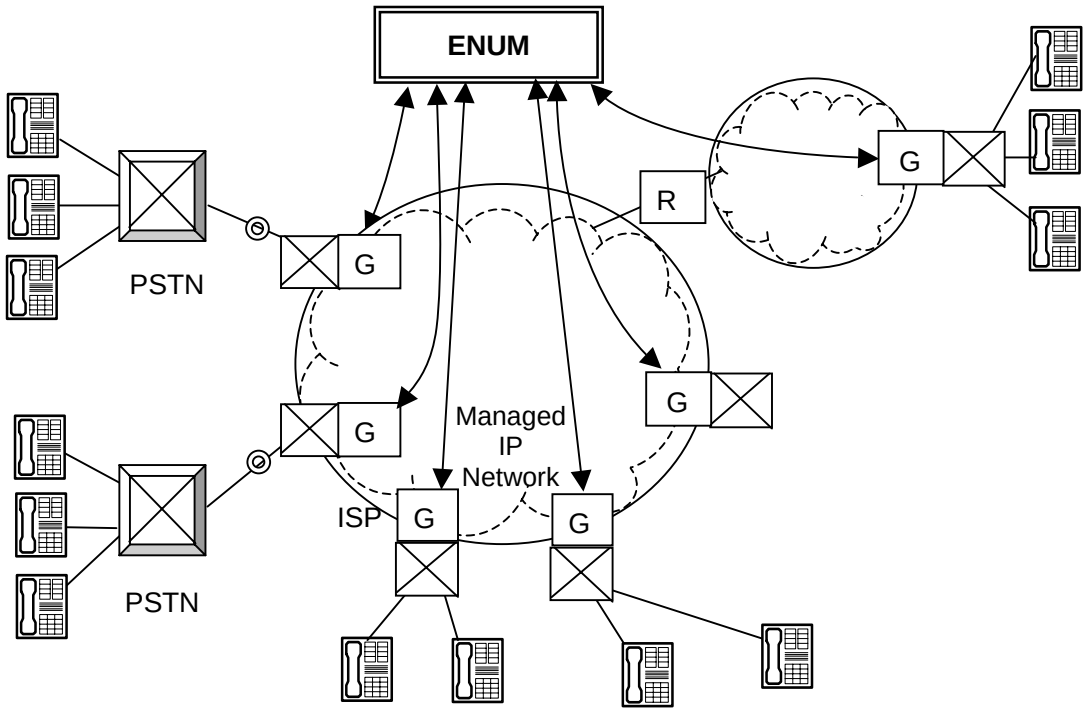
(1) Query to ENUM DNS
(2) Response from ENUM DNS
(3) Select and connect to destination based on response results

If there are multiple gateways on the Internet and telephone networks, a method of using a dedicated protocol for gateway selection like TRIP or a method of setting a NAPTR resource record to respond to a specific gateway can be considered a possible gateway selection method (e.g., if a gateway can be identified by each dialing code, a NAPTR resource record is set for each dialing code).

If an Internet telephone is connected to an existing telephone, it is necessary to consider consistency with existing telephone services in terms of accounting, system, etc., as well as technical issues.

(4) As means of number resolution of telephone networks (including IP telephone networks):

Using ENUM E.164 number database features, telephone operators can use ENUM to manage telephone networks and route information between operators.
If an IP network is used as a telephone network, the ENUM based on IP technology is considered to have a high affinity with the telephone service.



For example, this ENUM can be used as a means of implementing number portability (inter-operator, location, etc.), UPT and free phone (reverse charging).

Note: A complex mechanism is required to implement these features in addition to ENUM.

5. SIP and Its Accommodation to ENUM

Currently, a session initiation protocol that is expected to be the mainstream for Internet telephony is SIP.

This section provides an outline of SIP and describes its accommodation to ENUM.

The current specification does not completely define application of ENUM to SIP and contains ambiguities. The IETF is working on this issue with the Sipping (Session Initiation Proposal Investigation) Working Group.

5.1 SIP Overview

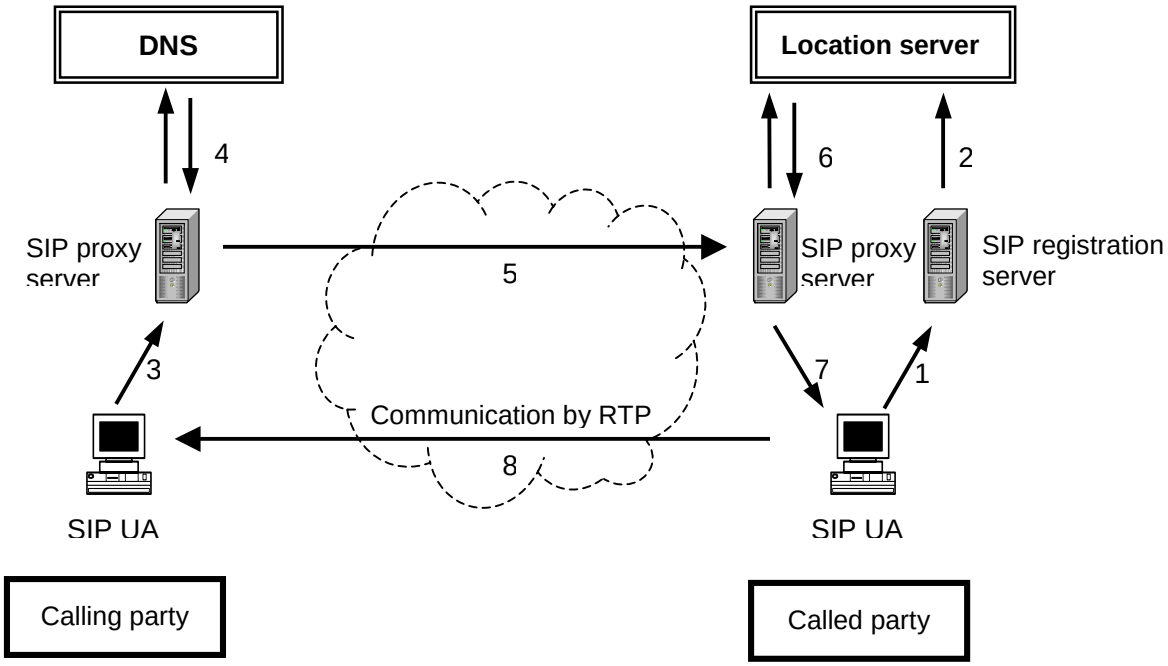
Session Initiation Protocol (SIP) is a protocol that enables endpoints (called user agents (SIP UAs)) on the Internet to identify each other to communicate, agree on session characteristics mutually, and initiate, modify and terminate sessions. Its basic specification is defined in RFC3261.

SIP is a protocol that initiates, modifies and terminates sessions, and actual communication is carried out according to a protocol agreed on by SIP. A typical protocol for telephone is RTP (Realtime Transport Protocol, RFC1889).

Endpoints – (i.e., SIP UAs –) can directly initiate sessions with each other using SIP, but normally, sessions between endpoints are initiated by transferring a session initiation message through a kind of SIP server called a SIP proxy server (hereinafter referred to as SIP proxy).

At the called-party end, a SIP registration server and a location server associate SIP UAs with SIP URIs that identify SIP connection destinations.

The following figure indicates these relationships.



A flow of typical session initiation is as follows.

The SIP UA of the called party is registered. It is carried out automatically by a prior setting, when a SIP UA is turned on or when an application is started.

1) The called SIP UA uses a SIP REGISTER request to request a SIP registration server to register the relationship between the SIP URI (logical address, Address-of-Record, AoR) of the user of the SIP UA and the SIP URI for reaching the SIP UA.

2) The SIP registration server stores the relationship in 1) on the location server (SIP protocol out of range).

This procedure completes the SIP UA registration of the called party. This registration procedure is normally performed periodically (standard value: every 1 hour).

In addition, a session initiation request (INVITE request) is sent from the SIP UA of the calling party to the SIP UA of the called party by the following procedure.

3) The SIP UA of the calling party sends the SIP URI (AoR) of the other party to a SIP proxy server that is preset or specified on calling with an INVITE request.

4) The SIP proxy server takes the domain name part of the SIP URI, makes an query to the DNS and obtains the IP address of the SIP proxy of the called party.

5) Transfer an INVITE request to the SIP proxy of the called party.

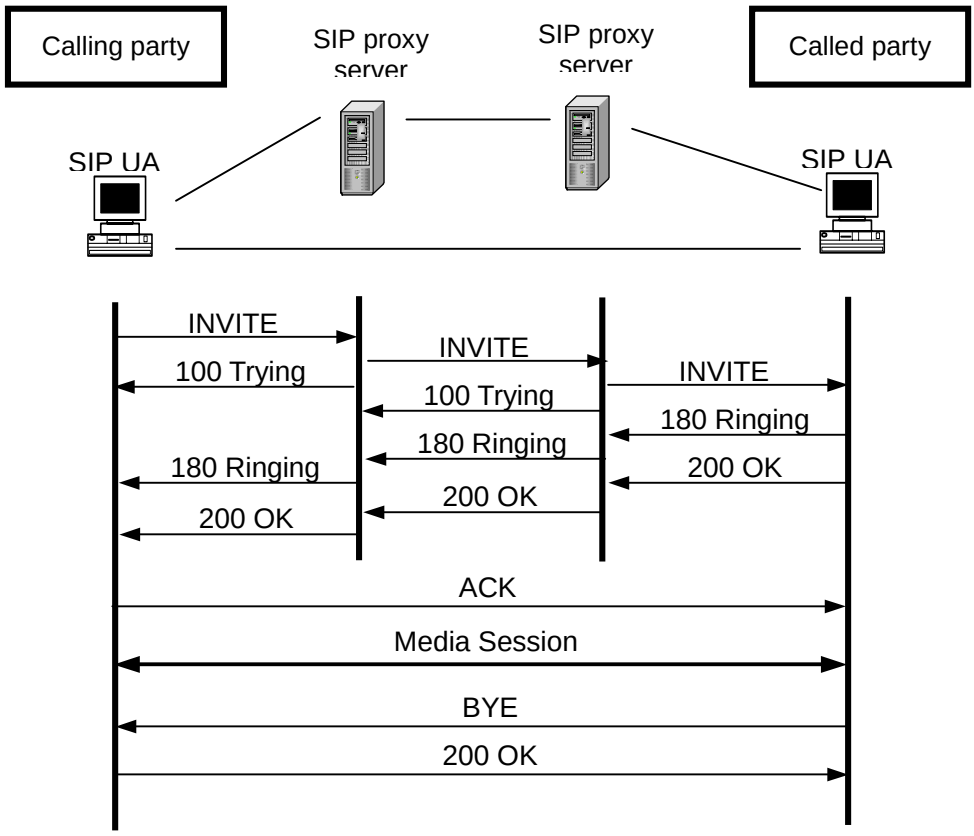
6) The SIP proxy of the called party requests the SIP UA corresponding to the SIP URI of the other party from the location server.

7) Transfer an INVITE request to the SIP UA of the called party.

The SIP UA of the called party responds to the INVITE request from the SIP UA of the calling party. The SIP UA of the calling party then sends a message of acknowledgement along with an ACK request.

8) Media session by RTP in 8) may commence.

The request and response messages might be transferred among four parties in this procedure as follows:


Calling party
SIP proxy server
SIP proxy server
Called party
SIP UA
SIP UA
INVITE
INVITE
INVITE
100 Trying
100 Trying
180 Ringing
180 Ringing
200 OK
180 Ringing
200 OK
200 OK
ACK
Media Session
BYE
200 OK

5.2 SIP URI and Discovery of SIP Proxy of the Called Party

SIP uses a kind of URI called an SIP URI as an identifier to identify the other party (RFC2363).

For example, it has a format similar to a mail address, such as sip:taro@example.co.jp;example.co.jp is the domain name of the called party and taro is the user name registered on the location server of the domain.

The SIP proxy of the calling party discovers the SIP proxy of the called party from this SIP URI. The discovery procedure is defined in RFC3263 "Session Initiation Protocol (SIP): Locating SIP Servers".

The SIP proxy of the called party looks for NAPTR, SRV, A or AAAA records in this order for the domain part of the SIP URI with the DNS, and obtains the IP address of the SIP proxy of the called party.

sip:taro@example.co.jp is shown below as an example. When the proxy of the calling party requests NAPTR records (for example.co.jp with the DNS) the following records are found.

```
;      order pref flags service        regexp replacement
IN NAPTR 50 50 "s" "SIPS+D2T"         "" _sips._tcp.example.co.jp
IN NAPTR 90 50 "s" "SIP+D2T"          "" _sip._tcp.example.co.jp
IN NAPTR 100 50 "s" "SIP+D2U"         "" _sip._udp.example.co.jp
```

This indicates that the server supports TLS, TCP and UDP on TCP with their priorities in the order listed. The SIP proxy of the calling party supports TCP and UDP, so it selects TCP and sends a query to SRV for _sip._tcp.example.co.jp. As a result of the query, the following records are found.

```
;;      Priority Weight Port    Target
IN SRV 0    1    5060    server1.example.co.jp
IN SRV 0    2    5060    server2.example.co.jp
```

In addition, the SIP proxy of the called party queries A or AAAA records to the DNS,

and obtains the other party's proxy server1.example.co.jp or the IP address of server2.example.co.jp.

5.3 SIP Service Accommodation to ENUM

There are two methods of introducing SIP services to ENUM: support by SIP client programs and by proxy servers.

Support by SIP clients

When a SIP application program receives the specifications of the other party with a telephone number from a user, the application program converts the specified telephone number to a domain name according to ENUM conversion rules and performs a DNS look-up with NAPTR records according to the domain name. If the SIP URI of the called party is obtained, the SIP process starts as SIP UA using the SIP URI.

Support by SIP proxy

When a SIP application program receives the specifications of the other party with a telephone number from a user, the application program converts it to the appropriate SIP URI (tel: scheme) containing the telephone number and sends a connection request to the SIP proxy using the SIP URI.

The SIP proxy converts the specified telephone number to a domain name according to ENUM conversion rules and performs a DNS look-up with NAPTR records according to the domain name. If the SIP URI of the called party is obtained, the SIP process starts as a SIP UA using the SIP URI.

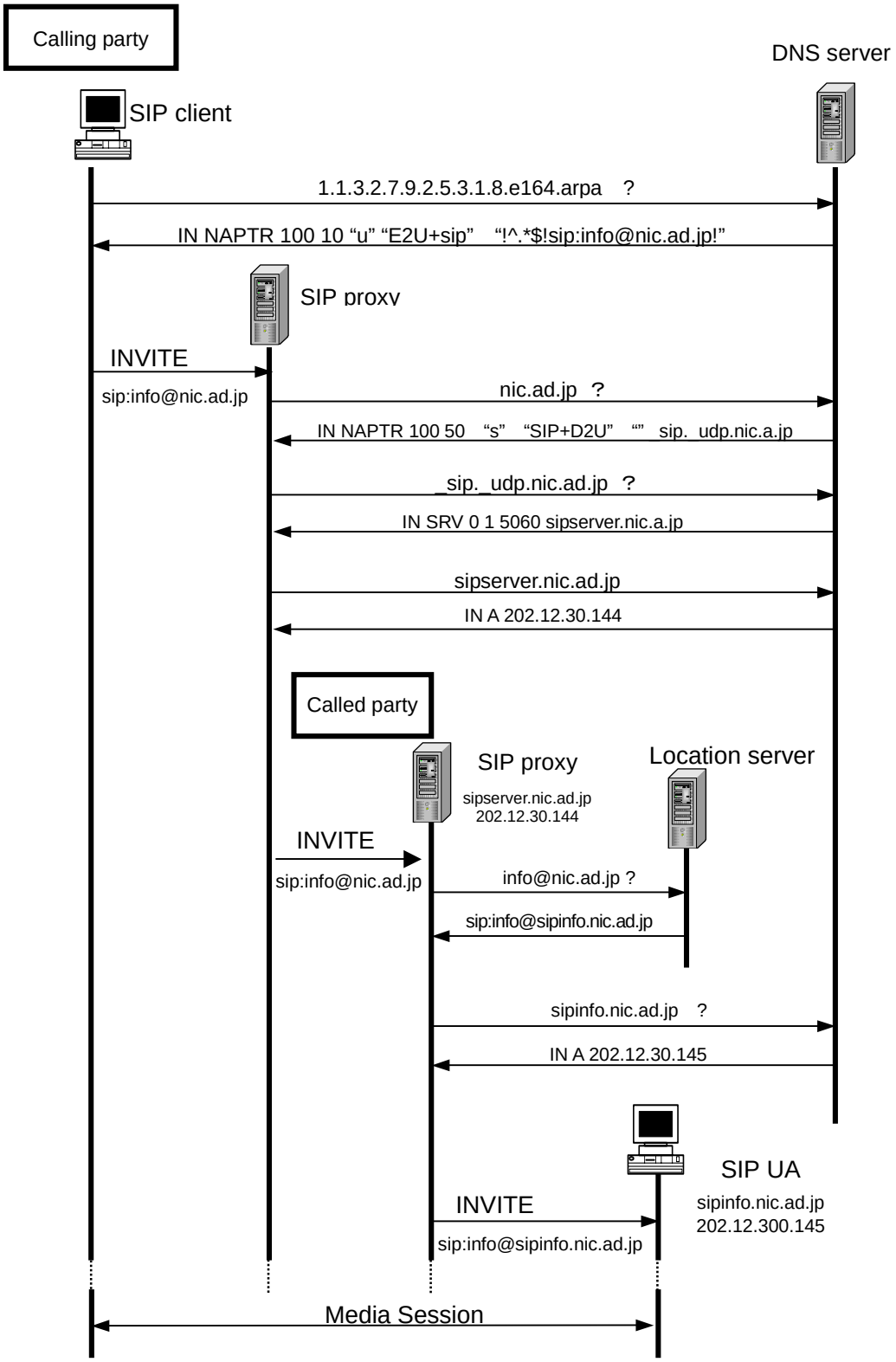
Instead of the SIP proxy, a SIP redirect server may perform this processing.

The current IETF discussion suggests that processing by clients is preferred.

- ☞ draft-ietf-sipping-e164-02.txt

If the SIP proxy is supported, the standard format and parameters of the SIP URI, containing a telephone number that is sent from the SIP UA, must be determined.

A typical session initiation procedure when a SIP client processes ENUM is shown in the figure below.


Calling party
DNS server
SIP client
1.1.3.2.7.9.2.5.3.1.8.e164.arpa ?
IN NAPTR 100 10 “u” “E2U+sip” “!^.*$!sip:info@nic.ad.jp!”
SIP proxy
INVITE
sip:info@nic.ad.jp
nic.ad.jp ?
IN NAPTR 100 50 “s” “SIP+D2U” “” sip._udp.nic.a.jp
_sip._udp.nic.ad.jp ?
IN SRV 0 1 5060 sipserver.nic.a.jp
sipserver.nic.ad.jp
IN A 202.12.30.144
Called party
SIP proxy
sipserver.nic.ad.jp
202.12.30.144
Location server
INVITE
sip:info@nic.ad.jp
info@nic.ad.jp ?
sip:info@sipinfo.nic.ad.jp
sipinfo.nic.ad.jp ?
IN A 202.12.30.145
SIP UA
sipinfo.nic.ad.jp
202.12.300.145
INVITE
sip:info@sipinfo.nic.ad.jp
Media Session

6. ENUM Registration Process

The process of registration using the ENUM service is described below (based on the ITU-T registry-registrar model).

6.1 ITU-T Registry-Registrar Model

The ITU-T defines ENUM service registration management according to the registry-registrar model. First, how ENUM records are registered and managed is described according to this model.

The ITU-T refers to the following entities as functions and responsibilities of registration and management.

- Manager (Designated Manager)

  The organization responsible for the management of the domain name.

- Registry

  The organization that operates and manages registry databases. The DNS zone file is generated from registry databases.

- Registrar(s)

  A responsible organization(s) that receives requests from registrants, verifies their data, and sends data to the registry when procedure is done.

- Registrant (Registration Applicant)

  A Applicant registering for a domain name.

The ITU-T SG2 Supplement, "National ENUM Supplement", defines roles in Tier 0, Tier 1 and Tier 2 as follows.

ENUM entities: Functions and responsibilities

Domain	(1) Manager (Designated Manager)	(2) Registry	(3) Registrar(s)	(4) Registrant (Registration Applicant)
ENUM Tier 0 e164.TLD	IAB (current time)	(Note 1) RIPE-NCC (current time)	(Note 2) ITU Bureau	The ITU member state
ENUM Tier 1 <CC> e164.TLD	The ITU member state	National matter (Member state/Administration)	National matter (Carrier, ISP, etc.)	National matter
ENUM Tier 2 <N(S)N>.<CC> e164.TLD	National matter	National matter	National matter (Carrier, ISP, etc.)	National matter (ENUM participants)

Note 1: Reseaux IP Europeans Network Coordination Centre.

Note 2: ITU-T Bureau. Assigns and manages international number resources, such as country numbers and international point codes. The official name is the ITU-TSB (Telecommunications Standardization Bureau of the ITU).

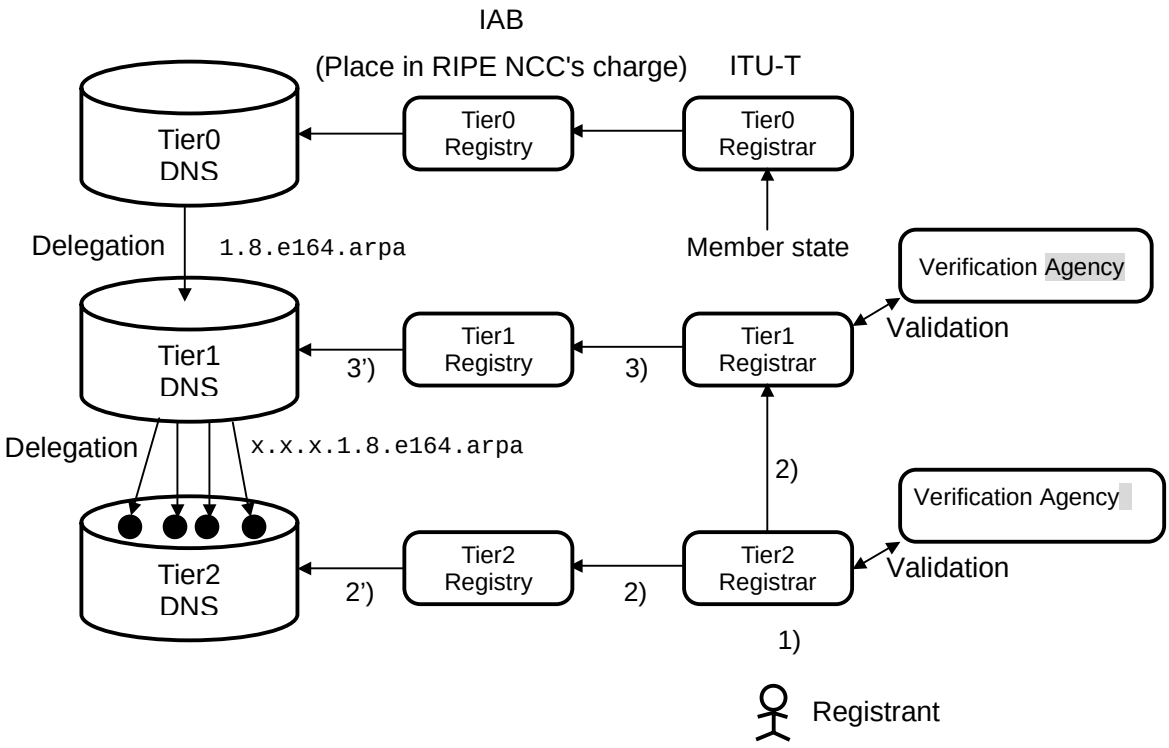
Source: 2nd meeting of study group concerning telecommunication numbers (of the year 2002) within the Ministry of Public Management, Home Affairs, Posts and Telecommunications.
2-2 Trend of ITU-T SG2 standardization regarding ENUM, page 7

☞ http://www.soumu.go.jp/joho_tsusin/polcyreports/chousa/bango/pdf/020704_2_02.pdf

Tier 1 and Tier 2 implementation is a national matter.

6.2 Registry/Registrar Registration Update Flow

In the registry-registrar model, the main flow of registration from registrants to the DNS is as follows:



1) The registrant applies for a registration update to the Tier 2 registrar.

2) As required the Tier 2 registrar asks the provider of the telephone services, who assigned an E.164 number to the applicant to ensure that this applicant is the only assignees of numbers, and if valid, it applies for a registration update to the Tier 2 registry. If the application is a new registration or a Tier 2 registry change (e.g., if details of the Tier 1 registration need to be modified), it must apply for a registration change with the Tier 1 registrar.

2') The Tier 2 registry updates the registry database, and then generates a Tier 2 DNS zone file.

3) The Tier 1 registrar checks the content of the application, and if it is valid, it applies

for a registration update to the Tier 1 registry.

3') The Tier 1 registry updates the registry database, and then generates a Tier 1 DNS zone file.

6.3 Registrar Checkpoints

The registrar receives a registration update application from a applicant, checks its content, and if it is valid, it forwards it to the registry.

Checkpoints are as follows:

- Applicant authorization. Verify identity of the applicant.

- Applicant authority validation. Check whether the applicant is qualified for application. The Tier 2 registrar verifies that the applicant is a applicant of a corresponding E.164 number and the Tier 1 registrar verifies that the applicant (Tier 2 registrar) is a Tier 2 registrar that manages corresponding NS records.

- Validation of details of application. Verify that the contents of registration update from the Applicant are appropriate. The Tier 2 registrar verifies that the details of the application are appropriate as a NAPTR record with the corresponding E.164 number, and the Tier 1 registrar verifies that name server information in the application is within the range of the domain names managed by the applicant.

6.4 Registration Management Information

Registries and registrars retain information about registrants as well as registration details to maintain and manage ENUM services. In addition, they generate DNS zone files according to the contents of applications, and open them to the public on the Internet as the DNS-service, and publicize part of them through a WHOIS interface.

Main registration contents, management entities and publicizing methods are summarized as follows:

Registration contents	Holder	Public Information by DNS	Public Information by WHOIS
E164 number	Tier 2 registrar/registry	○	○
NAPTR record	Tier 2 registrar/registry	○	○
Registrant name	Tier 2 registrar/registry	―	△
Contact	Tier 2 registrar/registry	―	○
Address	Tier 2 registrar	―	△
Authentication information	Tier 2 registrar	―	― 1)
Accounting information	Tier 2 registrar	―	― 2)
Tier 2 NS-RR	Tier 1 registrar/registry Tier 2 registrar/registry	○	○
Tier 2 name	Tier 1 registrar/registry	―	○
Contact	Tier 1 registrar/registry	―	○
Authentication information	Tier 1 registrar	―	― 1)

1) Authentication information, such as passwords and public keys

2) Credit card number, account number, etc. In case of Tier 2 registry accounts registrants

6.5 Registration Procedure Variations

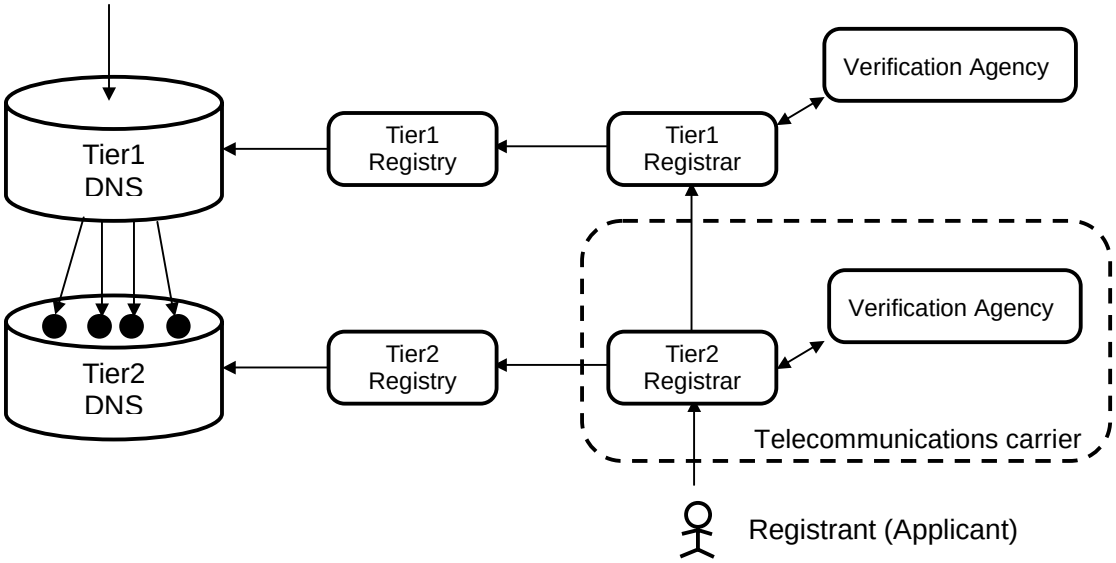
In Japan, E.164 numbers are assigned to telecommunications carriers. Since the numbers are assigned for the business of telecommunications carriers, the business purpose and use of ENUM must be consistent.

Variations in registration procedures when using existing E.164 numbers for ENUM services are provided.

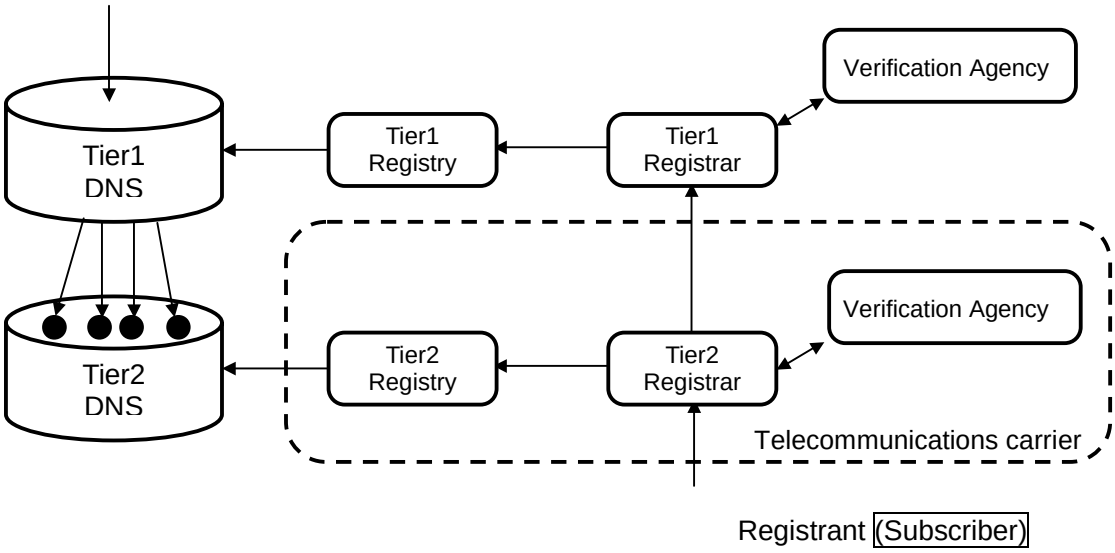
To actually implement ENUM services, it is not necessary to use only one registration procedure, but an original registration and management procedure can be used for each number space (carrier number assignment unit).

6.5.1 Registration Model 1

A telecommunications carrier receives an application from a subscriber applicant and updates Tier 2 DNS through a Tier 2 registry. Here, the telecommunications carrier has alsoTier 2 registrar functions.

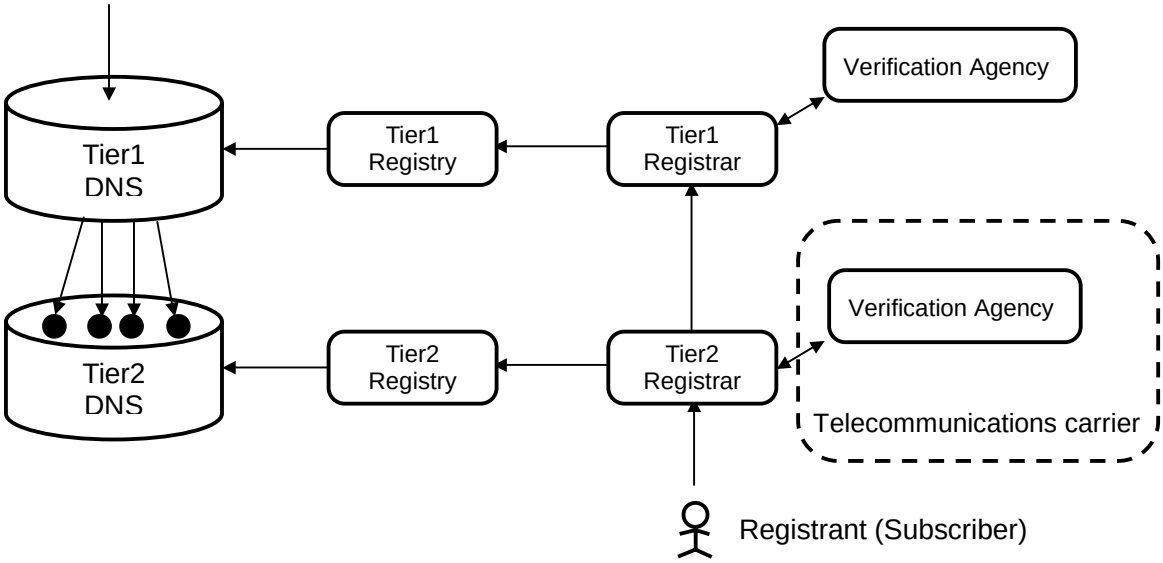


As a variation of this model, the telecommunications carrier has Tier 2 registry functions as well. It also manages Tier 2 registry databases and generates DNS zone files.



6.5.2 Registration Model 2

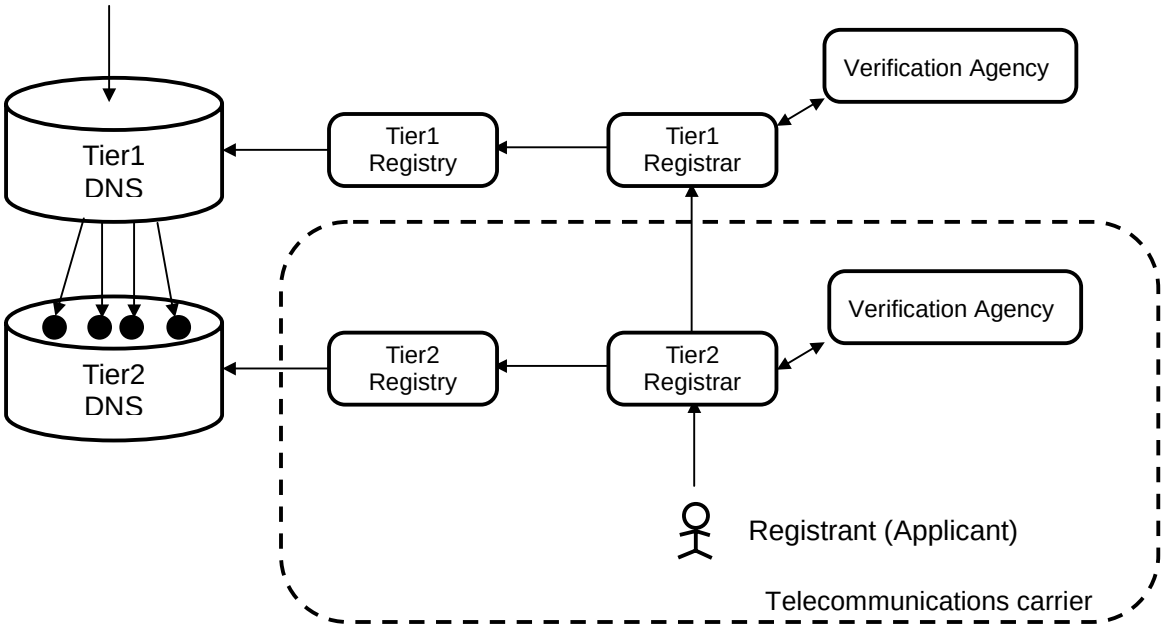
Tier 2 registrars, which are not telecommunications carriers, receive registration applications. Telecommunications carriers supports the validation of number assignments and approve the identity of those requesting ENUM records.



An ISP or another carrier works as a Tier 2 registrar in this model.

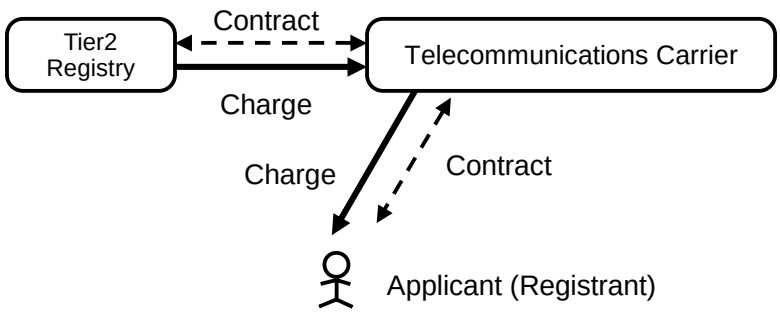
6.5.3 Registration Model 3

Telecommunications carriers set call termination using an ENUM service for that number. In this model, carriers register the ENUM record as an Operator ENUM to implement the service. Therefore, records for E.164 numbers are registered regardless of the intention of the applicant.



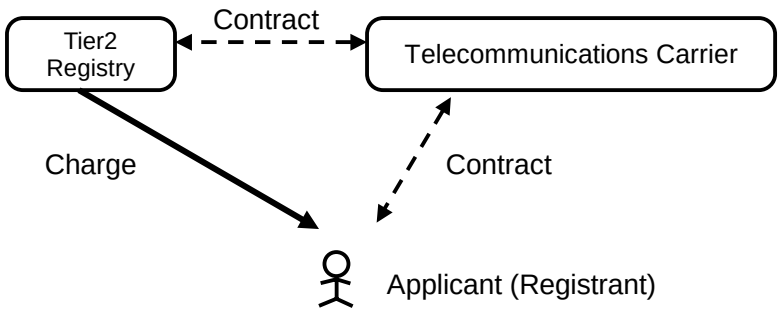
6.5.4 Accounting Model 1

- The registry charges telecommunications carriers.
- Each telecommunications carrier charges applicantapplicants (registrants) based on contracts with them.



6.5.5 Accounting Model 2

- The registry charges applicants (registrants).
- Applicants (registrants) may sign up with registries in advance.



6.6 Registration Policies

As previously described, E.164 numbers are assigned to telecommunications carriers in Japan. Since the numbers are assigned for the business of telecommunications carriers, the business purpose and use of ENUM must be consistent.

It is necessary to establish a mechanism in which a telecommunications carrier that is assigned a number creates a registration policy, and when registering to ENUM, the telecommunications carrier makes registrations according to the policy.

Several examples of registration policies are given below. Actual registration policies are combinations of these policies.

- **Enforcement**: Telecommunications Carriers enforce registration regardless of the intention of applicants to terminate telephones serviced by them. Standard registration policy in Operator ENUMs.

- **Selection**: Users register of their own free will. This concept is called opt-in. Standard registration policy in User ENUMs.

- **Service limitation**: A limitation of services that can be registered. For example, TEL URI and MAILTO URI of a number only.

- **Service and parameter limitation**: For example, limitation to a certain SIP proxy when the sip is registered.

- **Priority limitation**: For example, when a number is registered, the TEL URI of the number or the SIP URI specified by a telecommunications carrier is registered as a highest priority record.

7. Personal Information Protection, Security and Reliability

7.1 Personal Information Protection

Since ENUM services and communications between Internet users are used personally in many cases, personal information protection must be carefully considered. Policies and procedures for handling personal information and related information of ENUM users, which are handled by ENUM services, must be clarified.

Information handled by ENUM services are classified into three categories:

(1) Information registered in the DNS, specifically NAPTR records and parameters contained in them.

(2) WHOIS information. Registrant information, registrant name, contact address, etc.,of domain names publicized for Internet operation management. This public information is generally called WHOIS.

(3) Customer information. Information on registration management, registrant identification and payment , all of which are retained by registries/registrars.

Policies for handling information are different according to each category.

As a rule of handling personal information, it is necessary to explain the purpose of information collection for each category to registrants and obtain their approval in advance. That is:

- Registered NAPTR information is open to the public by the DNS.
- The points of contact of registrants are open to the public by WHOIS. The purposes of WHOIS are:
  - To manage distributed operations of the Internet.
  - To enable registrants confirm their registration information.

Information other than public information must be managed appropriately for system

and handling procedures. It is necessary to establish a mechanism that prevents its use for any other purpose or outflow. Furthermore, what needs to be questioned is the necessity of collecting or storing personal information such as age or sex, which is not necessary for rendering ENUM services.

It is necessary to pay attention to the trends of personal information protection and of handling personal information on the Internet.

Each of the categories is discussed below.

DNS Information

All information registered on the DNS is open to the public . It is required that appropriate anonymization are taken so as not to include information on personal identification in URIs that are registered in NAPTR records to protect personal information as much as possible.

For example, instead of registering mailto:yamada@exmple.co.jp that suggests a user named Yamada for mailto: information, one might instead register mailto:aci2hnwz@exmple.co.jp as NAPTR,choosing the random user name aci2hnwz. The mail server associates aci2hnwz with Yamada. This can hide the fact that the user corresponding to the E.164 number is Yamada.

WHOIS Information

As for WHOIS information, rules for publicizing registration information for maintaining distributed management on the Internet and personal information protection are being discussed by ICANN. With this study in mind, it is necessary to create and execute information policies that address both Internet operation management and user personal information protection.

Customer Information

It is necessary to manage confidential data appropriately so that information that does not need to be disclosed – i.e. registrant authentication information, including passwords, bank account numbers and credit card numbers for accounting, etc.) –

can be accessed only by those who need them in operaters. In addition, system security measures must be taken to prevent illegal access to information from outside.

7.2 Access Control

DNS information is open to the public on the Internet wide and any Internet user can access registration information in principle. Since ENUM uses global name spaces called E.164 numbers as keys, association of E.164 numbers with applications on DNS single trees is consistent with this principle of the DNS.

On the other hand, registered users or service providers do request that ENUM communication services be restricted from their service styles.

Since the DNS is a system opened to the public as a principle, it is difficult to strictly limit users who send queries. Therefore, it is difficult to strictly limit users of ENUM based on the DNS.

BIND has functions of access control list (ACL) that restricts IP addresses of clients who send queries. A split DNS mechanism can be implemented to divide DNS trees for each user. This access control cannot work as expected in some cache server operations.

In addition, ENUM (DNS) is the only mechanism, that maps numbers to URIs, so if a URI is known by some method, it can be used to access services directly.

To restrict services to specific users, the access restriction function of an actual application (SIP, mail, etc.) should be used finally.

7.3 Security Measures

ENUM services are based on DNS. Therefore, it is necessary to classify problems into ENUM-specific problems, problems attributable to the DNS, problems concerning communication services (including ENUM) and problems caused by network systems on the Internet when discussing ENUM service security.

This classification is important because a different entity (community) creates policies, takes actions and makes adjustments depending on the category.

It is necessary to explain risks to ENUM users in advance. It is necessary to restrict high-risk services to users who, only after the risks have been explained, give their assent.

ENUM-specific problems

- Spoofing (Applicant identify theft)
- Registration data alteration or invalid information registration
- Exhaustive look-ups
- DOS (denial-of-service) attacks to registration systems

Problems attributable to the DNS

- DNS query interceptions and DNS response alteration/forgery
- DNS server spoofing
- Zone transfer error, alteration with zone files
- Cache server poisoning
- DOS (denial-of-service) attacks to DNS servers

Problems concerning communication services, including ENUM

- Communication interception, alteration
- Spoofing (Caller authentication, caller notification)
- Receiver authentication
- Unsolicited e-mails ,Spam mail
- Congestion measures

- DOS (denial-of-service) attacks to other parties or servers

Problems caused by network systems on the Internet

- System intrusion and destruction, information outflow
- Disaster measures

7.3.1 ENUM-Specific Problems

Registrant spoofing

An attempt to register, update or erase ENUM information by spoofing registrants. To prevent this, it is necessary to authenticate registrants and check the validity of data updates appropriately.

If an accident occurs, it is important to establish a mechanism that restores the system to its original state before the accident.

Registration data alteration or invalid information registration

Registration of NAPTR records that are not allowed to be registered or registering URIs. When a registrant registers an address of another person that is not allowed to be registered.

Exhaustive look-ups

Since ENUM name spaces have continuous numbers, there is a high possibility that malicious exhaustive look-ups occur frequently. However, it is difficult to prevent exhaustive look-ups on DNS with the current DNS techniques.

Since most providers offer a flat rate for Internet telephone service, it is expected that junk telephone and spam telephone calls, like spam mail, occur frequently.

Mail address lists contained in NAPTR can be obtained easily by exhaustive look-ups.

There are several measures for WHOIS, such as the restriction of users and a regulation on access capacity, but it cannot be solved completely.

Services must be developed that will assume that information publicized on the Internet by DNS and WHOIS will be subject to exhaustive look-ups in ENUM services. For the Internet telephone, SIP sender authentication and access control must be managed properly.

DOS (denial-of-service) attacks to registration systems

Like general Internet service nodes, registration systems may be subjected to DOS attacks. Since registration systems are not so time critical as DNSs, it is sufficient to detect DOS and take appropriate action as usual.

7.3.2 Problems Attributable to the DNS

Security problems with DNS servers are well known, and techniques, such as DNSSEC and TSIG, are being technically developed as countermeasures. However, the root causes of those problems are not fixed, and critical security incidents are prevented by careful operation works. When creating ENUM services, it is necessary to understand DNS operation know-how to build and operate systems and promote technological developments, such as DNSSEC and TSIG.

Issues on DNS security are listed below.

DNS query interception and DNS response alteration/forgery

This is done by listenening to communication paths between a DNS client and a server, obtaining a query ID and returning a fake response using this ID.

DNS server identify theft

Causes clients to set false DNS servers.

Zone transfer error, alteration with zone files

Blocks transfers of zone files or tamper with them between the primary server and the secondary server.

Cache server content forgery

A special query is sent to a cache server to tamper with content on the server. This is called a Cache Poisoning attack.

DOS (denial-of-service) attacks to DNS servers

This attack sends a large number of queries to a DNS server to disable its services.

7.3.3 Problems Concerning Communication Services Associated with ENUM

ENUM service is just the first part of the connection in communication services on the Internet. Security measures are required while linking with services (SIP, H323, mail, etc.) following ENUM queries.

Communication interception and alteration

ENUM service is a mapping service that identifies communication partners and does not mediate communications. The confidentiality of the contents of communications and the prevention of alteration must be implemented by a protocol after connection.

For SIP, it is advisable to use TLS between a SIP UA and a SIP server or to operate RTP with IP Sec during communications. In case confidentiality is required for mail, S/MIME or PGP can be used.

Which records are queried from which IP address could be obtained from a log of DNS queries. Since most queries to a name server are queries from a cache server of ISPs or user organizations, the communication partners of each user cannot be easily identified.

However, logs must be managed appropriately.

Spoofing (sender authentication, sender notification)

Spoofing – (i.e., falsification of a sender address or telephone number) – is technically easy if the appropriate measures are taken.

Same as communication interception and alteration

Receiver authentication

Same as communication interception and alteration

Unsolicited e-mails, spam mail

In ENUM, mail addresses can be obtained by using telephone numbers as keys, so unsolicited e-mailing may occur. Spam mail may be forwarded as a result of exhaustive look-ups.

Authentication and access control are effective means of solving this problem. This must be considered thoroughly when building services, and authentication and access control functions must be provided to users.

DOS (denial-of-service) attacks to other parties or servers

It is necessary for service providers or ISPs to monitor and to take appropriate measures against DOS attacks that send a lot of packets to communication partner servers or terminals.

7.3.4 Problems Caused by Network Systems on the Internet

ENUM service has system-related issues like general network systems on the Internet. Typical examples are given below.

System intrusion and destruction, information outflow

There may always be the possibility of system intrusion and destruction by attacking the vulnerabilities of a system.
Attackers may access or modify confidential registration data after intrusion.

Therefore, security policies must be applied and general security measures, such as network access restrictions, countermeasures against vulnerabilities and a monitoring mechanism, must be implemented.

Disaster measures

A backup system must be established, assuming that the system may be damaged when disasters occur.

7.4 Availability Maintenance

It is necessary to maintain ENUM service availability. The requirements of registration change service are very different from those of DNS service. The parameters are as follows:

- Performance (response time)
- Failure rate
- Measures against disasters
- Measures against congestion and DOS (denial-of-service) attacks

Parameters must be specified as service level (service quality) and measures must be taken.

User ENUM services are basically part of the services on the Internet, so the service level should be set and implemented in the same way as for the service level of the conventional DNS service on the Internet.

If a service level is set higher than the normal Internet service for Operator ENUM services, some measures, such as the addition of DNS servers (secondary server, cache server) must be taken.

7.5 DNS Reliability

One means of improving the reliability of DNS service requires the installation of one or more DNS secondary servers, e.g. more than one DNS servers can be installed to manage specific DNS zones. The server that manages the master data is called the primary server, and the sever that has a copy of the master data is called the secondary server.

If registry data contents are updated, they are sent to the primary server. The primary server notified the change to all secondary servers. Each of the secondary servers sends a zone information transfer request to the primary server and updates its contents to synchronize the data between the primary server and secondary server.

Up to 10 secondary servers can be installed due to DNS protocol restrictions.
The number of servers can be increased by using an anycast technique, but provider independent eIP addresses and AS numbers must be assigned.

8. Conclusion

Since its establishment on September 11, 2002, the ENUM Study Group has held workshops every month and held subgroup meetings to deepen understanding of ENUM techniques, classifying ENUM services into User ENUM and Operator ENUM, and working on them. On the other hand, it has been studying legal and institutional issues in cooperation with the "Study Group Concerning Telecommunications Numbers" and the "ENUM Discussion Sub-Group" established inside the Ministry of Public Management, Home Affairs, Posts and Telecommunications (MPHPT). As a result of the discussions, understanding of ENUM has been deepened and many issues have become clear.

ENUM has been standardized internationally by the IETF , ITU-T and other organizations as a technique for registering E.164 numbers as domain names. In Japan, it was first introduced as a means of implementing IP telephony in the "Study Group Concerning IP Network Technology" in the MPHPT, and ENUM has started to receive widespread attention. This ENUM Study Group started its activities based on this concept. This concept is defined in this report as an application under the category of Operator ENUM.

IP telephone services are currently being developed, and several methods of interconnection between carriers and with the PSTN (public switched telephone network) are being studied by IP telephone carriers in cooperation with each other or individually. Under these circumstances, it may be premature to say that there is a strong need for ENUM itself at the present stage. The needs for a User ENUM in which users register by themselves are not actualized now.

However, the need for ENUM techniques are expected to increase rapidly as interconnection requests through more open interface between carriers, proliferation of the Internet telephone and requests for application identification other than telephone with E.164 numbers grow more intensified. And the situation of course varies depending on the trends of other countries.

To build and use ENUM techniques as services, a lot of technical, institutional and business issues must be solved and examined continuously.

Appendix A Telecommunications Numbers

A.1 Numbering Plan in Japan

In Japan, telecommunications numbers are managed by the Ministry of Public Management, Home Affairs, Posts and Telecommunications according to the "Telecommunications Business Law", and specific management procedures are specified in the "Telecommunication Numbering Plans".

Telecommunications numbers are assigned to telecommunications carriers to provide telecommunications services. For telecommunications numbers, business types for assignment and identification objects are specified according to ranges of numbers.

Major telecommunications numbers are as follows:

0ABCDEFGHJ

- These are telecommunications numbers for identifying transmission line facilities for fixed terminals .
- They are assigned to telecommunications carriers by FGHJ and carriers are identified by ABCDE.
- Normally, these are called 0AB-J numbers.

050CDEFGHJK

- These are telecommunications numbers for identifying voice transmission services rendered to terminal facilities, etc. connected to packet switched networks. However, if the Minister of Public Management, Home Affairs, Posts and Telecommunications deems it necessary, 0AB-J numbers are assigned.
- They are assigned to telecommunications carriers by GHJK and carriers are identified by CDEF.
- These numbers are designed for use in IP telephony (in a broad sense).
- A certain level of communication quality and reliability are required for assignment.

070CDEFGHJK

- Telecommunications numbers for terminal transmission line facilities for PHS（Personal Handy-phone System）.
- They are assigned to telecommunications carriers by GHJK and carriers are identified by CDEF.

080CDEFGHJK
090CDEFGHJK

- Telecommunications numbers for identifying mobile terminal transmission line facilities
- They are assigned to telecommunications carriers by FGHJK and carriers are identified by CDE.

There are other telecommunications numbers for “Toll Free Phone” service (0120DEFGHJ)), “shared charging Service” (0570DEFGHJ), etc.

For details, see Telecommunications Number Rules.

A.2 Telephone Number Management Authority

Telephone numbers (telecommunications numbers) are assigned to telecommunications carriers that own facilities or telecommunications carriers that render applicable services by the Ministry of Public Management, Home Affairs, Posts and Telecommunications, and are managed by telecommunications carriers. On the other hand, with User ENUM, users associate telephone numbers in NAPTR records with URIs, so they must manage accessibility to the associated URIs.

In any case, issues that must be managed concerning telephone numbers must also be considered in ENUM. (Example: A telephone number changing for some reason, such as “*Rapid Telephone Number Consumption”* (rapid use of telephone numbering resources))

A.3 Use of Telecommunications Numbers for Other Purposes

By using existing telecommunications numbers, the identification of services and applications other than "services and facilities that are actually identified" must be clarified in the legal and institutional aspect.

For the reason, since service may become impossible for the telephone carriers who are assigned of telecommunications number, it is necessary to prepare restrictions in the number block that can be registered, or to examine preparing restrictions (registration policies) in the registered contents (registration policies).

Clarification of Roles/Responsibilities/Management Authority of Assigned Carriers and Registered Users

A.4 Assignment of Telecommunications Numbers for ENUM

If User ENUM is developed, an assignment of telecommunications numbers for identifying ENUM records must be thoroughly discussed.

As telecommunications numbers are being used up, they cannot be assigned without careful consideration, although it is necessary to reexamine about the target of identification and assignment management system of the telecommunications numbers aiming at identification of voice service and telephone facilities.

The assignment of telecommunications numbers used for records for the above-mentioned User ENUM has not been sufficiently studied at this stage, but ENUM trials should be conducted for technical verification, there may be a scheme that assigns experimental telecommunications numbers that do not affect existing telecommunications numbers.

If experimental telecommunications numbers cannot be assigned, only the telephone numbers already assigned to experiment participants will be used, and therefore it may restrict the trials.

A.5 Handling of Special Numbers

The handling of special numbers used for emergency reporting, such as 110,118 and 119, in ENUM, must be examined. Here, only lists some possible solutions. If special numbers for emergency reporting through the Internet telephone are to be considered, the following points should be addressed:

a) Handling of special numbers in international name space.
b) Mechanism of name resolution that depends on sender location.
c) Various functions at connection time.

Special numbers for emergency reporting are determined by each country, so they are not consistent internationally. For example, the call number for the police is 110 in Japan, but in the U.S.A. it is 911. ENUM service uses DNS, and it manages global name spaces and returns the same response regardless of the query location, So, it is difficult to perform name management that differs with each sender country, such as with special numbers.

In addition, special numbers are not included in the E.164 number scheme, so it will be necessary to assign telephone numbers for emergency transmission for ENUM in the space under the ENUM tree.

For example, even if 0.1.1.1.8.e164.arpa is introduced, further study will be required.

Various functions, such as connection based on sender location, are required especially for emergency reporting. It is difficult to implement these functions using only ENUM.

List of ENUM Study Group Members

Members (in the order of the Kana syllabary; without titles)

- Shingo Ichii
- Japan Internet Forum
- Infosec Corporation
- NTT Communications Corporation
- Oki Electric Industry Co., Ltd.
- KDDI Corporation
- Shigeki Goto
- JENS Corporation
- The Telecommunication Technology Committee
- Telecom Services Association,
- POWEREDCOM, Inc.
- Nissho Electronics Corporation
- Nifty Corporation
- Japan Cyberspace Corporation
- Japan Telecom Co., Ltd.
- NEC Corporation
- Nippon Telegraph and Telephone Corporation
- Japan Network Information Center
- Japan Registry Service Co., Ltd.
- Net One Systems Co., Ltd.
- Fusion Communications Corporation
- Fujitsu Limited
- Mitsubishi Corporation

Observer

- Telecommunication Systems Division, Telecommunications Business Department, Telecommunications Bureau, Ministry of Public Management, Home Affairs, Posts and Telecommunications

Secretariat

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