Version	Date	Remarks	Author
1.0			Volker Messemer

Minutes of ENUM Day held on 26 September 2006 in Frankfurt am Main

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1. Welcome

(Sabine Dolderer, DENIC eG)

Sabine Dolderer welcomed the participants of the ENUM Day. She observed that the room was rather crowded due to the numerous late registrations and announced Robert Schischka from enum.at .

2. Infrastructure ENUM – Connecting the VoIP-Islands

(Robert Schischka, enum.at)

Robert Schischka, managing director of the Austrian ENUM Registry enum.at and co-director of nic.at, started his presentation with the statement that there were many new providers in the field of telecommunication who offered VoIP and that an increasing number of conventional telecommunication companies also turned to offering VoIP. He prognosticated that the Internet

Protocol (IP) would be dominating future telephone networks, but that it was not yet clear whether solutions based on open standards or closed models would prevail. The latter were being preferred in particular by large carriers because of the interconnection fees. The current standard was the signalling protocol SS7, the prerequisite for enabling interconnection between the closed systems of various carriers. That solution, however, was not recommendable for linking IP-based services. Therefore an Interconnect system based on the Internet Protocol would be the obvious way. The major challenge going with that solution was how to connect existing VoIP islands without the detour via PSTN (Public Switched Telephone Network). Some proprietary solutions already existed for the interconnection of individual VoIP islands. That however, was not of great help but simply moved the problem to the next higher level. Robert Schischka presented Infrastructure ENUM as a potential component suited for the interconnection of VoIP islands. Enum.at was offering infrastructure ENUM in a trial as the first ENUM registry in the world.

Robert Schischka explained the difference between User ENUM and Infrastructure ENUM: In case of User ENUM the final user registered his/her telephone number as an ENUM domain and entered his/her Internet resources. In case of Infrastructure ENUM, in contrast, a carrier registered its telephone number blocks and thus controlled the entries corresponding to the blocks. In case of User ENUM the target addresses were freely accessible and the call flow omitted the carrier. In case of Infrastructure ENUM, in contrast, the carriers remained involved in the call flow so that fee recording and billing became possible. The carriers remained control over the conditions governing the connection. There also was a difference with regard to structure between User ENUM and Infrastructure ENUM. With User ENUM, one telephone number normally corresponded to one ENUM domain, which was delegated accordingly in the DNS. With Infrastructure ENUM, however, whole number blocks were registered. The Austrian Infrastructure ENUM model did not use any delegations, so that a resolution independent from the DNS would theoretically be possible. For that purpose, local database replications were used, which were also placed at the disposal of the carriers. That allowed for deterministic response times. The registering operator could enter even ported numbers in the registry. Compared to User ENUM validation was easier, since the carriers were able to enter and administer only their own number blocks.

To avoid interaction between User ENUM and Infrastructure ENUM, Infrastructure ENUM must be assigned its own number space. In Austria, so Robert Schischka, the subdomain “i” under “3.4.e164.arpa” had been established for that purpose. In the long run, the Austrians wanted a “nicer” solution, better suited for international interoperability of “ie164.arpa”).

The Austrian registry had started a test and production system and placed at disposal a client tool kit based on EPP (Extensible Provisioning Protocol). As software supporting Infrastructure ENUM lookups OpenSER modules were provided and corresponding modules were being planned for Asterisk.

The participating providers concluded peering agreements, so that so-called peering federations, i.e. groups of operators exchanging their VoIP traffic at clearly defined technical and commercial conditions, were formed. Each operator could be a member of various federations. Up to then, six carriers were participating in the trial.

For the complete presentation of Robert Schischka please refer to our website under: http://www.denic.de/media/pdf/enum/veranstaltungen/schischka_20060926.pdf

3. Public Business ENUM

(Dirk Rennekamp, T-Systems Enterprise Services GmbH)

Dirk Rennekamp introduced the term of Public Business ENUM with his presentation. Public Business ENUM is a type of User ENUM particularly designed for the special needs of large and medium-sized companies. He explained that T-Systems had developed an “Enterprise Grade Telephone and ENUM Solution” for this target group, which had the name BENny (Public Business ENUM Router and IP-Media Gateway) and which was the subject of his presentation.

Following the definition of a few terms and abbreviations from the fields of ENUM and telecommunications Dirk Rennekamp described the ENUM query procedure in the context of a call set-up during which the ENUM resolver translated a dialled telephone number into a domain, queried its DNS server for NAPTR entries on the domain, received an URI (Uniform Ressource Identifier) like an SIP address as a response and than used that very URI for establishing a connection.

Afterwards, he gave a presentation of the then current situation. Dirk Rennekamp supported the assumption that PSTN still was the leading model and that VoIP was implemented almost exclusively within closed islands. Up to then, the calls between the VoIP islands were normally routed via the PSTN, and only within the islands themselves subscribers were able to communicate directly via VoIP. That was due to the fact that the address spaces of the VoIP islands were not compatible with each other, that people had reservations concerning the security of the existing VoIP protocols with regard to firewall penetration and tapping of calls as well as to the alleged bad voice quality of VoIP compared to PSTN. One disadvantage of the prevailing situation was the high

communication costs. In addition to that, certain features like “Least Cost Routing” or “Follow Me Services” could be implemented under the current conditions not at all or only at very high costs. Dirk Rennekamp presented the “Public Business ENUM Router and IP-Media Gateway” (BENny) as a possible solution, a simple ENUM-supported system for secure IP telephony via the firewall, with which VoIP islands could be connected. The solution was based on open-source and/or freeware software components with low requirements for the applied hardware. The existing telecommunication system was coupled with a VoIP server in the Intranet, which allowed also for the registration of soft phones. Another VoIP server was located in the DMZ (Demilitarized Zone), which communicated with the server in the Intranet via the IAX (Inter Asterisk Exchange) protocol. The advantage of that protocol was that it could bundle signalling and voice channel, so that only one port had to be opened between Intranet and DMZ. Moreover, the DMZ contained a name server, via which ENUM queries could be posted in the Internet. In the event that a SIP-URI was returned the VoIP server established a direct connection to the target with the DMZ via another firewall without being obliged to use the detour via the PSTN. Own ENUM entries (Naming Authority Pointer Ressource Records, NAPTR-RR) located on the name server in the DMZ could be configured and modified by means of various different clients via an ENUM Web service. So you had the possibility to set automatic profiles from the Intranet with the help of a Windows Tray Client when starting and shutting down the computer, which would define the priority order of the communication addresses under which a staff member could and wanted to be reached. By means of clients for mobile end devices or via a Web browser ENUM entries could also be configured out of the Internet and profiles be administered for various situations (e.g. “on the way”).

Dirk Rennekamp illustrated the solution’s benefits for a company by means of a diagram for a location with 500 IP ports showing the saving potential with regard to telephone costs achievable through Public Business ENUM as a function of the hits of ENUM queries concerning PSTN and mobile phone numbers. On top of that, companies would experience a productivity gain. Productivity of communication would be increased by improved reachability, desktop integration, customized forwarding options and audio and video conferences.
Dirk Rennekamp voiced the opinion that on the one hand the use of Public Business ENUM would cause the ENUM domain business to develop at a lower rate than with Public User ENUM. On the other hand, the critical amount required to achieve noticeable savings would be reached quicker with Public Business ENUM. Development opportunities were granted due to the fact that about

300,000 locations of medium and large enterprises in Germany involving approximately 20 million users were eligible for the use of Public Business ENUM, and 60% of those were expected to replace there telephone exchange systems within the next 4-5 years. Once the critical threshold was passed ENUM would also become of interest to other segments. Dirk Rennekamp assumed a total saving potential for medium and large companies in Germany of about EUR 5-8 billion. The integrated BENny solution shall be available on the market approximately in mid-2007.
For the complete presentation of Dirk Rennekamp please refer to our website under:
http://www.denic.de/media/pdf/enum/veranstaltungen/rennekamp_20060926.pdf

4. ENUM at DENIC: plans and starting points for future projects
(Sabine Dolderer, DENIC eG)

Sabine Dolderer started her presentation with an overview of the various ENUM versions. In case of Public ENUM the final user controlled the stored data and data access is public. That ENUM version was currently offered by DENIC for the German telephone number space. Another version was Private ENUM. Here, data control rested with the Telecom provider or network operators. Data access was limited to authorized persons. Private ENUM was mainly used for telephony routing within VoIP islands. The third version was Infrastructure or Carrier ENUM, which was promoted in Austria, for example. Again data control remained with the Telecom provider, data access, in contrast was open to the public. Infrastructure ENUM was undergoing the process of standardization, but there were many open questions, e.g. on peering policies and rates.
After presentation of the number ranges available for registration, Sabine Dolderer explained that single numbers as well as complete telephone number blocks could be registered via a so-called main number. There was no difference with regard to the fees to be paid to DENIC. Then she explicated the various roles involved in ENUM registration and described the process of validation. In Germany, there were two validation service companies at that time. If an ENUM domain was delegated without appropriate justification, complaint proceedings could be triggered. But up to that time no such complaint proceedings had occurred.
DENIC provided various interfaces for the registration of ENUM domains. With RRI (Realtime Registry Interface) ENUM domains could be registered in real time via a secure connection. MRI v2 (Mail Registry Interface Version 2) enabled a registration by means of signed e-mails. Since mid-September ENUM domains could also be registered via a Web interface.

Sabine Dolderer said that more than 50 members of DENIC offered ENUM domains. The number of ENUM domains registered under “9.4.e164.arpa” was growing slowly but steadily. The number of registered domains did, however, include many more extension numbers. Public ENUM had by then become internationally available in numerous countries, partly as trial and partly in the production environment. Particular difficulties had been faced with regard to the structuring of the country code 1 (North American Numbering Plan) because that country code was a summary code for various countries. So an alternative island solution had been developed in the USA. But at that time, a trial in North America was being planned so that a standardized procedure would become feasible.
Continuing with her presentation, Sabine Dolderer explained DENIC’s strategies with regard to ENUM. She said that the Cooperative intended to advance the services within the framework of Public ENUM and had plans for new developments in cooperation with partners in the fields of Private and Infrastructure ENUM. In this context, ENUM was the component which enabled different worlds to be linked. At that time, the driving element for ENUM was Internet telephony. Potential partners for a further development of ENUM were registrars, service providers, alternative network operators, portals, distributors and the specialized trade as well as producers and system integrators. Their focus lay on different ENUM versions. Sabine Dolderer introduced the various market participants in the field of communication technology, which include the registrant, the network operator, the Internet service and peering provider, the producer and the application service provider as well as the registrars. She illustrated which fields produced which solutions, how cooperation between the various participants was going to develop, what their business relationships would probably be like and how they could gradually develop. At that time, she said, business relationships were rather uncoordinated, but there would be an increasing number of integrated solutions with product bundles.
In the fields of Private ENUM and Infrastructure ENUM there were several island solutions of peering providers at that time. She named XConnect, Switch & Data / Versign and SITA (Société Internationale de Télécommunication Aeronautique) as examples of companies offering derivates of Infrastructure ENUM for closed groups. In the Netherlands, too, five cable network operators had joined together to have their VoIP peering and ENUM directory management technically implemented by XConnect. DENIC was going to offer mainly comprehensive and open solutions in that environment with the focus on connecting the various islands in the field.
Integrated communication platforms were gaining increasing importance in the market. All in all, one could observe that the various networks for which ENUM would play a decisive role like PSTN,

mobile service, video and data networks were growing together. Given this trend, the core competence of DENIC was in the field of guides and directories.

For the complete presentation of Sabine Dolderer please refer to our website under: http://www.denic.de/media/pdf/enum/veranstaltungen/dolderer_20060926.pdf

5. ENUM at RIPE NCC

(Brett Carr, RIPE NCC)

Brett Carr started his presentation with a short overview of the services offered by RIPE NCC in connection with ENUM. RIPE NCC had been entrusted with the operation of the “e164.arpa” domain by the IAB (Internet Architecture Board). One of RIPE’s tasks was the processing of applications for ENUM delegations of E.164 country codes. The according workflow was shortly presented and was available under http://www.ripe.net/enum/instructions.html. Following a presentation of the ENUM team, Brett CAR described the DNS order processing system at RIPE NCC, which enabled the updating of domain objects. Then he pointed out that the ENUM request form for the ENUM delegations of E.164 country codes was updated in August and now had a clearer format and a simpler wording.

Brett Carr gave a survey of the new delegations of country codes made within the last twelve months. During this period, 12 new delegations had been effected including those for Italy, Japan, the North American Numbering Plan (NANP), Greece, Bulgaria, China, and Vietnam. Only the delegation for the Vatikan City was rejected.

In the further course of the presentation Brett Carr showed some statistics on ENUM queries in August 2006. One statistic giving the number of queries per “e164.arpa” name server revealed, for example, that a total of 1,893,792 queries were made in August 2006: That corresponded to 42 queries per minute. It must be taken into account, however, that due to the DNS caching mechanism that number represented only a subset of the actual queries. Another diagram showed the top ten with regard to the number of ENUM queries per delegation. Accounting for a share of 8.45%, German ENUM domains were those queried most frequently. The average number of “9.4.e164.arpa” ENUM domain queries was 0.74 per minute, which again presented only a subset of the actual number of queries. A statistic on queries for ENUM domains from undelegated zones revealed Russia and Belgium to be the leading countries. Another slide of Brett Carr gave an overview of invalid queries, the share of which amounted to 6.6%. The invalid queries were probably caused by misconfigured equipment.

Then Brett Carr represented DNS improvements achieved at RIPE NCC. He showed that it was possible to check DNS delegations by means of a zone delegation checker, which was available under the URL http://www.ripe.net/cgi-bin/delcheck/delcheck2.cgi. Moreover, RIPE was developing an ongoing DNS quality check. Additional progress was achieved with the new support of IPv6 DNS glue name servers. Up to then, only IPv4 glue name servers could be used. Brett Carr showed on the example of a Japanese "1.8.e164.arpa" delegation how IPv6 glue name servers could be stated in ENUM zones.

He finished his presentation with a short introduction of RIPE NCC working groups dealing with ENUM matters. Those were the ENUM and the DNS working group. He pointed out that the next RIPE Meeting was going to take place in Amsterdam from 2-6 October 2006.

For the complete presentation of Brett Carr please refer to our website under:
http://www.denic.de/media/pdf/enum/veranstaltungen/carr_20060926.pdf

6. Telephone Numbers in the DNS (ENUM)
(Patrick Fältström, Cisco Systems)

Patrick Fältström, author of the ENUM standard and chairman of the ENUM Working Group of IETF, started his presentation with explaining the problem that triggered the development of ENUM: It was the use of different communication services, some of which were IP-based and some PSTN-based. However, a convergence towards IP-based communication was being observed. About two billion people were using a numeric pad for addressing a communication partner. ENUM placed at disposal a mechanism that made it possible to link the two worlds. It applied an E.164 address to identify the communication services linked to the address. Identification was achieved by mapping the E.164 number to an ENUM domain. Under the domain, a list of URIs for addressing various communication services was stored. One of the possible features supported by that mechanism was the option to state only one contact address on a business card, which would stand for numerous communication addresses. Patrick Fältström continued with the illustration of user cases including the communication between two IP telephones and that between an IP telephone and a PSTN phone via a VoIP/PSTN gateway. In both cases, he explained, the user dialled an E.164 number. The contact information corresponding to the number was then queried via DNS. E.164 was a standard of ITU-T, which governs addressing within telephone networks on an international level. The standard defined the components permitted in a telephone number and the maximum number of digits it might contain. The mapping of an E.164 number on a domain followed clearly

defined rules, and the contact information was stored in NAPTR-RRs (Naming Authority Pointer Ressource Records). These also provided for the possibility of prioritizing certain communication addresses. The E.164 number space was administered by the ITU-T, which in turn delegated the responsibility for the administration of the number spaces under the country codes to the respective member states. Care of the “e164.arpa” zone had been delegated to RIPE NCC (see presentation of Brett Carr).

Patrick Fältström continued with the presentation of the administration model, the various roles involved and their respective interrelationships.

At that time, an increasing number of discussions was taking place on the use of Infrastructure ENUM, which applied the ENUM of telephony carriers for publishing routing data. The carriers wanted to control the flow of messages that way without revealing information about their customers. Patrick Fältström made clear that ENUM had been designed for the final customer, and that it was not possible that two levels (final user and telephony carrier) disposed of the entries in one zone simultaneously. He went into the economic aspects of VoIP and illustrated the general differences compared to the classical telephony models. With the classical models (PSTN), the telephony carriers gained their earnings from fixed charges and interconnection fees levied for the calls. With VoIP, in contrast, fees were paid for the incoming and outgoing IP traffic. Therefore, new business models different from those used for telephone communication via PSTN and not based on interconnection fees were required for VoIP.

In the further course of his presentation Patrick Fältsröm explained the technical aspects of ENUM. He gave an overview of the available ENUM services, which were registered at IANA up to then, and pointed out that further services would be added. Then he dealt with the difficulties involved in ENUM domain administration and with problems specific to the ENUM protocol. He said that it was possible that several service providers would be interested in the administration of one and the same an ENUM delegation. But as there was only one zone for each ENUM delegation, it was not possible at that time to have it administered by several service providers. On the protocol level problems must be expected if the maximum package size of 512 bytes for responses to an ENUM query was exceeded. According to Patrick Fältström such problems might occur if too many NAPTR-RRs had been stored for an ENUM domain or if DNSSEC was used for the authentication of the response. So the extension mechanism for DNS, EDNS0, which allowed also for lager response packages had to be installed. Given these difficulties, Patrick Fältström had developed concepts and ideas for the next ENUM generation, which was meant to solve the above problems.

The central idea was to structure the ENUM name space more comprehensively, i.e. to create sub-domains under the ENUM domains, as well as to introduce a new resource record type, the URI record, the major component of which was an URI address. This made it possible to lodge targeted queries for certain services and thus avoided that all NAPTR-RRs were transmitted as a general rule every time. That reduced the size of the packages to be transmitted. If, for example, only the SIP service was of interest, the domain "_sip._enum.3.8.0.0.6.9.2.3.6.1.4.4.e164.arpa", under which the corresponding SIP address was stored, could be queried with the phone number +441632960083. The use of NAPTR-RRs was maintained as an additional option. The problem of zone administration by various service providers could also be solved by this procedure, because it would include the creation of corresponding sub-domains, for which the respective service provider would then be responsible. The submitted proposal provided for the possibility to distinguish between the question, which services were available for a domain and which URI existed for a certain service. Further investigations must, however, be carried out with regard to compatibility with the currently used system.

For the complete presentation of Patrick Fältström please refer to our website under:
http://www.denic.de/media/pdf/enum/veranstaltungen/Faeltstroem_20060926.pdf

7. Market Development of VoIP/ENUM

(Klaus Landefeld, DE-CIX Management GmbH, eco)

Klaus Landefeld started his presentation "Market Development of VoIP/ENUM" with the statement that VoIP is one of the fastest growing markets on the international stage, and supported his statement by corresponding figures. All new investments were made in VoIP, nearly no investments were directed to classical telephone systems. All providers, even the classical telephony carriers restructured their core networks so that the Internet Protocol was used as a basis. Great Britain had announced a particularly aggressive conversion strategy, which was to include the complete shut-down of the PSTN before 2010 and its replacement by IP-based networks. Also with regard to operating models, clear changes could be noticed. More and more users preferred connection-related to variable fees, which was expressed by a continuous trend towards flat fees, which had even reached the market sector of mobile telephone services in the meantime.

The situation prevailing at that time was characterized by an aggressive change from PSTN to NGN (Next Generation Networks). Well established providers of conventional telephone services relied on the provision of dual services. In that case communication normally took place within islands,

which were connected via normal PSTN. At that time, standards as well as practical applications only provided for an interconnect via the “classical” SDH networks, i.e. for the digital exchange by means of SS7 switches. Exceptions could be found with new providers offering exclusively VoIP, who implemented the exchange by coupling SIP servers. The established providers had not yet reached an agreement as to how a VoIP exchange should be designed. There was no right to an IP interconnect for the time being. As to ENUM, Klaus Landefeld remarked, that yes, ENUM was available and worked, but in his opinion it was used only to a minimal extent. For the carriers ENUM was a particular challenge because number control switched from the provider to the final customer. Many problems involved in that situation were not yet perceived in all detail, so Klaus Landefeld. He assumed that the majority of the final customers would leave number control to the provider because the only thing that was important to them was that a communication service worked properly.

With regard to market entry barriers for VoIP Klaus Landefeld distinguished between barriers caused by regulations and standards and barriers created by the “establishment”. The barriers due to regulations and standards included for example the request for certain basic services like Legal Interception and emergency call. As barriers created by established providers he considered the lack of an IP Voice Interconnet, the non-existence of an up-to-date agreement for number porting that gave appropriate consideration to new providers, as well as a structure in which DSL and the telephone connection were totally unbundled. He also displayed a critical attitude towards the “IP Network Interconnect” working group created by the German Federal Network Agency because only representatives from the “old” world had been appointed to it but no provider exclusively offering VoIP.

During talks with the established providers it had become obvious that one had to clearly distinguish between regulatory and technical questions because the corresponding contacts in the companies were different persons. One essential requirement of the providers was to keep control over the telephone calls. In this context the question arose, however, how to define the term ‘provider’. All in all, one had to wait for the results of the specialist working group of the German Federal Network Agency.

As critical prerequisites to be met in order to implement a VoIP exchange Klaus Landefeld pointed out a satisfying number of participants in terms of network operators, the participation of key players and the support of the project by the German Federal Network Agency. The attitude towards public

directories like ENUM and the questions concerning the subject of billing (interconnection fees, service numbers, …) had to be clarified.

In the further course of his presentation he outlined approaches that would be possible if the DE-CIX provided a solution for voice peering. In a first step, routing information had to be exchanged, i.e. information about which number can be charged where. The concept behind the idea was the creation of an autonomous system for VoIP (VoIP-AS) to enable a "policy-based" exchange of information. It should be possible to query information in real time as well as to provide it to the participating parties in form of pre-compiled data trees. Decisions concerning the routing or the visibility of telephone numbers in publicly accessible trees should be based on policies, so that different business models were supported. At DE-CIX a working group was dealing with these questions. The open items included among other things, if and to what extent an exchange point for VoIP signalling, e.g. in the terms of Private Infrastructure ENUM, was to be created, how to generate billing information, if to create a platform for the exchange of contents data and how to guarantee the quality of service in that case. Moreover, it was unclear if the concept suited the ideas of the working group of the German Federal Network Agency, which would probably propose a "Federated Walled Garden" for the carriers.

For the complete presentation of Klaus Landefeld please refer to our website under:
http://www.denic.de/media/pdf/enum/veranstaltungen/landefeld_20060926.pdf

8. Tutorial: NAPTR-Records - in ENUM and elsewhere
(Peter Koch, DENIC eG)

Peter Koch started his presentation with explaining the reasons why ENUM had been developed. One reason had been the desire to link the different communication services to one identifier. In this context he pointed out that ENUM could also be used for identity management with an E.164 number being used as identifier.

He valued the fact that the ENUM protocol was being reworked as a proof of its usefulness. He pointed out that ENUM was a DDDS (Dynamic Delegation Discovery Systems, RFC 3401-3405) application, which is also the system used for the definition of NAPTR-RR (RFC 3403).

Peter Koch explained that an AUS (Application Unique String) is formed out of an E.164 number by removing all characters that are no digits except for the leading plus. The AUS is then used to form an ENUM domain by inserting dots between the digits, reversing their order and adding the suffix "e164.arpa".

Then Peter Koch turned to the use of NAPTR-RR in the context of ENUM. NAPTR-RRs made it possible to refer from a domain to an URI. One could store various NATPR-RRs per domain. They were assigned the fields `order`, `preference`, `flags`, `service`, `regexp` and `replacement`. The record type to be stated was NAPTR.

The fields `order` and `preference` contained unsigned 16-bit integer values respectively, which were important for the sequence of implementing the NAPTR-RRs. `Order` defined the absolute sequence in which the rules must be observed. Records with smaller `order` values had to be processed before those with larger values. That was a stringent default. In case of NAPTR-RRs with identical `order` values processing should be determined on the basis of the `preference` value. Again, smaller `preference` values should mean higher priority. Other than the `order` value, the `preference` value was a recommendation the client should but did not have to follow. So the `preference` value left the final choice which NAPTR-RR to select to the client. A problem was, however, that some implementations apparently did not accurately process the stated `order` and `preference` values.

The standard flag used with ENUM was a “u”. It indicated that the result of the request was an URI and the algorithm thus was complete. An empty string in the flag field (“ “) stood for a so-called Non-Terminal-NAPTR. Such a string indicated that further queries were necessary to receive an URI. Empty flag fields were not normally used in standard ENUM operation at that time.

The `service` field stated the protocol of the resolution service followed by the specification of the ENUM service. ENUM always applied the E2U (ENUM to URI) resolution service. The specification of the ENUM services was always introduced by a plus. ENUM services must be registered with IANA via RFC. A list of registered ENUM services was available under the link http://www.iana.org/assignments/enum-services. When running through the NAPTR-RRs for the ENUM tree under “9.4.e164.arpa” Peter Koch had noticed that numerous ENUM services were stated, which were not registered and thus did not represent standards. It was doubtful whether those entries worked. Their operativeness was determined by the degree of tolerance with which client implementations treated these unregistered ENUM services. Even ENUM services defined according to the obsolete RFC 2916 could be found. Peter Koch recommended the providers to preferably use only standardized ENUM services or those, which they knew to be processed by the clients.

The `regexp` field stated how to map the input (the “Application Unique String”) by means of a regular expression onto an URI. The easiest way was to replace the entire AUS by an URI. For exchange installations, more complex regular expressions might be used, e.g. for mapping a group of numbers onto a group of URIs by only one NAPTR. The `regexp` field consisted of several parts, which were separated by anchor characters. The exclamation mark was recommended as an anchor character, other characters were also possible, however. The first section of the field described a matching with the AUS. The second section indicated the elements by which the input should be replaced. However, not all clients implemented regular expressions completely. Special attention must be paid to the use of special characters in the `regexp` field. Under certain conditions these had to be masked to avoid that they were interpreted already by the name server. The `replacement` field always was a dot at ENUM, which meant that no replacement should be made. As a matter of principal, only one of the two fields, i.e. either the `regexp` field or the `replacement` field must contain information if NAPTR-RRs are used. Since ENUM produced an URI as the response to the query, it always was the `regexp` field that was used.

One of the technical prerequisites required for the use of ENUM was the support of NAPTR records. With modern DNS servers, which normally supported RFC 3597, that was no problem. Another technical requirement to be met by the implementations was the ability to process large DNS packages, since an ENUM domain could contain quite a lot of NAPTR records. So the extension mechanism for DNS EDNS0 (RFC 2671) must be supported. It enabled the use of response packages of more than 512 bytes. Peter Koch recommended to provide a configuration e.g. via a web interface in order to save the final customers the necessity to deal with the complexity of NAPTR records. When developing such a web interface the DDDS framework and in particular RFC 3403, the standard for defining NAPTR records, must be taken into consideration.

Peter Koch concluded his presentation with a description of the DDDS framework, for which ENUM was a possible application. Every DDDS application must specify certain parameters. The first one to be mentioned was the “Application Unique String”, which was already referred to above and which corresponded to standardized E.164 numbers in case of ENUM. In addition to that a “First Well-Known Rule” was required, which also was very simple in case of ENUM, because it was the identity rule, where the input was identical with the output (E.164 number). Every DDDS application must specify a “database”, which can be used for the algorithm. For ENUM and other DDDS applications the DNS was currently used as the “database”. Moreover, it had to be determined,

which output was expected within the framework of a DDDS application. In case of ENUM it was an URI.

As an example for another DDDS application Peter Koch referred to ONS (Object Name Service), which was used by the RFID systems. ONS enabled the determination of the product information corresponding to an electronic product code via the DNS. Peter Koch exemplified the DDS algorithm by means of a diagram and pointed out that ENUM was a rather simple application of that algorithm.

Another DDDS application was S-NAPTR (Straightforward-NAPTR, defined in RFC 3958). S-NAPTR enabled the storage of data on services for defined domains.

For the complete tutorial of Peter Koch please refer to our website under:
http://www.denic.de/media/pdf/enum/veranstaltungen/koch_20060926.pdf