A Telephone Domain Name System (T-DNS) for Internet Telephony Service at All IP Network

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Abstract: - Lately, Internet is generally accepted as a principle communication protocol for voice and data networks. Moreover data and voice is converging with one network over the Internet. Each node has its own IP address for existing packet data on the Internet. Even multi-media terminals including Internet phone, Internet fax, and Internet-enabled electric devices, are transferring variable-sized packets. There are several working groups for studying converged data and voice communication in Internet. Such converged network services especially for Internet telephony as Voice over IP (VoIP) or SoftSwitch have already been suggested. We believe that the VoIP service become a killer application on the Internet for the future. Many protocols such as Session Initiation Protocol (SIP), Media Gateway Control Protocol (MGCP), MEGACO, SIGTRAN of Internet Engineering Task Force (IETF) and H.323 series of International Telecommunication Unit (ITU-T), are accepted as standards required for the VOIP service.

In this paper, we suggest a Telephone-Domain Name System (T-DNS) architecture for detecting simply the destination IP address at the converged network. T-DNS is based on a Client and Server and an original Internet Domain Name Service (DNS) model. But it expands the DNS architecture for detecting destination IP address by querying the Uniform Resource Locator (URL) of telephone numbers. T-DNS client is responsible for converting a user-requested phone number to a telephone number architecture called a phone URL, and resolving the phone URL to the destination IP address. T-DNS is providing a simple connection solution between calling and called parties by resolving each IP address from a telephone number over the converged IP network. This architecture is effective on the interworking area of various protocols such as SIP, MGCP, H.323.

Key-Words: Domain Name System, all IP Network, VOIP, Telephone DNS

1 Introduction

The Internet is expanding at an exponential rate. With the growth of the Internet, there are several working groups for studying converged data and voice communication. Such converged network services especially for Internet telephony as Voice over IP (VoIP) or SoftSwitch have already been suggested. We believe that the VoIP service become a killer application on the Internet for the future. Many protocols such as Session Initiation Protocol (SIP), Media Gateway Control Protocol (MGCP), MEGACO, SIGTRAN of Internet Engineering Task Force (IETF) and H.323 series of International Telecommunication Unit (ITU-T), are accepted as standards required for the VOIP service [1-5].

Basically, each network node including an Internet Phone or a multimedia terminal, has its own IP address and communicates with TCP/IP protocol. The VoIP phone must have a telephone number as well as an IP address in order to inter-work with existing telephone network. Traditional telephone has to call to VoIP phone and vice verse. A H.323 or SIP client, is able to be identified with an e-mail address, a domain name or an E.164 phone number. A special server, Gatekeeper or SIP location server, was designed for resolving destination e-mail addresses, domain names, or E.164 phone numbers. But most of other node computers on the Internet have fully qualified domain names (FQDN) and IP addresses. Such names have to be registered at a local DNS server in order to identify uniquely[6][7].

In this paper, we suggest a Telephone-Domain Name System (T-DNS) architecture for world-widely identifying destination E.164 phone numbers at the Internet-based converged network. T-DNS is based on the Client-Server model of original Internet Domain Name System. We expand the DNS architecture for

resolving an IP address from an E.164 phone number. In addition, this architecture includes such hierarchical telephone numbers as a national code, a geographic code, a local code and a user phone number. T-DNS can provide a simple identifying mechanism for E.164 telephone number by means of name resolution of DNS. This architecture is applicable to the call control function independent on any VoIP protocols.

Furthermore T-DNS can handle the IP optional field to not only transfer source and destination phone numbers for Caller ID Display(CID) service but also convert IP addresses to phone numbers and vice verse at a media gateway[8].

This paper is organized as follows: Section 2 suggests Telephone Domain Name System architecture and section 3 presents the Telephone DNS(T-DNS) service model. Section 4 describes call setup and data transfer procedures using T-DNS. This paper is concluded in section 5.

2 The Architecture of T-DNS

The VoIP phone must have a telephone number as well as an IP address in order to inter-work with existing telephone network. An IP address is identifying end IP terminal and a phone number is inter-working with existing telephone system. There are several signaling protocols for resolving an E.164 phone number to an IP address such as H.323 protocol, SIP protocol and MGCP protocol. Each protocol has registration server for resolving a destination address by differently represented address. This section consists of requirements and address representations.

2.1 Requirements of T-DNS

The requirement of VoIP service is as follows: location services, call controls, and voice data communications. Location services are registering its private resources, identifiers, capability of terminal, and mobility. Call controls have a role of making a call from source to destination. Proposed T-DNS architecture has consists of several functions, naming services of E.164 phone numbers, An E.164 address representation, E.164 address translations, and resolving E.164 address. Supporting these requirements, T-DNS architecture has several functional requirements as follows:

- To be a naming service for phone number
- To be a representation of Telephone number
- To translate from a represented phone number to fully qualified domain name (FQDN)
- To query IP address from FQDN

These requirements are attained by simply modification original DNS system.

2.2 Address representations of VoIP protocol

There are several protocols for VoIP services such as SIP, H.323, and MGCP. Session Initiation Protocol (SIP) was developed by Multiparty Multimedia Session Control(MMUSIC) working group of Internet Engineering Task Force (IETF). SIP has several destination identifier, an E.164 phone number, an e-mail address, and an IP address. The representation format of SIP is *sip:foo@bar.com*, so called SIP Uniform Resource Locator(URL). A SIP client must resolve the destination SIP URL with a SIP location server. If the end user is a phone user, then SIP could supplement the URL with the term user=phone, like *sip:8601211@etri.net; user=phone*.

H.323 series are specified by International Telecommunication Union (ITU) recommendations. H.225, a call signaling protocol, is similar to ITU-T recommendation Q.931, ISDN signaling specification. H.323 terminal has several identifier too, e-mail

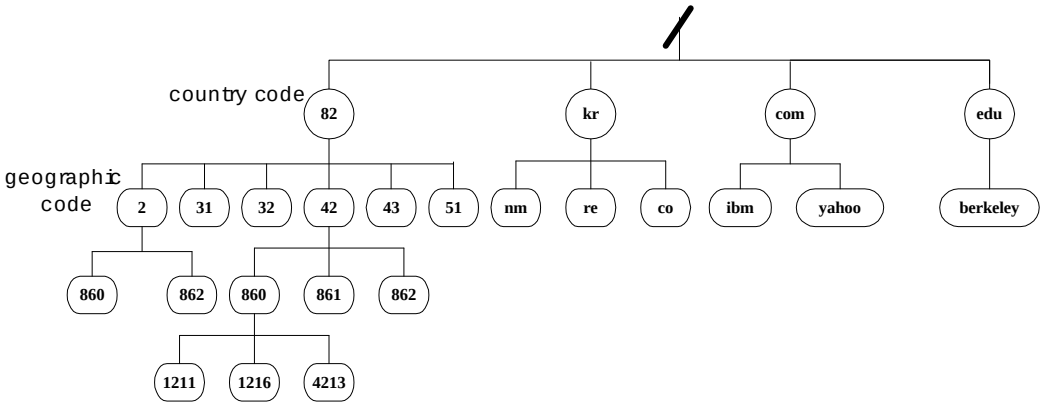


Fig.1 The Hierarchical Numbering structure of T-DNS Service

address, domain name, and E.164 number and is represented by URL like *ras://foo@bar.com* on registration. All H.323 terminals are registered to the GateKeeper by H.225 RAS(Registration, Admission, and Status) signaling. An H.323 client resolves a destination address represented by an E.164 phone number, an e-mail address, or an IP address to the gatekeeper.

MGCP is a control protocol for a Media Gateway(MG). It was developed at the IETF working group. It was co-worked with ITU-T and succeeded by Megaco/H.248. Megaco protocol handles both text encoding and a binary encoding protocol unit. A text encoding is written according to Augmented Backus-Naur Form (ABNF), described at the RFC 2234 and binary encoding is written according to Abstract Syntax Notation One (ASN.1). Megaco protocol uses the IP address format at the dialing to destination.

2.3 Address representation of T-DNS

At a proposed T-DNS architecture, an address is represented by the E.164 phone number in order to inter-work the existing telephone system. A E.164 phone number describes a phone URL as *phone:+82-42-860-1211*. At a T-DNS client, It receives unique name represented by phone URL, converts phone URL to Fully Qualified Domain Name(FQDN), 1211.860.42.82, and looks converted FQDN up the IP address to a T-DNS server.

A T-DNS server makes relationships between phone numbers and IP addresses. A T-DNS client is able to resolve the destination IP address. There is a working group to mapping E.164 telephone number, Telephone Number Mapping, enum working group on IETF. But proposed scheme is distinguished an address representation from enum working group.

3. The structure of T-DNS Service

A T-DNS service is consists of client and server model. A Client resolves an IP address from an E.164 phone number and a Server responds a resolved query message as a result of client requesting. A T-DNS server is based on the current DNS system. A DNS system has several root nodes and tree based structure from a root node. It is resembles a file system, therefore each name of a node is uniquely exist on same level of DNS system. A DNS server has to control the fully qualified domain name (FQDN).

3.1 A T-DNS Server

Fig. 1 shows a structure of the naming rules on a T-DNS server. It is an analogy structure of a phone system. A phone system has several numbering plan and T-DNS support each numbering plan. A T-DNS server is running like DNS server and responses on a client requesting.

At the Fig. 1, we show an example of an E.164 numbering plan of Korea rep, of. There is “82” as a country code of Korea, many regional codes divided by geographical location under the country code, and local number under each regional codes. The fully specified phone number with country code is shown as +82-42-860-1211.

A root DNS server knows already that which nation has the country code “82” and which DNS server managing a 82 code. A DNS server controlling 82 code knows a server location on possessing regional code of “2”, “31”, ”32”, ”41”, “42”, “43”, “51”, etc. A server which is managing “42” regional code knows a local phone code of “860”, ”861”, “862”, etc. Finally, a “860” server controls local phone numbers and has a IP address of each phone number. Several phone number has same IP address, because this phone is connected to Media Gateway (MG) and controlled by MG. At Fig. 2, It shows the example configuration of “82” domain and “860.42.82” domain.

A DNS service has an advantage of a viewpoint of distributed managing. Also in a T-DNS, a manager of “860” domain should manage his own local phone numbers like local DNS server.

```
@ in soa ns.82. sysadmin.ns.82. (
            serial,…
            )
            IN NS ns.82.
$ORIGIN 82.
2   IN   NS  2.foo.bar.
31  IN   NS  31.foo.bar.
32  IN   NS  32.foo.bar.
42  IN   NS  42.foo.bar.
43  IN   NS  43.foo.bar.
51  IN   NS  51.foo.bar.
```

```
@ in SOA ns 860.42.82     webmaster.860.42.82 (
              serial info,….
              )
              IN NS ns.860.42.82
$ORIGIN 860.42.82
1211 IN  A   129.254.192.130
1216 IN  A   129.254.130.18
4213 IN  A   129.254.130.33
5213 IN  A   129.254.170.45
```

Fig 2. A example configuration

3.2 T-DNS Client

A T-DNS client is in charge of replacing E.164 phone number to FQDN, and requesting a resolve message to a DNS server. For examples, an E.164 phone URL like *phone:+82-42-860-1211* has to be converted FQDN name like "1211.860.42.82" for resolving. A server simply responses the IP address of a FQDN "1211.860.42.82" as the same way of original DNS architecture. If a local phone requests a phone number without a country code, then a T-DNS client adds up the country code to the pushed destination phone number. If a local phone has the phone number without a country and a regional code, then a client recognizes the same country and regional code with the source phone. At a table 1, it shows the adding up a hidden number to the pushed destination phone number on a client.

Table 1. Added number for full phone number

Missing code	Original number	For FQDN
Country code	042-860-1211	+***82***-42-860-1211
Regional code	860-1211	+***82-42***-860-1211
Sub-region code	1211	+***82-42-860***-1211

An Internet FAX service is similar to proposed Telephone-DNS architecture except to a fax URL, *fax:+82-42-860-1211*. From the viewpoint of the application, a Fax service does not differ from a Internet telephone service.

4 Call Setup and Data Transmission

4.1 Call Setup

A basic call setup is depending on the standard VoIP protocol, but there is simple modification from original call setup flow on a VoIP phone client. First of all, a VoIP phone client resolves a destination IP address from a pushed destination phone number. After resolving the destination IP Address, source phone starts the call setup processing using SIP, H.323, or Q.931 protocols. Call setup processing is not depending on the T-DNS architecture, but it rely on a original call setup procedure of a used VoIP Protocol. Therefore an end node makes a new call using already resolved information, a source E.164 phone number, a source IP address, a pushed destination E.164 phone number and a destination IP address resolved by T-DNS architecture.

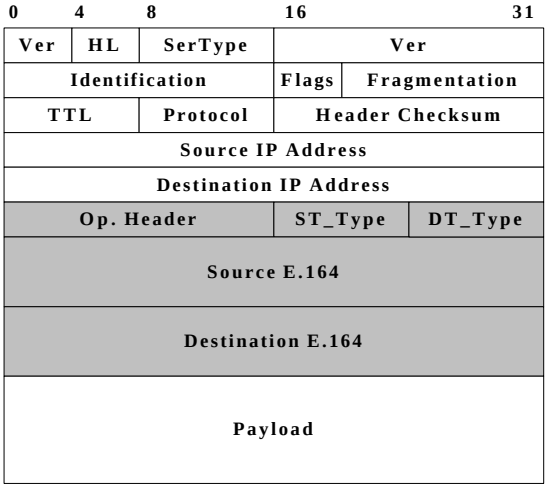


Fig. 3. IPv4 Header format with phone number

Sometimes, a phone number on a procedure of call setup is required across a Media Gateway. A Media Gateway needs existing phone numbers connected its local ports and an its IP address, and inter-works an existing phone system and an Internet phone system. For giving the simplify connection between Internet phone and existing phone system, Source and destination E.164 phone numbers are at the optional field of the IP header when a call setup is flow across the Media Gateway. At a figure 3, it shows the IP header format contained with source and destination E.164 phone numbers on the optional field. An IP optional field is used for distinguishing each stream flows on a Media Gateway. This extended call setup procedure provides an unique identification at a Network Address Translation (NAT) of Media Gateway device. A Media Gateway is an end point of a VOIP protocol and the other end point of a PSTN signal. An extended call setup is efficient on a Media Gateway, for already identified source and destination E.164 phone numbers and source and destination IP addresses.

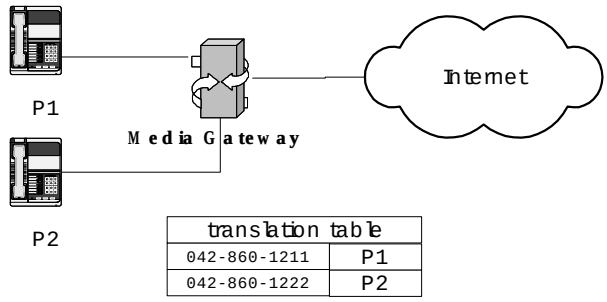
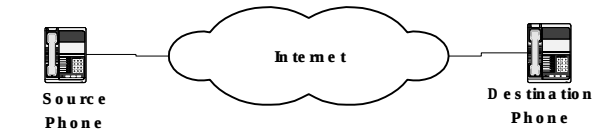


Fig. 4. NAT translation on Extend Call Setup

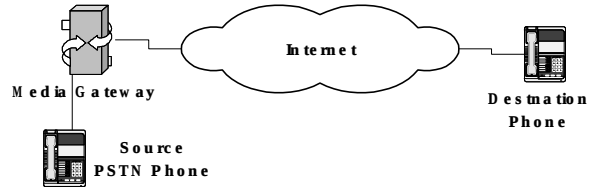
4.2 Data Transmission

At a fig. 5, there are three types of connection between source and destination terminals, an Internet phone to an Internet phone, an Internet phone to a PSTN phone with a Media Gateway, a PSTN phone with a Media Gateway to a PSTN phone with a Media Gateway. At a type (a) connection of a Fig. 5, a source phone has IP address and an E.164 phone number and the destination IP address as a result of querying the destination E.164 phone number by T-DNS client. At a type (b) connection, There is a Media Gateway on converting and translating a media and signal. A Media Gateway has a T-DNS client for resolving the IP address from an E.164 phone number. On going a call control, a Media Gateway translates a destination phone number, resolves the destination IP address, and makes a call connection between a source phone and a destination phone.

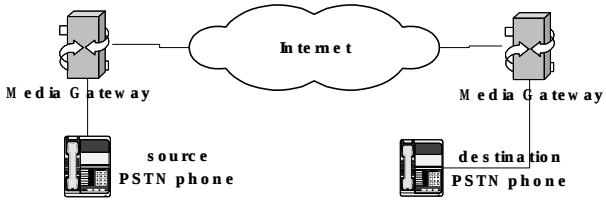
At a type (c) connection, There are two times convesion on the Media Gateway, but it is similar to type (b) connection. At a source phone, it sends a destination phone number to Media Gateway, Media Gateway decodes the source phone number by the port, position, or other signal and takes the destination phone number and resolves the destination IP address by requested destination phone number. A source phone number, a source IP address of a source side Media Gateway, a destination phone number, a destination IP address of the destination side Media Gateway are added to IP frame on the call processing procedure.



(a) Internet Phone to Internet Phone connection



(b) PSTN with MG to Internet Phone connection



(c) PSTN with MG to PSTN with MG connection

Fig. 5. Different types of connection

As a result, at the data transmission, each phone and Media Gateway insert the phone number like an E.164 into the optional filed of an IP header format and send IP packet containing both Real Time Protocol(RTP) header and voice data to the destination phone or a Media Gateway. At the Media Gateway, It distinguishes the received packet as a destination phone number contained an IP optional field.

An extended call setup and data transmission is different from the suggested Media Gateway control protocol (MGCP) of the IETF. And suggested setup procedure is not need the MGCP protocol on the Media Gateway.

5 Conclusion

T-DNS resolving an IP address from a destination E.164 phone number at the IP-based voice and data converged network is proposed. We believe that suggested standard VoIP protocol and service model is very complex to deploy and to inter-work among several different protocols. However proposed T-DNS architecture provides very simple call setup and communicates VoIP phone and PSTN phone. Futhermore, T-DNS architecture can provide inter-operability between H.323 and SIP networks. T-DNS is going to be popular, since DNS is already converged world-widely and gracefully served on the Internet.

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