Let’s migrate to ENUM

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The development of information technology and telecommunications makes more and more electronic services available. These services (SMS, MMS, e-mail, instant messaging) facilitate an advanced communication between users. MMS, e-mail, fax, etc. define points of presence of a user. These points can be reached via different addressing schemes. If someone wants to present all his/her contact information on the same phisical medium, it is quite inconvenient when one of these information changes. In this case all pieces of the business cards (for example) must be reprinted. Using ENUM, this problem can be solved – one should print only one identifier on the businiess card, that wouldn’t change over time. The question occurs, hovever: If ENUM is such useful, why is it not widely used? Present article tries to answer this question.

The name ENUM is an abbreviation, its meaning is tElephone NUmber Mapping. The first aim with this technology is to translate E.164 numbers into DNS domain names. These names could than be used as keys to search for address information of users in the DNS database. The address information can be an e-mail address, a GSM number, a SIP address, etc. These information are encoded in so-called Naming Authority Pointer (NAPTR) Resource Records in the form of URIs and service descriptions according to RFC 3402 [7].

The ENUM system is not a protocol, it is a convention for the use of a specific set of existing protocols, like:

- using E.164 numbers and the “e164.arpa” domain [4];
- the DNS protocol [5,6];
- using NAPTR Resource Records [7];
- and interpreting the URI results of the NAPTR lookups [8].

Using ENUM it is possible to provide a service where the user has to publish only one communications identifier, which serves as a pointer to all his addresses.

ENUM enables the convergence of conventional telephony and IP telephony and the usage of the well established E.164 numbers to access IP-based applications. This includes the access from terminals with numeric keypads, even from the TDM-based circuit-switched PSTN/ISDN network [3]. Platform independent addressing forecasts the vision of a unified telocommunications system [21].

The two problem statements of ENUM are the following [9]:

1) How do network elements (gateways, SIP servers etc.) find services on the Internet if you only have a telephone (E.164) number.
2) How can subscribers define their preferences for nominating particular services and servers to respond to incoming communication requests?

It should be noted that the introduction of ENUM itself does not require any change to the national numbering plans and will not imply any additional demand of E.164 number resources. However, new services and applications triggered by the availability of ENUM may generate demand for additional numbering resources. [1]

There are three different conceptional approaches to ENUM. These are “user ENUM”, “operator ENUM” and “infrastructure ENUM”. *User ENUM* refers to the use of the single public ENUM root domain (.e164.arpa). *Operator ENUM* refers to implementations of ENUM typically for large organisations using internal telephone and IP networks, and uses a private implementation of the ENUM principle rather than the public root domain. *Infrastructure ENUM* refers to implementations of ENUM within communications networks for network addressing and routing rather than end-user addressing purposes.

Present article concentrates only on user ENUM issues.

SIP or ENUM?

This question often arises during discussions in connection with VoIP in an explicit or an implicit way. However it is a badly formulated question. There is no answer because the two mentioned technologies are not alternatives of each other. While SIP is a protocol ENUM is rather a convention for the use of a specific set of existing protocols, as mentioned earlier. The reason for the confusion could be the fact that it is possible to initiate calls with E.164 addressing in a SIP server based VoIP system without using any additional system or technology. Only IP network, SIP server and some SIP user agents are nedded. So what is the added value with ENUM?

ENUM provides a global solution for unifying communication identifiers, while the VoIP solution with E.164 addressing and one (or more) call server (SoftSwitch, SIP proxy, etc.) provides an isolated system where one can use E.164 addressing as well. In this case it is the Call Server that makes the mapping (using a mapping table) between application level communication identifiers and E.164 numbers. The problem with this (and the reason why it is an isolated solution) is the propagation of mapping tables between Call Servers. There hasn't been any viable protocol that would solve this problem until recently. Users can reach only those subscribers via E.164 numbers who have registered themselves with the same Call Server. This approach is neither scalable nor universal.

In the ENUM system SIP is not the only protocol that can be used to reach services. There are some Internet Drafts [11] that define a basic set of enumservice descriptions that are intended for use in deployments of ENUM. These descriptions form a set of enumservice registration requests, as laid out in section 3 of [2].

The enumservice names are 'talk', 'voice', 'ivoice', 'video', 'msg', 'fax', 'sms', 'ems', 'mms', 'email', 'chat', 'tp', 'im', 'info', 'web', 'ft', 'srs', and 'all'.

DNS – The only database?

DNS [5,6] is a hierarchically arranged distributed database. It is used mostly on the Internet to do the mapping between IP addresses and domain names. The unit of data in the DNS is the Resource Record (RR). There are several sorts of RRs, but from the point of view of ENUM it is the NAPTR RR (Naming Authority Pointer Resource Record) [7] that is important. It specifies a regular expression based rewrite rule that, when applied to an existing string, will produce a new domain label or Uniform Resource Identifier (URI) [8]. Also the lists of ENUM services belonging to an E.164 numbers are stored here. One can acquire this information by using the method (algorithm) defined in the ENUM RFC [2]. According to this, E.164 numbers must be converted into domain names first in the following way.

Reverse the digits of the E.164 number, put dots between them and append the string '.e164.aprpa' to the end. For example the number +36-1-234-5678 would be transformed into

8.7.6.5.4.3.2.1.6.3.e164 .arpa.

This string can be used as a key to the DNS database to retreive information (records) about available services belonging to number +36-1-234-5678.

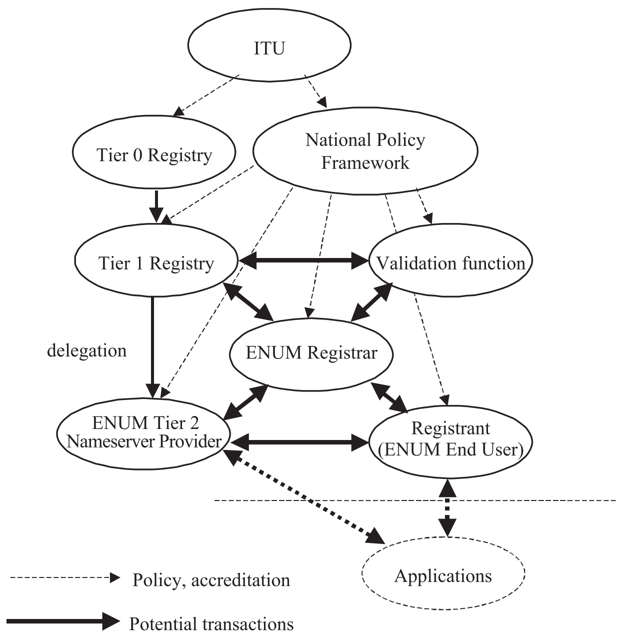
Using the DNS to store service information belonging to E.164 numbers is plausible, because DNS is a publicly available distributed database. The question arises however whether it is an optimal solution or not. There are some imperfections of the DNS that need to be examined thorougly [16]:

- DNS is insecure.
  TSIG [13], DNSSEC [14], PKI [15]
  could make it more secure.
  The question is, how mature are
  these technologies and how big is the gap between the theory and the implementation.
- DNS is variably timed.
- DNS is generally not well maintained.
- DNS is generally not well synchronized.
- There is no "DNS says 'no'",
  only an indistinct timeout.
- Putting regular expressions in the DNS is a fascinating complication.

Remark: Under ENUM this article means a system where the root of the hierarchical DNS database is 'e164.arpa'. ENUM systems with different root are regarded as ENUM-like systems.

Abbreviations

DNS	Domain Name System
DNSSEC	DNS Security Extensions
DoS	Denial of Service
E2U	ENUM to URI
ENUM	tElephone NUmber Mapping
ETSI	European Telecommunications Standards Institute
GSM	Global System for Mobile Communication
IN	Inelligent Network
IP	Internet Protocol
ITU	International Telecommunication Union
MMS	Multimedia Messaging Service
NAPTR	Naming Authority Pointer
PINT	PSTN/Internet Interworking Service
PKI	Public Key Infrastructure
PLMN	Public Land Mobile Network
PSTN	Public Switched Telephone Network
RR	Resource Record
SCN	Switched Circuit Network
SIGTRAN	Signaling Transport
SIP	Session Initiation Protocol
SMS	Short Message Service
SPAN	Services and Protocols for Advanced Networks
SPIRITS	Service in the PSTN/IN Requesting Internet Service
SS7	Signaling System 7
TIPHON	Telecommunications and Internet Protocol Harmonization over Networks
TISPAN	SPAN+TIPHON
TRIP	Telephony routing over IP
TSIG	Secret Key Transaction Authentication for DNS
URI	Universal Resource Identifier



ENUM functional model

ENUM Administration

The following *figure* shows the functional model of ENUM. [1]

To understand the tasks of the entities in the figure, some terms must be defined:

ENUM registrar:
entity that provides direct services to domain name registrants by processing name registrations

ENUM registrant:
entity initiating the ENUM registration process (end user or agent)

ENUM Tier 0:
level in the tiered architecture corresponding to the ENUM root, i.e. e164.arpa NOTE: Records at this level contain pointers to Tier 1 for an E.164 Country Code or portion thereof.

ENUM Tier 1:
level in the tiered architecture corresponding to the E.164 Country Code (CC), i.e. <CC>.e164.arpa NOTE: Records at this level contain pointers to Tier 2 for an E.164 number.

ENUM Tier 2:
level in the tiered architecture corresponding to the E.164 number, i.e., <N(S)N>.<CC>.e164.arpa NOTE: Records at this level contain NAPTR records for an E.164 number.

ENUM Tier 2 Nameserver Provider:
entity responsible for the servers within DNS that hold the NAPTR resource records NOTE: In some other documents this entity is also referred to as the ENUM Tier 2 Registry or the ENUM Tier 2 provider. [1]

The ENUM functional and administrative model is based on a ternary separation. The three distinct levels are: Tier 0, Tier 1 and Tier 2.

The main functions performed at Tier 0 level are the administration and technical management of ENUM domain. These functions are implemented by the Tier 0 registry that is a single international registry containing pointers to the Tier 1 registries.

The main functions performed at the Tier 1 level are management and operation of the ENUM domain corresponding to an E.164 country-code in the country or area identified by that given country code. These functions are implemented by the ENUM Tier 1 registry that is a national registry containing pointers to the ENUM Tier 2 Nameserver Providers.

The main functions performed at the Tier 2 level are the commercial provision of the ENUM functions. These functions are implemented by the ENUM Tier 2 Nameserver Provider and ENUM registrar which can be carried out by the same or separate entities. [1]

The 'Validation' entity is responsible for the authentication of users.

According to the 'opt-in principle': The assignee of a number must make an explicit request to participate in ENUM before the ENUM domain corresponding to that E.164 number can be registered and any NAPTR records for the number can be populated. [1]

ENUM risks and threats

Beyond the possibilities of ENUM it should be recognized that this system has some risks as well. These can be the following:

Unscrupolous use of information
ENUM system makes possible that an ENUM client attempting to initiate a call, based on an E.164 number, can retrieve all information about the communication identifiers of the called party. This makes possible to retrieve information on users by entering randomly an E.164 number.

Identity theft, Spamming
The previous point makes possible to build 'identity lists' that can be used for spamming.

Theft of user-provider relations
Provider specific information can be revealed in connection with a user, so one could offer alternative services based on this stolen information.

Denial of Service
'Flood attack' on the DNS NAPTR records can block the retrieval of any communication addresses.

Passing off
Passing off could occur when an entity provisions another end user's E.164 numbers in the DNS by having their own details inserted in the NAPTR records corresponding to another person's or company's number. This would undermine the trust in the ENUM system

Hijacking

“Hijacking” is where a provider of communications applications and services is inserted in a communications path without an end user’s permission. In the context of ENUM, hijacking could occur when: a provider of communications applications or services arranges for end users’ E.164 numbers to be provisioned in the DNS without their consent. [1]

Related issues (Problems, Protocols, Architectures)

Regarding the cooperation and convergence between IP and PSTN it is necessary to develop new and existing protocols. This section is about protocols and systems aiming to help the IP-PSTN cooperation.

The problem of locating the proper voice gateway is closely related to ENUM. VoIP applications are getting more and more popular that formulates the need for installation of more and more IP-PSTN voice gateways. For calls from the IP network to the PSTN, the caller must locate a gateway that is able to complete calls to the desired destination. There may be several available gateways, and selecting the most suitable one is a nontrivial process. Currently the gateway must be selected by the user or by the signaling servers. The selection and configuration of gateways to use involves manual work.

The list of available gateways must be configured into the signaling servers and updated when new gateways become available [10]. It would be nice to have a protocol that would help users to locate the most appropriate gateway dinamically. One solution can be the TRIP [17,12] protocol to this problem that is under development.

PINT [18] protocol specifies how to reach PSTN services from the IP. There is an other protocol often mentioned together with PINT, this is called SPIRITS [19]. It’s RFC describes the architecture for supporting SPIRITS services, which are those originating in the PSTN and necessitating the interactions between the PSTN and the Internet (Internet Call Waiting, Internet Caller-ID Delivery, and Internet Call Forwarding are examples of SPIRIT services).

Specifically, it defines the components constituting the architecture and the interfaces between the components.

An other related framework is the SIGTRAN [20]. SIGTRAN defines an architecture framework and functional requirements for transport of signaling information (SS7, Q.931, etc.) over IP. The framework describes relationships between functional and physical entities exchanging signaling information, such as Signaling Gateways and Media Gateway Controllers. It identifies interfaces where signaling transport may be used and the functional and performance requirements that apply from existing Switched Circuit Network (SCN) signaling protocols.

Summary

As every tehcnology ENUM has some advantages and disadvantages as well. The aim is to make use of ENUM, provide services and convenience for users while minimizing the threats and risks that may arise. To reach this aim, the importance of standards can not be emphasised enough. It is ITU-T Study Group 2 and ETSI TISPAN working group 4 who do the majority of the standardization work.

Beyond standardization it is necessary to build experimental systems as well, to be able to reveal the problems of the system in real-life circumstances. Theory and implementation are often different matters.

The question, why ENUM is not widely used yet, can now be answered. There are some privacy and security issues where the answers are not well elaborated yet. Some of the problems can be solved by the development of the technology while others can be solved by policing. Both approaches are important and can not be neglected. It is better to introduce a good service a bit later than to introduce a bad one immediately.

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News

Global Support for Information Society Targets

Targets set for improving access and connectivity to information and communication technologies (ICT) by 2015 at the first phase of the World Summit on the Information Society (WSIS) have received strong support in a global ITU survey. The Summit approved a Declaration of Principles and Plan of Action that set forth a roadmap to bring the benefits of ICT to underdeveloped economies. The Summit was organized by ITU under the patronage of UN Secretary-General Kofi Annan to ensure that social and economic development, which is increasingly driven by ICTs, will result in a more just, prosperous and equitable world. The survey shows overwhelming support for the belief that if the information society is to be one in which all citizens throughout the world can equally access and use information resources for sustainable economic and social development, that cyberspace should be declared a resource to be shared by all for the global public good.

ITU Standard gives operators brighter future

ITU has set a global standard for a new optical fibre that will make it easier for network operators to deploy bandwidth to maximize technology in their core networks.The development of standards in is important if network operators are to reduce costs and provide more innovative services to customers.

G.656 allows operators using CWDM (Coarse Wave Division Multiplexing) to deploy systems without the need to compensate for chromatic dispersion a phenomenon that at low levels counteracts distortion but at high-levels can make a signal unusable. Although it is not complicated, but do not the management of chromatic dispersion is crucial as the number of wavelengths used in WDM increase. G.656 also means that at least 40 more channels can be added to DWDM (Dense WDM) systems. In this case chromatic dispersion generate harmful interference over this – unprecedented – range of the optical spectrum.

ITU-T G.656 (Characteristics of a fibre and cable with Non-Zero Dispersion for Wideband Optical Transport) is the recent in the G-series which specifies the geometrical, physical, mechanical and transmission characteristics of optical fibres. Other Recommendations in this series include:

ITU-T G.652 – Characteristics of a single-mode optical fibre and cable
ITU-T G.653 – Characteristics of a dispersion-shifted single-mode optical fibre and cable
ITU-T G.654 – Characteristics of a cut-off shifted single-mode optical fibre cable
ITU-T G.655 – Characteristics of a non-zero dispersion-shifted single-mode optical fibre and cable