ENUM

Driving Convergence in the Internet Age

NeuStar

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Introduction to ENUM

The average business card today lists a host of information on how to find an individual. At the least, it lists company, name, address, telephone number, fax number, email address, and web site URL. It is a great deal of information for one small, 2" x 3.5" card, and also a great deal of information for a person to remember.

But what if a business card could list a single point of contact for all media? What if a person could be reached using the information contained in one line of information, instead of three or four? Is it possible that network elements can be enabled to find services on the Internet using only the twelve keys on a telephone keypad? How can telephone numbers be used to access Internet services?

ENUM was developed as an answer to many of these questions. It is a solution to the question of how network elements can find services on the Internet using only a telephone number, and how telephones, which have an input mechanism limited to twelve keys on a keypad, can be used to access Internet services. It will provide cost savings and revenue opportunities for both carriers and customers, and it will solve many of the interoperability problems faced by the Voice over IP (VoIP) industry.

ENUM at its most basic is the convergence of the Public Switched Telephone Network (PSTN) and Internet Protocol (IP) networks; it is the mapping of a telephone number from the PSTN to Internet functionalities. ENUM takes a complete, international telephone number and resolves it to a fully qualified domain name address using a Domain Name Service (DNS)-based architecture.

To fully understand the significance of this convergence, it is important to understand the differences between the PSTN and IP networks. The telephone network is circuit switched. A call that originates on that network travels from switch to switch along a dedicated path, so that only one call can use that path at a time. Addressing for the PSTN is by telephone number. By contrast, the Internet uses a packet-switched network. Data on this network is broken up into packets that are sent in multiple routes across the network to their destinations. There is no dedicated path for each call in the way that such a path exists over the PSTN. Addressing for the IP network is by URL (Uniform Resource Locator), for example, http://www.neustar.com, where "http" is the protocol (hypertext transfer protocol) and "www.neustar.com" is the address of the http server. A side-by-side comparison is below.

Network Aspect	Telephone Network	IP Network
Switch Type	Circuit Switched	Packet Switched
Traffic Type	Voice	Data
Connection	Dedicated Connection	Multiple Routes, Multiple Sessions
Addressing	Telephone Number	URL

ENUM enables what would traditionally be circuit-switched traffic to be carried along a packet-switched network, because it matches a circuit address (a telephone number) to a network address (a URL). Because this traffic is not restricted to traveling along a dedicated line, flow of traffic becomes more efficient and much more flexible.

What will ENUM allow you to do? For one, ENUM will change the way that Voice over IP (VoIP) works by removing many of the limitations of current VoIP technology. ENUM solves the problem of addressing by translating a telephone number into a URL. Current Voice over IP allows you to make a call over the Internet to others who have subscribed to a specific service, but that system is not interoperable with the PSTN.

Technologies in conjunction with ENUM will also allow you to send an email message using a telephone number, and a subscriber's email, fax, instant messenger, and phone will all be reachable by using the same telephone number. If an application is capable of using a URL, then it can be enabled for use with ENUM.

The workings of ENUM are designed to be invisible to both user and subscriber. The IP network will be accessible, either by use of an Internet-enabled telephone, or from a standard telephone that has access to either a soft switch (a switch that allows access to the IP network) or a circuit switch that has had IP-enabling software added to it. It is important to note that a call placed from an Internet-enabled telephone will be able to reach the Public Switched Telephone Network if the phone number cannot be found on the Internet. How ENUM completes a telephone call will be expanded upon in the next section.

To avoid confusion as to what ENUM is and isn't, ENUM does not change the North American Numbering Plan or any other telephone numbering plan, and it does not change telephony numbering or its administration in any way. ENUM will not drain already scarce numbering resources, because it uses existing assigned telephone numbers. In fact, if properly implemented, ENUM could conserve these resources. ENUM does not change telephone numbers themselves but translates them into domain names so that they can be used by the DNS. ENUM does not carry traffic, and it does not set up calls.

ENUM does allow both the caller and the called party (that is, the ENUM subscriber), to establish preferences as to how communications will be handled.

ENUM—An Evolving Architecture

In order to take advantage of ENUM, the telephone number must first be assigned to a user by a telephone company for services. That number must then be registered for one or more ENUM services. For example, a subscriber might wish to register a telephone number to receive calls at a home phone, or at the office. Additionally, that subscriber might wish to register an email address, as well as a fax machine, to match the telephone number. However the user chooses to set up these services, the information for the registered services is saved

in what are called NAPTR (Naming Authority Pointer) Resource Records.

In order to place an ENUM call, the person initiating the call dials the telephone number as it would normally be dialed. For example, the caller dials the number 1-202-555-1234. In cases where the caller dials less than a complete number (for example, a caller within the 202 area code might leave off the "1," or a caller within an office system might dial only "1234"), network equipment will recreate the complete form of the number for use with ENUM.

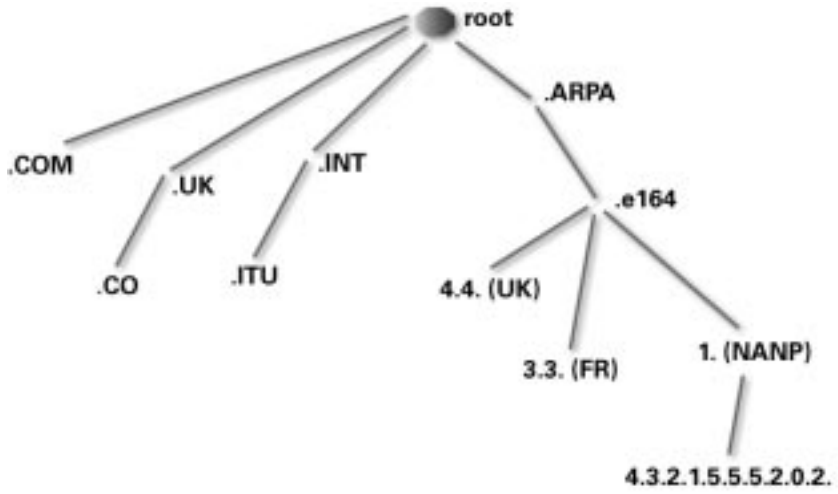
Next, the phone number is translated into an address that can be used by the DNS. Because this address is based on a complete, international telephone number (for example, +1-202-555-1234), a unique Internet address exists for every unique phone number. To determine if the number (and address) are registered in ENUM, the telephone number is translated in the following manner:

1. In this example, the telephone number we are using is 1-202-555-1234. The number would first be stored as +1-202-555-1234. "1" is the country code for the United States, Canada, and the seventeen other countries that make up the North American Numbering Plan (NANP). The "+" indicates that the number is a complete, international telephone number, known as an E.164 number. E.164 is the name of the international telephone numbering plan administered by the International Telecommunication Union (ITU).
2. All characters are removed except for the digits. Example: 12025551234
3. The order of the digits is reversed. Example: 43215552021
4. Dots are placed between each digit. Example: 4.3.2.1.5.5.5.2.0.2.1
5. The domain "e164.arpa" is appended to the end. Example: 4.3.2.1.5.5.5.2.0.2.1.e164.arpa

E164.arpa has been proposed as the DNS domain for use with ENUM. This designation may change as a result of ongoing discussions between the ITU, the Internet Engineering Task Force (IETF), and other international organizations involved with ENUM. In the event that the international community chooses a different ENUM domain, the structures discussed here will apply to that new designated domain. The .arpa domain is under the administrative management of the Internet Architecture Board (IAB). It has been designated specifically for Internet infrastructure purposes. ENUM is considered appropriate as an infrastructure application because it provides a set of DNS-based resource directories, referenced by phone number, for use by various ENUM-enabled application clients. The telephone number is reversed because DNS reads addresses from right to left, from the highest level to the lowest level. In this case, a DNS lookup would start at the .arpa domain, and it would continue with .e164. Under e164 it would look for the "1" as the country code for the North American Numbering Plan. It would then look up each succeeding digit in the telephone number until the address is fully resolved. The diagram below shows a number of branches, with top-level domains of .com, .uk, .int, and .arpa. As you can see in the diagram, if DNS begins to search under .arpa, it can then search under .e164, followed by the country code and reversed telephone number. DNS cannot, however, look under .int once it has begun to look in the .arpa tree.

Once the phone number is translated into an Internet address, ENUM issues a DNS query on the domain, as previously described. One of two things can happen.

1. If an authoritative name server is found, ENUM will retrieve the relevant NAPTR Resource Records and the call will proceed according to the subscriber's registered services for that number. The telephone call that is connected will be conducted entirely over the Internet, without using the Public Switched Telephone Network. This call will be connected in as little time, or even in less time, as a circuit-switched call.



2. If an authoritative name server cannot be found, ENUM will return a 404 Not Found error to the telephone, a connection to the PSTN will be opened, and the call will be routed conventionally.

The diagram below displays one possibility for a voice call flow using an ENUM lookup. In this case, the subscriber has registered for ENUM services using the Session Initiation Protocol (SIP) address sip:name@domain.com. A query based on the telephone number dialed is sent to the DNS server, which returns the SIP address, and the SIP proxy sets up the call. This is only one of a number of ways that ENUM can be used to set up a call.

The flow of information will remain the same no matter what the application; of course, depending on the originating and receiving media, the results will vary. The next section of this document shows some of the various applications that will be possible under ENUM.

Defining ENUM Applications

It should be fairly clear by now that ENUM can be used to register numerous services besides what is fast becoming the most popular service, Voice over IP. Because telephone numbers will be stored in the DNS, any device that has access to the Internet should be able to look up that telephone number as an Internet address. That device will be able to tell what other services are ENUM-registered and can be accessed for that number.

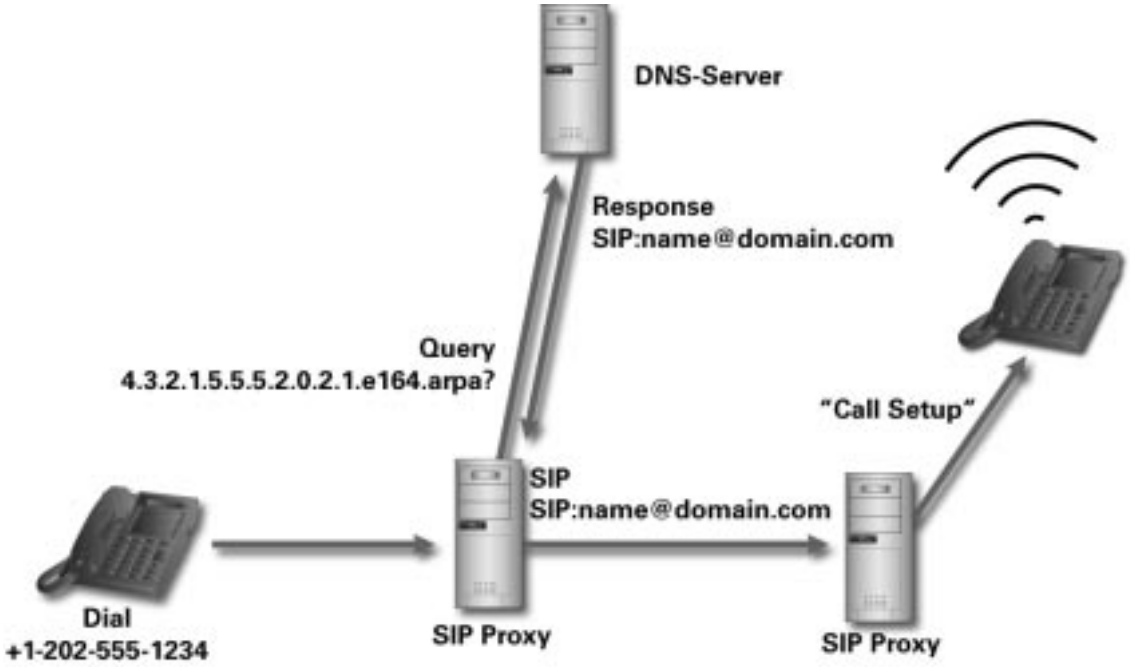
The voice application has been explained in the previous section.

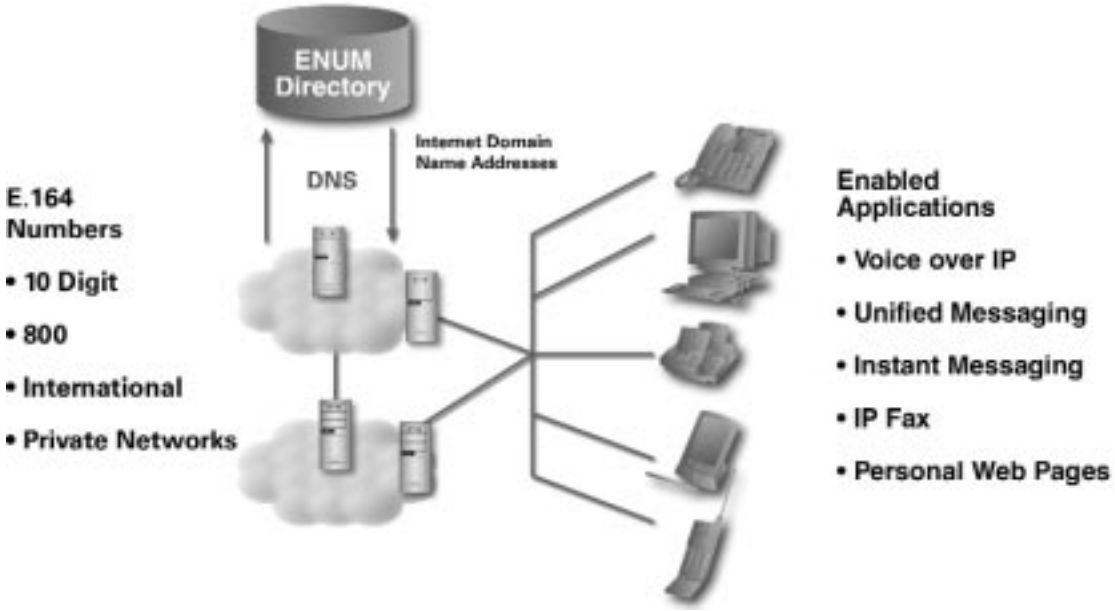
Along the same line as telephone usage, faxing will become just as easy, and as efficient. In fact, for fax applications it is even more logical and much more efficient to use the IP network. Circuit-switched networks were designed to carry voice, but fax machines do not send voice traffic—they send data.

An Internet-enabled fax machine (or a fax machine on an Internet-enabled circuit-switched network) will have the same basic functionality as an Internet-enabled telephone. As long as the owner of a phone number has registered that number for fax services, another Internet-enabled fax machine will be able to reach it using an ENUM lookup. If not, that fax machine will still be reachable via the PSTN; if a 404 Not Found error is sent to the originating fax machine, that machine will be able to open a connection to the PSTN and dial the number traditionally.

Using email is just as easy. Rather than typing in an email address, the sender could type in the recipient's telephone number. Once again, if that number has been mapped to an email address and if the email software is ENUM-enabled, the mail will be sent, and the address lookup will be invisible to both sender and recipient. In this case, the sender would type in the complete, international telephone number; the email client would see that this is a phone number and not an email address. The only changes to email clients will be to accommodate ENUM functions that will look up the email address registered for that phone number in the DNS.

The possibilities become even more far reaching when you think about the number of Internet applications that can be used. Instant messaging could easily be modified for use with telephone numbers, and gone will be the problem of remembering





screen names. A fax machine could send a document to an email address, or a computer could email a document to a fax machine. Voice Protocol for Internet Mail, a protocol that stores voice mail electronically, could potentially use ENUM as a method to retrieve voice mail from anywhere in the world.

The diagram above shows the several types of numbers that may be registered for ENUM services, along with examples of services that can be enabled under ENUM.

Just as ENUM enables convergence, it will also help to enable many of the functions of SIP, the Session Initiation Protocol. SIP, in turn, enhances convergence by enabling converged services. Some of the applications and services that SIP may enable include traditional call-forwarding, follow-me, and do-not-disturb functions, but they also include new features that will merge Internet applications with video and voice communications. Using applications that use SIP resources, a person using a telephone connection with his or her computer could be prompted on that computer that another call is arriving. He or she could make a selection on the computer to either end the dialup session and answer the phone, forward the call to another number, or send the caller to voice mail. As another example, a user could transfer a caller to a web page instead of to another phone. In this case, the call would end, and the user's web browser would open the new page.

In terms of ENUM support of applications, remember this: if an application exists that can use a URL, it can potentially benefit from use with ENUM.

The ENUM Road to Success

It is important to remember that ENUM does not disallow the placing or receiving of traditional PSTN telephone calls, and customers are not restricted to communicating only with other ENUM customers. It gives telephone customers the best of two distinct worlds: the ability to place telephone calls over the Internet when a recipient is an ENUM customer, and the ability to place traditional PSTN calls.

The one-contact business card is merely the start of the advantages that ENUM will bring to customers. If an application exists on the Internet, it can potentially be mapped to a telephone number and reached using ENUM. Although a large number of applications will be accessible using the ENUM protocol, by far the most exciting have to do with IP telephony.

Standards bodies and equipment providers have in the last two years been working toward improving the quality of and developing equipment for IP telephony. This equipment is meant to significantly increase the quality of Voice over IP, so that a telephone call made over the Internet will sound as good or better, and be connected faster than a traditional circuit-switched call. The quality of service for VoIP has highly improved over versions of this technology from just two years ago, not just because of increases in the quality of equipment, but also due to incredible increases in broadband technology. The time for true IP telephony has come.

There are 400 million telephone numbers* and over 130 million Internet customers** in the United States alone, and, because both DNS and E.164 are consistent world-wide, ENUM is a not just a US system but a global one. There are unstoppable trends toward convergence, and these trends will create fantastic opportunities for both telephony and Internet industries. ENUM is the protocol that will allow it to happen.

* Source: Numbering Resource Utilization/Forecast Reports data filed as of October 23, 2000, Database roll-ups by Craig Stroup of Industry Analysis Division, FCC

** Source: The Standard.com, March 19, 2001, "The 5 Year Forecast"

The Time Is Now

The time for ENUM has come. The Internet has matured to the point where true Voice over IP is not only possible but inevitable. The last two years have seen several conferences and meetings of industry and standards organizations meant to define ENUM and its potential roles. Equipment manufacturers have spent that time developing Internet-enabled equipment for use with ENUM. Plans for testing of ENUM are underway, and companies already experienced in administering telephony and IP systems are prepared to take leadership positions in the administration of ENUM.

The telephony and Internet industries are on the verge of significant changes. ENUM will do much more than merge all the contact information on a business card into just a single phone number. It will expand the access capabilities that we have with current technology, and it will promote research into new technologies. Once ENUM becomes widespread, it may well enable the greatest changes to the Internet that we have yet seen.

Acronyms

DNS . . . . . .Domain Name System

IETF . . . . . .Internet Engineering Task Force

HTTP . . . . . .Hypertext Transfer Protocol

IP . . . . . .Internet Protocol

NAPTR . . . . . .Naming Authority Pointer

PSTN . . . . . .Public Switched Telephone Network

SIP . . . . . .Session Initiation Protocol

URL . . . . . .Uniform Resource Locator

VoIP . . . . . .Voice over IP

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