PUBLIC CONSULTATION

ON

ENUM

(TELEPHONE NUMBER TO UNIVERSAL RESOURCE IDENTIFIER MAPPING)

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ENUM FUNDAMENTALS

This section briefly describes E.164 numbering as well as the Internet domain name system. In addition, the manner in which the ENUM protocol links these two addressing methods is also explained.

Definition of ENUM

ENUM[1] is a protocol based on the work of the IETF[2] and described in the RFC 2916[3] specifications. It defines the translation of an E.164 telephone number into a domain name which can be used for a wide variety of communication services (telephony, e-mail, fax, messaging, etc.).

Conventional E.164 Telephone Numbering

The structure and organization of conventional telephone numbers was standardized on an international level in the ITU's Recommendation E.164. The recommendation describes the number structure to be used internationally and defines criteria for the assignment of country codes (CCs). The ITU coordinates the international numbering plan and assigns country codes to its member states.

On a national level, the individual member states are responsible for designing and administering their assigned number ranges in their own territories. In Austria, these responsibilities have been delegated to the High Telecommunications Authority (*OFB*) and subsequently to RTR, which manages the telephone number ranges assigned to country code 43 and allocates them to licensed network operators.

Domain Name System: Functions

The Internet's Domain Name System (DNS) consists of distributed and hierarchical servers which are monitored by a system of root servers.

The primary function of the DNS is to create a logical link between the addresses of computers connected to the Internet (IP addresses) and domain names, which are used to increase the user friendliness of the Internet. Example: http://www.rtr.at is easier to remember than 135.56.112.249.

The abbreviations at the end of the name provide information on the top-level domain (TLD) under which a certain name is registered. The following three types of TLDs are currently in use:

- 243 national domains, called country code top-level domains (ccTLDs), which are defined by the two-letter code under the ISO 3166 standard. The code for Austria, for example, is .at
- 1 international domain for international organizations, using the abbreviation .int
- 6 generic top-level domains (gTLDs) which correspond to the main area of activity of the registered organization:

[1] ENUM: Stands for TElephone NUmber Mapping, Electronic NUMbering, TElephone Number URI Mapping or Enhancement of NUmbering and NaMing.
[2] IETF: Internet Engineering Task Force; an Internet standardization body.
[3] RFC: Request for Comment der IETF: http://www.ietf.org/rfc/rfc2916.txt

- 3 gTLDs for worldwide organizations: .com, .org, .net
- 3 gTLDs for U.S. organizations: .edu, .mil, .gov

The following are also in use:

- 2 new gTLDs recently accredited by ICANN[4]: .biz and .info, as well as additional gTLDs expected in the future: .aero, .coop, .museum, .name, .pro
- The .arpa TLD is administered jointly by IANA[5] and IAB[6] under the supervision of the U.S. government.

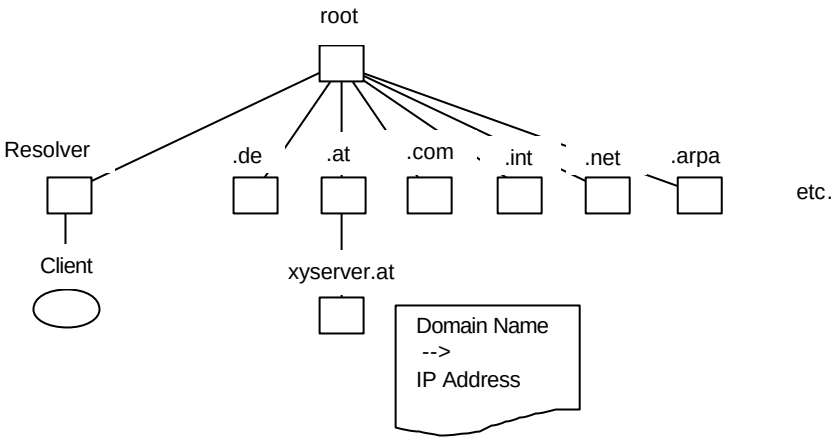
In Austria, domain names ending with .at are managed by NIC.AT, which defines structural rules for names in this domain.

IP Addressing

IP addresses are administered by three regional non-profit organizations authorized by ICANN:

- RIPE in Europe and Africa
- ARIN in North America
- APNIC in the Asia Pacific region
- AFRINIC in Africa: currently in startup phase

ICANN coordinates the DNS system by delegating the management of TLDs and ensuring coherence in the global DNS data basis. The Internet Root[7] is a file for which administration has been delegated to a technical service provider (currently Verisign in the U.S.) by the U.S. Department of Commerce as well as ICANN. This file is duplicated and distributed to the other root servers.



In practice, a request for the IP address of a web page (e.g., http://www.rtr.at) is handled by a local DNS server, which sends a request to the root server and receives the IP address of the DNS server for the ".at" zone, to which the request is then forwarded. This strictly hierarchical procedure repeats itself until the request has been sent to the server which can provide the correct IP address for http://www.rtr.at.

[4] ICANN: Internet Corporation for Assigned Names and Numbers. ICANN was established for the global coordination of domain names, IP addresses and protocols for the Internet. ICANN is a non-profit organization incorporated under California state law.
[5] IANA: Internet Assigned Numbers Authority.
[6] IAB: Internet Architecture Board.
[7] Root: There is one primary root server (a.root-server) and 12 secondary root servers.

ENUM: Functions

ENUM defines an Internet domain name on the basis of an E.164 telephone number, thus establishing a link for a wide variety of other telecommunication services.

The ENUM service is based on the Internet's existing DNS system and uses a sub-domain name reserved for ENUM. The IETF has suggested using the domain name .e164.arpa[8]; this name is used in the descriptions and explanations below. The required coordination between ITU and IETF has not been implemented to date, although we expect a position paper on the topic from ITU SG 2 soon. At the same time, however, the list below provides examples of sub-domains reserved by a number of commercial organizations for services similar to ENUM:

.arpa	.int	.com	.org	.net
.e164	.e164	.e164	.e164	.e164
		.enum	.enum	.enum
		.enumworld	.enumworld	.enumworld

Using this .e164.arpa domain name server, an ENUM client can access special ENUM name servers with naming authority pointer (NAPTR) records, which provide information on the services available in connection with a certain E.164 telephone number.

Translation of E.164 Numbers into Domain Names

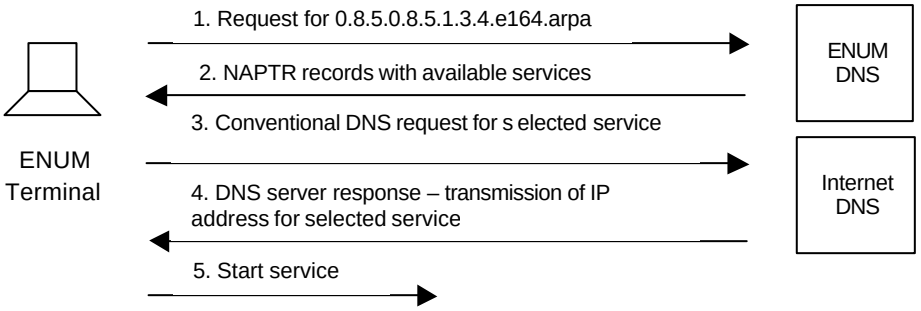
The core of ENUM services is the process of translating telephone numbers entered by callers into domain names (see below), allowing the caller to access the services available at that number.

1. The calling party enters the E.164 number of the called party, complete with country code.
   Example: +43-1-58058-0
2. All non-numeric parts of the number are removed.
   Example: 431580580
3. Dots (".") are then inserted between each number.
   Example: 4.3.1.5.8.0.5.8.0
4. The sequence of the resulting string is then reversed.
   Example: 0.8.5.0.8.5.1.3.4
5. The string ".e164.arpa" is then added at the end of the string above
   Example: 0.8.5.0.8.5.1.3.4.e164.arpa

Detection of Available Services

The domain name resulting from the ENUM service algorithm (see above) uses the Domain Name System (DNS) protocol to point to a DNS server, which stores the naming authority pointer (NAPTR) records and the services available for the E.164 numbers it manages. These NAPTR records are sent to the calling party, who can select the desired service from the list of available ones.

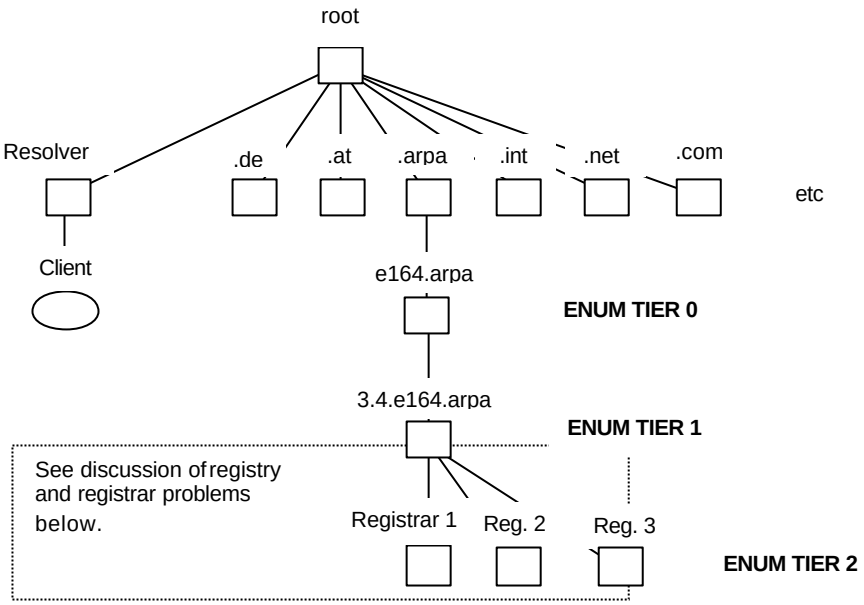
[8] .e164.arpa: .arpa is administered by ICANN as well as the IANA Registry. The second-level domain .e164.arpa is administered by IAB, which has delegated technical responsibilities to RIPE NCC.



ENUM IMPLEMENTATION AND PROCESSES

ENUM DNS Structure

Because ENUM uses existing DNS structures, a typical ENUM query is handled in a manner analogous to the procedure described above. Because an e164.arpa domain is requested, the root server channels the request to the .arpa server, which forwards the request via the e164.arpa sub-domain and the pan-continental IP address administration servers to the registrars.



ENUM DNS Request Handling

Analogous to a request for the IP address that corresponds to a certain domain name, a request for the NAPTR records for the number +43-1-58058-0, for example, triggers a handshake procedure in the ENUM DNS system. The client sends a request for the NAPTR records of a certain E.164 telephone number via a local DNS server or resolver, which in the case of +43-1-58058-0 is sent as 0.8.5.0.8.5.1.3.4.e164.arpa to the ENUM DNS. As in the conventional DNS request, the resolver finds the IP address of the server containing the

desired information in several steps, from the root to the various ENUM tiers. If the server's IP address is known, the data is queried and sent to the client. In the case of our ENUM DNS request, the data would typically be in the following format:

IN NAPTR 10 10 “u” “sip+E2U”	“!^.*$!sip:rtr@rtr.at”
IN NAPTR 10 10 “u” “mailto+E2U”	“!^.*$!mailto:rtr@rtr.at“
IN NAPTR 10 10 “u“ „http+E2U“	“!^.*$!http://www.rtr.at”
IN NAPTR 10 10 “u“ „tel+E2U“	“!^.*$!tel:+43-664-1234567”

The calling party can not select one of the available services (in this example SIP, E-MAIL, WWW and MOBIL) and initiate a connection until it has received this information from the called party's NAPTR records for the +43-1-58058-0.

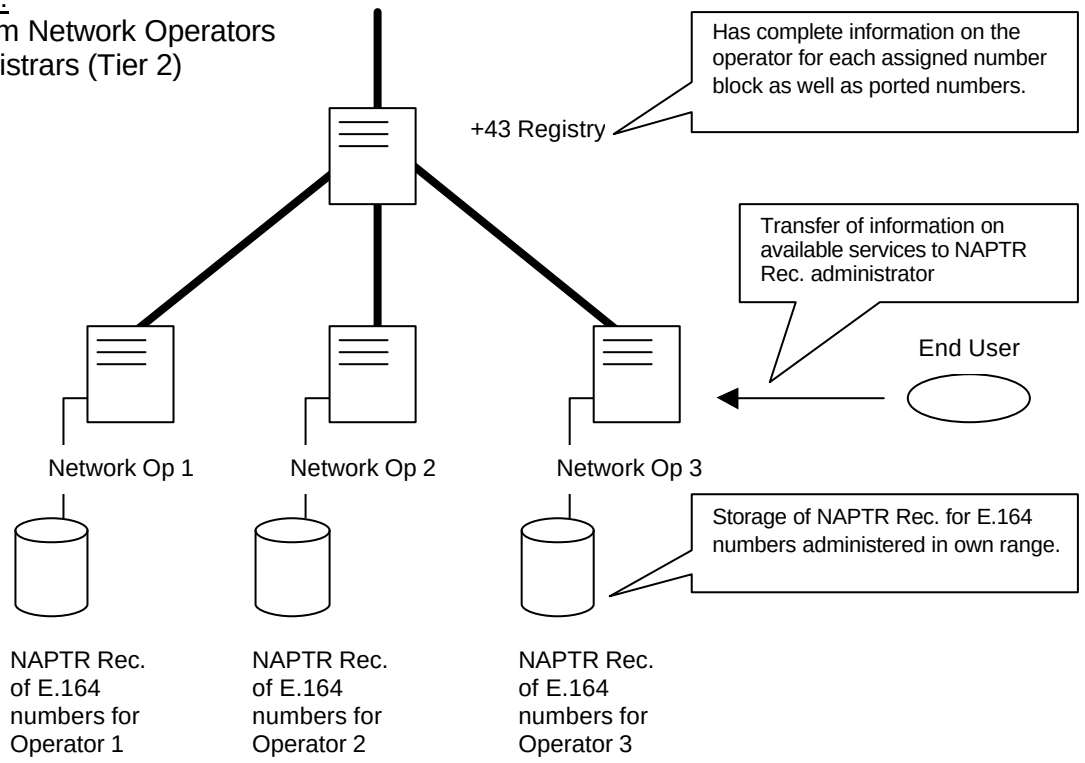
Problems with National Registries / Registrars

Essentially, possible NAPTR database operators include current telecom operators (with their access to the E.164 numbers they use and to the accompanying user data) or neutral ENUM registrars.

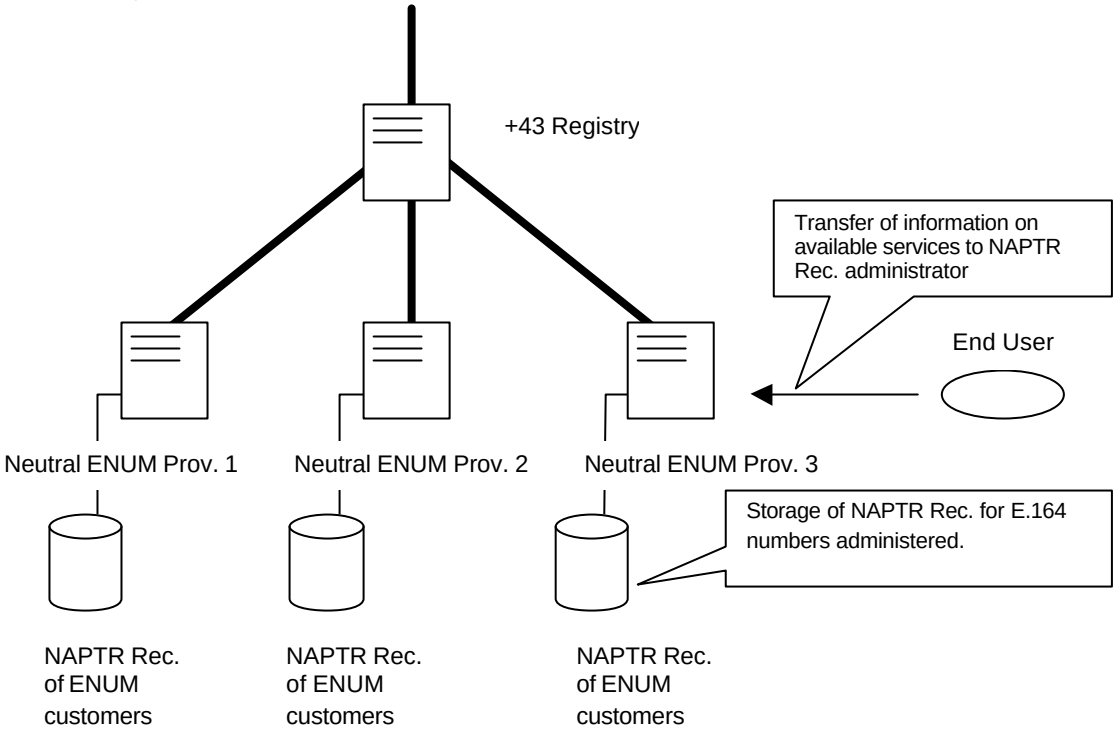
- Case 1 (see below) brings the advantage that the telecom operator always has the necessary information on the E.164 numbers it uses, and that the customer's authenticity can be verified by means of already existing procedures. One disadvantage might be that the conventional operator will have little interest in storing and updating information on the services of other operators in its NAPTR record databases.
  In this case, the superordinate registry (for all of Austria) could perform its function by delivering a pointer to the appropriate operator on the basis of a telephone number relatively easily, as this essentially only involves the administration of entire number blocks.
  One problem to address is the porting of E.164 telephone numbers, for which the clear assignment of E.164 numbers to the registrar responsible has to be ensured, even in cases where customers switch providers.

- Case 2 (see below) shows a scenario with an independent ENUM registrar in which updating the NAPTR database forms the basis of the registrar's business activities and is thus entirely in its interest.
  One possible problem would be verifying the authenticity of end users as well as the accuracy of the data transmitted.
  In this scenario, the pan-Austrian registry could no longer use number blocks but would have to store the current registrar responsible for the NAPTR records of each individual E.164 number. That would involve a considerable increase in administrative effort at the agency responsible for the database.

Case 1:
Telecom Network Operators
as Registrars (Tier 2)

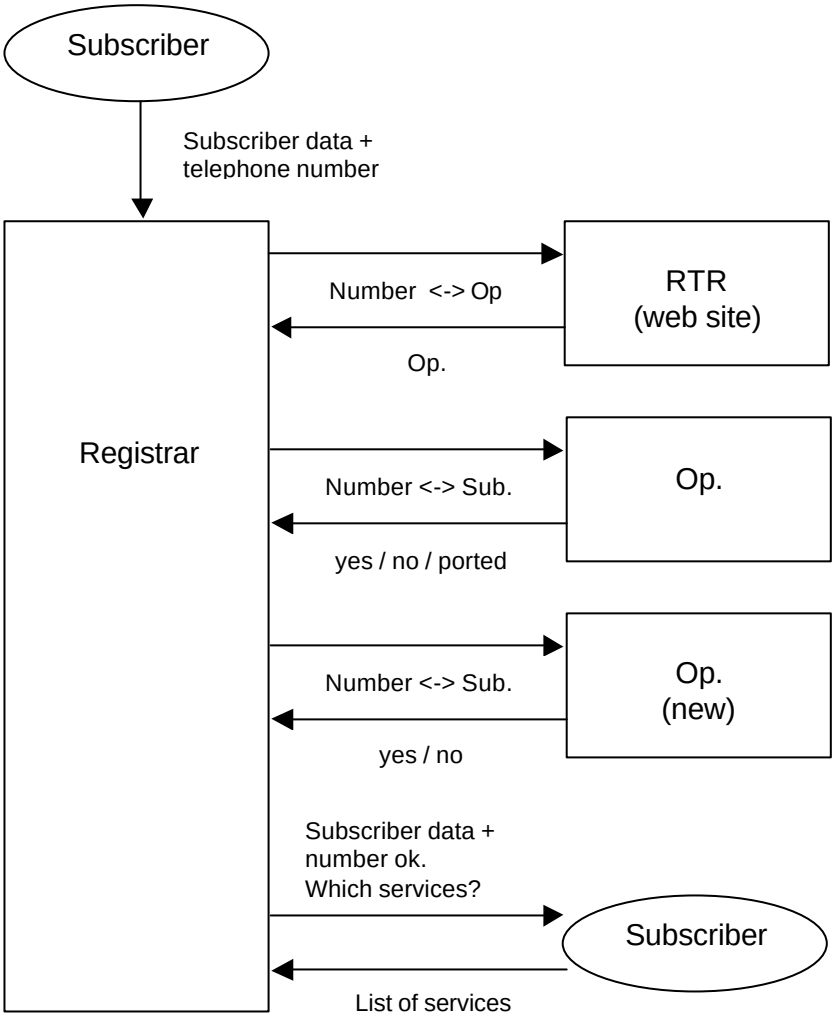


Case 2:
Independent Registrars



Authentication of Subscribers and their Numbers (Case 2 only)

In order to authenticate subscribers, the neutral registrar would have to determine the network operator (Op.) to which the E.164 telephone number (TN) via RTR GmBH's web site. The registrar would then check the authenticity of the subscriber/telephone number relationship with the network operator. If the telephone number has been ported, the registrar would check with the new network operator. The registrar would not enter the customer's data in the NAPTR records database until these data checks have been performed.

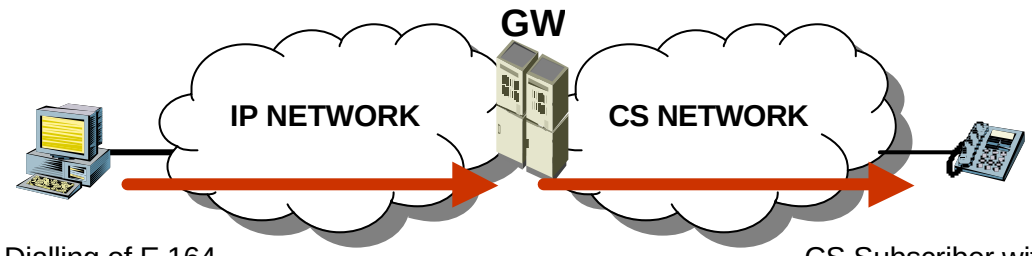


POSSIBLE INTERCONNECTION SCENARIOS

The diagrams below depict possible interconnection scenarios between IP and circuit-switched (CS) networks as well as other IP networks. These considerations have made it particularly clear that the assignment of E.164 numbers to ISPs would facilitate the convergence of line and packet-switched networks. In the implementation of ENUM, the assignment of E.164 numbers to IP network operators is necessary because the ENUM service is based on E.164 numbers.

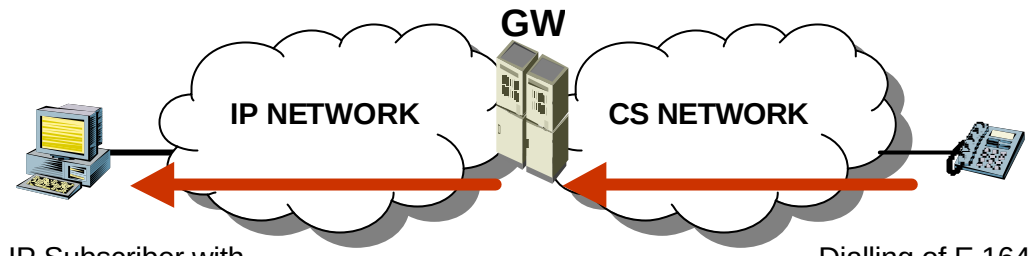
IP --> CS

It is already possible to call CS networks from IP networks. The CS network subscriber's E.164 number can be entered on the PC or dialled using an IP telephone, and the call can be routed via a gateway from the IP network to the CS network. ENUM would enable subscribers in IP networks to choose among the available services for the called party.



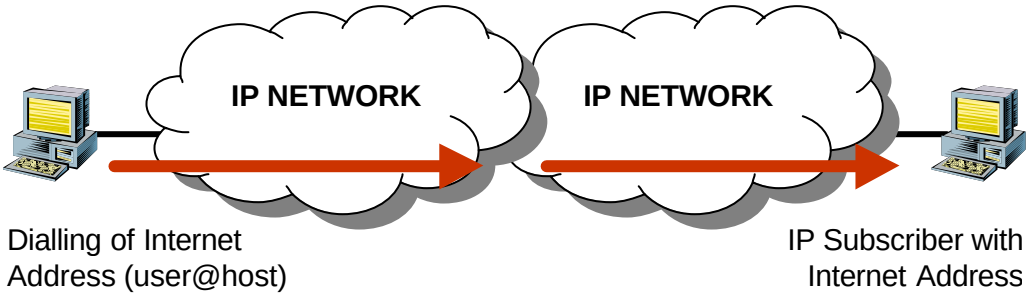
CS --> IP

The reverse case, in which an IP network subscriber can be called by a CS network subscriber, is currently not possible because conventional CS terminals do not allow the entry of "user@host address". This would be made possible by the assignment of E.164 numbers to IP networks. The implementation of ENUM would not even help in this case because the service also requires E.164 numbers for IP subscribers.



IP --> IP

It is currently possible for IP network subscribers to call each other using IP addresses, Internet names (user@host) and special services. ENUM would be used as an add-on to enable the selection and use of a wide variety of services, at the same time allowing subscribers to telephone in the accustomed manner (i.e., by entering an E.164 number).



Dialling of Internet Address (user@host)

IP Subscriber with Internet Address

CONSULTATION QUESTIONS

Administrative Issues

- What role should ITU and ICANN play?
- What roles should be assumed by the Austrian Federal Ministry of Transport, Innovation and Technology, the High Telecommunications Authority and the Regulatory Authority for Telecommunications and Broadcasting (RTR GmbH)?
- Who should assume responsibility for the ENUM registry (Tier 1)?
- Who should assume the responsibilities of the registrars (Tier 2)?

- Is it necessary to define one top-level domain for ENUM implementation, or can the service be handled using several domains?
- Who will guarantee that data is authentic and up to date?
- How can we prevent piracy in domain names and the accompanying telephone numbers?
- What procedures would have to be implemented for number portability (domain name database updates, registration and de-registration of subscribers)?
- How should the problems of "1 number – *n* subscribers", "1 subscriber – n numbers", and telephone extensions be handled?

Service-Specific Issues

- Will ENUM lead to the accelerated convergence of the Internet and telephony?
- What types of services and applications will arise from the introduction of ENUM?
- Which customer groups and service providers will see the greatest benefit in ENUM?
- What business models are conceivable for ENUM?

Implementation Issues

- Are you basically interested in ENUM?
- Would your suppliers/providers be able to support ENUM?
- Will field trials be necessary? If so, who should take the initiative to conduct these trials, and what should their objectives be?
- Are there bottlenecks which can be identified now and would hinder the trouble-free use of ENUM?
- Will it be necessary to adapt today's Internet DNS in order to handle the additional ENUM DNS requests efficiently?

APPENDIX 1: Preliminary RTR Views on ENUM (July 4, 2001)

A public consultation on ENUM is scheduled to start in July 2001. Three major aspects of our preliminary views regarding ENUM are described below:

1: Interoperability between PSTN/ISDN and IP Telephony

Subscribers in a completely IP-based network with IP-based telephones can only be called from PSTN/ISDN networks if the IP subscribers are assigned E.164 telephone numbers. For this reason, we would suggest that the issue of assigning E.164 numbers to ISPs be treated as a prerequisite for interoperability (and for unrestricted ENUM service) and handled by member states with a maximum of coordination and harmonization. Therefore, issues such as the following have arisen:

- What are the pre-conditions for ENUM?
- Which number ranges will be used (geographical telephone numbers)?
- Which conditions should be required for use?

2: ENUM Uses and Benefits

We have also tried to find answers to the question, "Who will derive the most benefit from an ENUM service?"

We believe that it is important to reiterate that the ENUM service is not necessary to allow PSTN/ISDN network subscribers and IP network subscribers to call one another, rather the assignment of E.164 numbers to ISPs / IP network operators as described above.

Consider the following scenario: An IP subscriber in Network A calls another IP subscriber in Network B using an IP-based telephone. In this case, the IP address of the called party, determined via DNS on the basis of the party's telephony domain name, is used for routing. The ENUM service will be extremely valuable if we want to maintain conventional dialling procedures for reasons of user friendliness, i.e., using an E.164 telephone number instead of a telephone domain name (user@host) in order to save the calling party the effort of searching for the telephone domain name manually. We are thus of the opinion that ENUM would be especially beneficial to ISPs which offer voice telephony.

3: ENUM Database Integrity

One essential requirement of ENUM is the integration of the ENUM database with regard to the relationships between E.164 telephone numbers and the assigned subscribers as well as the assigned additional service names and addresses. In this regard, administrative processes would be highly complex, and practical restrictions would limit the updating of the database, similar to the problems in current directory assistance services. Requiring the cooperation of PSTN/ISDN network operators (and ISPs which are assigned E.164 numbers) in such processes is thus indispensable and should be defined in ENUM's regulatory framework. As a general rule, network operators are indeed the only ones who will know the current assignments of E.164 numbers to the appropriate subscribers in their assigned blocks at any given point in time.

APPENDIX 2: QUESTIONS FROM OTHER DOCUMENTS

This section contains a list of questions gathered from a variety of other countries' documents which have been reviewed by RTR.

France

- What types of services will arise from the introduction of ENUM?
- Are these fundamentally new services?
- What influence will ENUM have on existing services?
- Which customer group is addressed?
- What level of penetration can be expected within what period of time?
- How will subscribers react to the service?
- Is the use of conventional telephone numbers truly an advantage in terms of acceptance and acclimation?
- Are trials necessary?
- Who should assume responsibility for these trials?
- What should be the objectives of these trials?
- Are there bottlenecks which can be identified now and would hinder the trouble-free use of ENUM?
- What legal consequences will result from the introduction of ENUM?
- In particular, what will the consequences be for today's voice telephony?
- What consequences will arise from the introduction of E.164 numbers in the ENUM protocol's domain name system?
- What special rules will be necessary in the relationship between E.164 and ENUM?
- Who will define these rules?
- What role should the ITU play in order to ensure the coherence of ENUM and the numbering plan?
- What alternatives are there?
- What is the relationship between the ITU and ICANN?
- How can we maintain the principles of free competition, non-discrimination and transparency in the process of introducing ENUM?
- What role should the ITU and the national number administration agencies play?
- Is it necessary to define a top-level domain for the implementation of ENUM?
- What influence will this have on potential applications?
- What influence will this have on competition?
- What consequences would the implementation of ENUM under various domains have?
- Should Teir-2 activities be reserved for network operators, or should it also be possible for others to offer these services?
- Will it be necessary to ensure competition among Tier-2 operators (as is the case with domain name registrars)?
- How can we prevent piracy or cyberpiracy in domain names and the accompanying telephone numbers?
- What procedures would have to be implemented for number portability (domain name database updates, registration and de-registration of subscribers)?

Sweden

- What is interesting about ENUM?
  Service for calling party (search function, directory assistance) and for called party (real-time service, IP telephony)
- Is ENUM of interest to conventional telecom operators?
- Is ENUM of interest to ISPs which are not assigned E.164 numbers by RTR GmbH and could bypass the system?
- Is ENUM of interest to private network operators?
- Are there other mapping functions between electronic communication networks, such as: Routing addresses (E.353) or roaming functions (E.212)?
- Which ENUM will be generally used? The "official" e164.arpa, or one of the commercial services such as enumworld.org or enum.com?
- Which of these ENUM services has to be regulated?
- Should one ENUM solution be supported/favored by member states or regulators if various ENUM functions are able to establish themselves on the market?
- Who will be delegated the national authority to manage the <cc>.e164.arpa sub-domain by RIPE NCC? Who will be responsible in Austria
- Who is responsible for ensuring that domain names and E.164 telephone numbers are mapped 1:1?
- Who should be the Tier-2 registrar?
- How will number portability be handled in ENUM?
- Who will administer the NAPTR records with the ENUM data?
- Who will finance the ENUM DNS service?
- Who will enter user data, who will delete it, who will guarantee its plausibility and integrity?
- How will the problem of "One number – many users" be handled?

USA

- Who will perform the functions necessary at the various levels (Tiers 0 to 2)?
- How will access to NAPTR records, as well as their security, be ensured?

Netherlands

- Will the realization be as simple as the principle?
- How will the data bases be filled?
- In what time frame will implementation occur?
- What about assigning responsibilities?
- Will users have control over their own numbers
- What will be the role of the telecoms?
- Will they be given special status on the basis of the numbers assigned to them?
- Will they therefore be the first ENUM providers?
- Will pricing then be their responsibility as well?
- Can the telecoms block the way for ENUM?
- Will ENUM services allow telecom services to be bypassed?