

ENUM FINAL REPORT

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Abstract <p>On 17 April 2003, FICORA established a working group to plan the national ENUM pilot architecture, coordinate the pilot and to give recommendations for commercial ENUM operations. The working group completed the ENUM pilot plan in November 2003. This report is the final report of the national ENUM pilot group and describes the group's recommendations for commercial administration of the 8.5.3.e164.arpa domain. Chapter 1 Introduction also shortly describes the national ENUM pilot and its results.</p> <p>The working group recommends that the Tier 1 operator should be chosen in beauty contest using the rules defined later in this document. Pilot group's proposals for commercial phase Tier 1 architecture, functions and requirements are described in Chapters 3 and 4. The group's proposal for the criteria to be used to choose the Tier 1 operator are described in Chapter 5. Working group also gives some requirements for Tier 2 name service providers, ENUM registrars and validation entities in chapters 6, 7 and 8.</p> <p>The working group have held 19 meetings and attended by the following organisations: FICORA, Elisa Corporation, Finnet, Nordic LAN&WAN Communications Oy, Saunalahti Group Oyj, Song Networks Oy and TeliaSonera Finland Oyj. The organisations have been represented by the following persons:</p> <p>Antti Pokela (Ch) (FICORA), Henry Fils (Elisa Corporation), Tero Forsström (Saunalahti Group Oyj), Hannu Gylden (FICORA), Mikko Haikonen (Elisa Corporation), Matti Halonen (TeliaSonera Finland Oy), Lasse Halttunen (Finnet-liitto ry), Petteri Hummelin (Finnet Oy), Kim Jakobsson (Song Networks Oy), Petri Karttunen (Softera Oy/Finnet), Sami Kilkkilä (FICORA), Esko Kuitunen (TeliaSonera Finland Oyj), Marko Lahtinen (FICORA), Timo Läärä (Song Networks Oy), Klaus Nieminen (Secr) (FICORA), Lauri Nikkanen (TeliaSonera Finland Oyj), Jyri Puumalainen (Finnet Oy), Tuomo Rostela (Elisa Corporation), Kari Salmela (Nordic LAN&WAN Communications Oy), Katja Tiainen (Song Networks Oy) and Simo Tossavainen (Song Networks Oy).</p>			
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YHTEENVETO - FINNISH SUMMARY

ENUM on IETF:n määrittelemä teknologia (RFC 3761), jossa E.164-numeroista muodostetaan Internetin nimipalvelinjärjestelmän mukainen domainnimi. Esimerkiksi puhelinnumeroa +358 9 6966 634 vastaava ENUM-nimi on 4.3.6.6.6.9.6.9.8.5.3.e164.arpa. Saadun ENUM-nimen avulla voidaan osoittaa useita kyseiseen E.164-numeroon liittyviä viestintäpalveluita, kuten Internet-puhelinta tai sähköpostia.

Tämä työryhmäraportti on 17.4.2003 perustetun ENUM-pilottityöryhmän loppuraportti ja se kuvaa lyhyesti työn taustat sekä pilotin rakenteen ja tulokset. Laajan kansainvälisen kiinnostuksen takia raportin kieleksi valittiin englanti. Kansallinen ENUM-pilotti alkoi 1.12.2003 ja sen on tarkoitus päättyä 1.6.2005. Pilotin tarkoituksena oli hankkia käytännön kokemuksia erilaisten ENUM-mallien soveltuvuudesta ja niiden ylläpidon järjestämisestä. Pilotti oli avoin kaikille aiheesta kiinnostuneille yrityksille sekä yksityishenkilöille.

Pilotin aikana työryhmä määritteli ja toteutti Tier 1-operaattoritestihojelmiston. Viestintävirasto jakaa ohjelmistoa ilmaiseksi kaikille siitä kiinnostuneille. Lisätietoja on saatavissa osoitteesta: <http://www.ficora.fi/suomi/tele/enum.htm>.

Pilotin tuloksena työryhmä päätti suositaa kaupallisen ENUM-toiminnan aloittamista ja tämän raportin päätarkoitus onkin kuvata työryhmän antamat suositukset kaupallisen ENUM-palvelun järjestämisestä perustuen pilotissa testattuun Tier 1-operaattoriohjelmistoon. Työryhmä on antanut suosituksia Tier 1 ja Tier 2 palveluntarjoajille, rekisteröinnin hakijoille, rekisteröijille sekä käyttöoikeuden varmistajille asetettavista vaatimuksista. Alla luettelo tärkeimmistä suosituksista:

- Tier 1-toiminteet (nimipalvelu, rekisteröintipalvelu sekä käyttöoikeudentarkistusprosessi) tulee toteuttaa markkinalähtöisesti.
- ENUM-nimen voi rekisteröidä tai rekisteröintiä voi muuttaa vain kyseisen E.164-numeron tilaaja tai tilaajan valtuuttama palveluntarjoaja.
- Rekisteröinnin hakijalla tulee olla oikeus valita rekisteröijänsä, Tier 2-nimipalveluntarjoajansa sekä muiden ENUM:iin liittyvien palveluidensa tarjoajat.
- Tier 1-operaattoripalvelu tulee kilpailuttaa kauneuskilpailulla 3-4 vuodeksi kerrallaan.
- Tier 1-operaattorin tarjoaman palvelun arviointia ja kaupallisen vaiheen koordinoitua varten Viestintäviraston tulisi perustaa ENUM-koordinointiryhmä.
- Tier 1-operaattorivalinnan tekee Viestintävirasto.
- Kaupallisen vaiheen toimijoiden tulee toteuttaa ainakin työryhmän määrittelemä salasanaan perustuva käyttöoikeudentarkistusprosessi.

Näiden vaatimusten lisäksi työryhmä on asettanut Tier 1-operaattorille sekä muille toimijoille useita muita vaatimuksia, jotka on kuvattu tässä dokumentissa.

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1 INTRODUCTION

ENUM is a technology that defines the transformation of E.164 numbers into DNS (Domain Name System) names. This ENUM domain name can be used to point associated contact information, e.g. IP-telephony, email, fax and web addresses, stored in NAPTR resource records. ENUM is defined in RFC 3761. For instance, telephone number +358 9 6966 634 corresponds to ENUM name 4.3.6.6.9.6.9.8.5.3.e164.arpa. By means of the generated ENUM name it is possible to assign various communications services, such as Internet phone or email, to the relevant E.164 number.

The working group believes that the permanent commercial introduction of ENUM would facilitate technological development of the electronic communications and information society services in Finland. Therefore, the group recommends that the Finnish Communications Regulatory Authority (FICORA) should promote the commercial introduction of ENUM in Finland.

This report briefly summarises the national ENUM pilot, but the main focus of this report are the commercial phase requirements to be set to different ENUM entities. The working group suggests that the Tier 1 operator requirements defined in this report should be used as a basis for Tier 1 operator beauty contest requirements.

1.1 Background

On 28 November 2001, the Finnish Communications Regulatory Authority (FICORA) established a working group to study ENUM technology and to give recommendations for national ENUM administration. The ENUM basic study working group completed its work¹ on February 28, 2003 and recommended that a national ENUM pilot should be started. To enable the national ENUM pilot, FICORA registered the 8.5.3.e164.arpa domain from RIPE NCC in February 2003.

On 17 April 2003, FICORA established an ENUM pilot working group to plan the national ENUM pilot architecture, coordinate the pilot and to give recommendations for commercial ENUM operations. The working group completed the ENUM pilot plan² in November 2003. This report is the final report of the national ENUM pilot group and describes the group's recommendations for commercial administration of the 8.5.3.e164.arpa domain. The working group was attended by the following organisations: FICORA, Elisa Corporation, Finnet, Nordic LAN&WAN Communications Oy, Saunalahti Group Oyj, Song Networks Oy and TeliaSonera Finland Oyj.

The national ENUM pilot was launched on 1 December 2003 and it is scheduled to end 1 June 2005. The purpose of the pilot was to get practical experience from various ENUM models, applications and from organisation of different ENUM entities. However, the main focus of the pilot was to get experience on Tier 1 management and ENUM domain validation processes and therefore be able to give recommendations for commercial administration of the 8.5.3.e164.arpa domain. During the pilot Tier 1 service was provided by FICORA. The pilot was open to all interested companies and individuals.

1.2 Pilot description

The Finnish ENUM pilot was based on a single Tier 1 registry operated by FICORA and NAPTR records were administered in Tier 2 or Tier 3 levels. The reference architecture and possible interactions between different entities used in the pilot are presented in Figure 1. In practise, the pilot architecture was more simplified, because there were no independent ENUM service providers and registrar and Tier 1 operations were both carried out by FICORA.

¹ FICORA WG report 2/2003: ENUM Basic Study Report (in Finnish), <http://www.ficora.fi/suomi/document/Tyoryhmaraportti022003.pdf>

² FICORA WG report 4/2003: ENUM Pilot Plan (in Finnish), <http://www.ficora.fi/suomi/document/Tyoryhmaraportti042003.pdf>

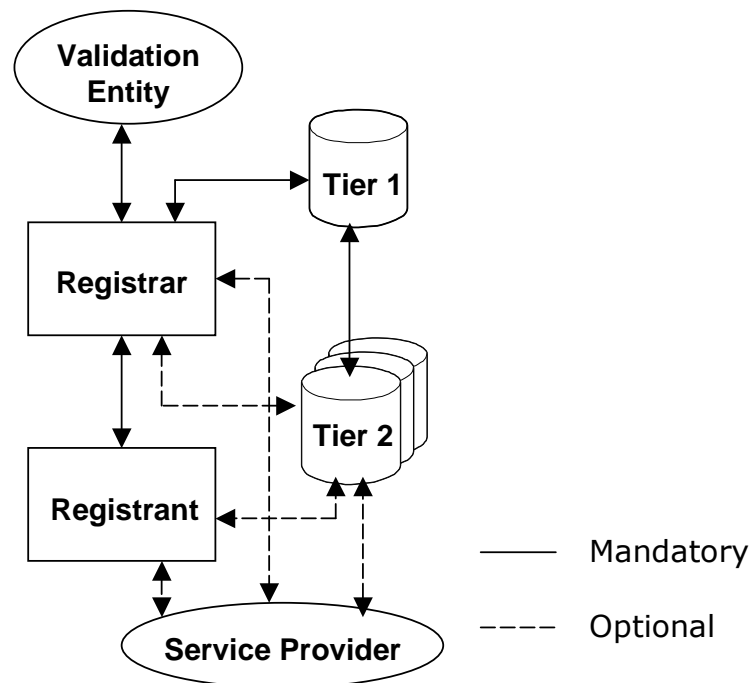


Figure 1: ENUM pilot reference architecture

During the pilot, the participating operators offered validation and registration services for their customers requesting a delegation. Most participants also provided their own Tier 2 name services and no real commercial business cases were tested. Either no independent ENUM service providers emerged. For 071-numbers validation and registration functions were provided by FICORA.

ENUM pilot working group implemented an ENUM Tier 1 operator software that is available for all interested parties. The software is intended to enable organisations to test Finnish Tier 1 structure, but organisations also have a freedom to develop the software further or use it commercially (the software is under BSD licence). Interested organisations may order the software for free from <http://www.ficora.fi/englanti/tele/enum.htm>.

The Finnish ENUM reference architecture and system interfaces were tested using the Tier 1 software. The application had an IP-access to a number database including all ported numbers. Some participants implemented their own IT-based validation procedures for some of the existing number ranges. The validation procedures were based on subscriber's telephone number and unique password. However, the password delivery mechanism to the subscribers was not implemented. At least one operator tested web-based self-service interface for pilot users. Pilot users of this operator had possibility to change NAPTR-records on Tier 2 name servers in real time.

The main result from the pilot was that ENUM technology seems to work and it can be used for instance for routing of multimedia sessions (e.g. phone calls) on top of IP-networks. From operator's perspective, global ENUM can provide benefits, but many of the services can also be implemented using ENUM technology internally (infrastructure/carrier/operator ENUM).

However, these private solutions still rely heavily on the existing circuit switched infrastructure and the global reachability may only be achieved through PSTN, which also limits the supported service selection to PSTN services. In addition, global ENUM gives subscribers more control over their communication services.

The working group found that there are only few ENUM enabled applications available in the market and business case is still at least somewhat unclear. Despite this fact, the working group believes that the permanent commercial introduction of ENUM would facilitate technological development of the electronic communications and information society services and that ENUM should be commercially introduced in Finland.

2 TIER 1 MANAGEMENT

The Finnish Communications Regulatory Authority (FICORA) coordinates numbering in telecommunications networks and specifies the national numbering plan. FICORA is also the domain name holder for the ENUM domain 8.5.3.e164.arpa corresponding to the Finnish country code (+358). To enable the national ENUM pilot, FICORA registered the 8.5.3.e164.arpa domain from RIPE NCC in February 2003. The domain was delegated to a name server managed by FICORA.

It is suggested that FICORA should maintain a static Tier 1 service also in the commercial phase and further delegate the whole domain to a commercial Tier 1 operator. According to pilot group's analysis, this additional level should not have any significant impact on the overall system performance and it should enable FICORA to maintain greater level of control over the system. When the ENUM market stabilises this decision should be reconsidered.

Due to the DNS system overall architecture and design, the chosen Tier 1 operator has a natural monopoly over the national ENUM domain and must fulfil the requirements set in Act on Competition Restrictions. Therefore, the operator should be chosen in beauty contest using the rules defined later in this document. Pilot group's proposals for commercial phase Tier 1 architecture, functions and requirements are described in Chapters 3 and 4. The group's proposal for the criteria to be used to choose the Tier 1 operator are described in Chapter 5.

If none of the companies fulfilling the requirements set for Tier 1 operations is willing to maintain the Tier 1 service and commercial interest to use ENUM still clearly exists, the working group suggests that the authorities could also administer the Tier 1 service temporarily. However, it is strongly recommended that the service should be financed on a commercial basis.

The static Tier 1 operations managed by FICORA shall fulfil the availability and reliability requirements set for the Tier 1 operator. In addition, static Tier 1 shall have at least two secondary name servers fulfilling the same requirements.

FICORA should inform the Tier 1 operator of any foreseeable or occurring changes regarding the ENUM TLD 8.5.3.e164.arpa without delay.

3 COMMERCIAL PHASE TIER 1 OPERATIONS

The ENUM pilot group suggests that the commercial phase architecture should be based on the principles described in this section. However, the Tier 1 operator should have a commercial freedom to develop the service further. This could be done for instance by adding additional functions and interfaces that enhance the service provided to registrars, Tier 2 name service providers or validation entities. The architecture description should not prevent this development and it can be considered to provide only the required minimum service level.

The Tier 1 operator has to provide Tier 1 registry, registrar and Tier 1 name service operations as defined in this document. In addition, the Tier 1 operator can also provide Tier 2 name services, but all third party providers should be treated in a non-discriminatory manner. The Finnish commercial phase reference architecture is described in Figure 2.

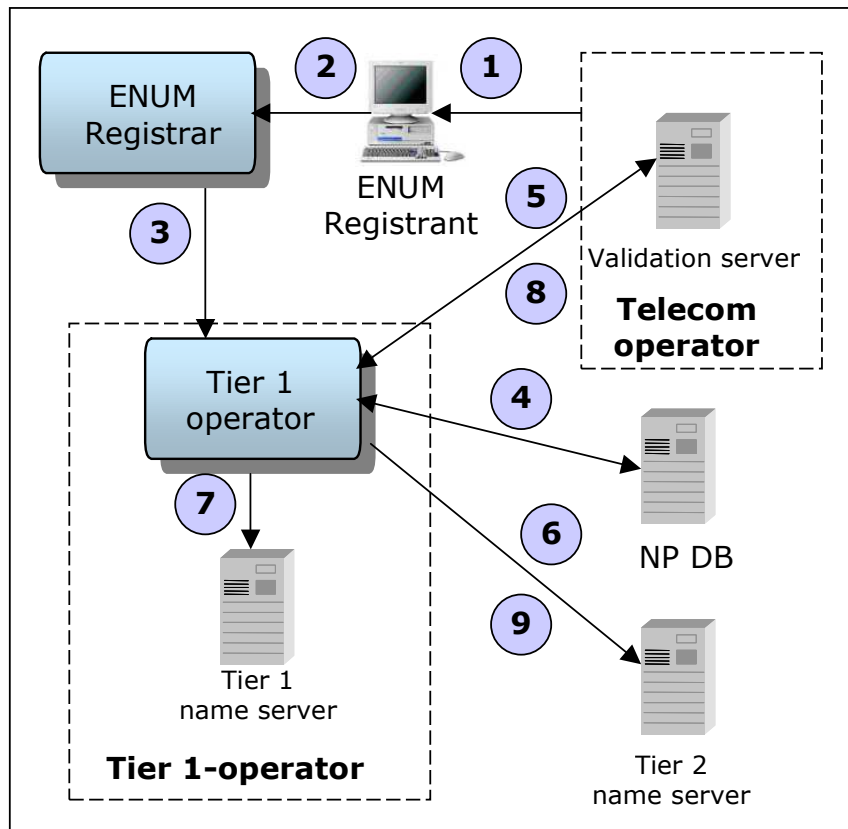


Figure 2: Tier 1 reference architecture – a new registration

The commercial phase is based on a contract between the chosen Tier 1 operator and FICORA. The Tier 1 operator's compliance with the contract and the operation of other ENUM entities are supervised by an ENUM coordination group which will be formed after the commercial phase has started. The group is also responsible for formulating the rules for choosing the next Tier 1 operator and accepting possible new validation methods. The group will be open for all interested parties.

3.1 Registration process

This section presents a possible ENUM domain registration process for a new ENUM domain and the Tier 1 functions. The chosen Tier 1 operator can also provide other registration mechanisms.

1. **Giving the password:** First all ENUM registrants must receive their ENUM password from their telecommunications operator that is serving the corresponding E.164 number. The password is used in the validation phase (5) to check the authorisation.

2. **Registration:** ENUM registrant sends an ENUM domain registration request to ENUM registrar. In practice, the ENUM registrar can be an ENUM service provider, enterprise registering its own number range or the Tier 1 operator. This middle-level is necessary to ensure that the customer relationship between the ENUM registrant and the ENUM registrar remains even though the Tier 1 operator is changed.
3. **Registration to Tier 1:** ENUM registrar sends an ENUM registration request to the Tier 1 operator.
4. **Finding the current operator:** To be able to perform validation, the Tier 1 operator needs to find the current operator serving the corresponding E.164 number or numbers. This can be done for instance by means of the national number portability database.
5. **Validation:** The Tier 1 operator performs validation for instance by sending validation requests to the current operator.
6. **Tier 2 name service validation:** The Tier 1 operator checks if the given Tier 2 name servers exist and that they fulfil the technical requirements that are set for SOA records (MNAME field, zone contact and serial numbers).
7. **Delegation:** The Tier 1 operator makes the requested delegation to Tier 1 name server.
8. **Re-validation:** The Tier 1 operator must be able to know if the registrant's right to use the E.164 number has expired and to remove the corresponding delegation. This can be done by routine checks and by receiving removal requests from validation operators.
9. **Tier 2 notice:** The Tier 1 operator should also notify the registered Tier 2 name service providers about expired delegations so they can remove the corresponding \$ORIGIN/NAPTRs from their DNS servers.

3.2 ENUM entities

This section describes the mandatory entities in the Finnish ENUM reference architecture. The division is logical and it does not prevent the providers from acting in several roles. For example, it could be reasonable for Tier 2 name service providers to provide also ENUM registrar functionality.

3.2.1 ENUM Registrant (ENUM subscriber)

ENUM registrant is the entity authorised to request ENUM delegations. In the commercial phase ENUM registrant can either be the subscriber of the corresponding E.164 number or a service provider authorised by the subscriber. Due to the opt-in principle, ENUM domains can be added and modified only with the express consent of the subscriber authorized to use the corresponding telephone number.

ENUM registrants have the right to choose their registrar and Tier 2 name service providers freely regardless of their telecommunications operator.

3.2.2 ENUM Registrar

In the commercial phase ENUM registrar is a thin front-end providing a constant ENUM domain registration service to ENUM registrants also in situations where the Tier 1 provider changes. Even though this entity may not be necessary it is described to provide consistency towards ENUM registrants.

3.2.3 Validation Entity

Validation entities are responsible for the validation of the ENUM domain. Currently ENUM domains can only be validated by telecommunications operators. In this document validation process is

described to be based on a password that the ENUM registrant can receive from his/her telecommunications operator. In addition to giving the password, validation entities are required to maintain validation servers that can be queried to check the authorisations of the delegation. The Tier 1 operator can also develop alternative validation mechanisms.

3.2.4 Tier 1 operator

The Tier 1 operator is a key entity in the Finnish ENUM architecture. The Tier 1 operator is a de-facto monopoly for Finnish ENUM domain (8.5.3.e164.arpa) and it is responsible for maintaining the Tier 1 registry and name service functions and to provide the following additional functions: reliable validation process, ENUM registrar service and service information on its WWW pages.

3.2.5 Tier 2 name service provider

Tier 2 name service providers are responsible for hosting the actual NAPTR records. Tier 2 name service can be provided as a commercial service or the ENUM registrant can provide its own Tier 2 name service functionality.

3.3 Permitted number ranges

The Tier 1 operator may only delegate an ENUM domain whose corresponding E.164 telephone number lies in one of the all national number ranges:

- Geographic telephone numbers
- Mobile telephone numbers
- Universal access numbers
- National service numbers
- Nationwide portable numbers
- Nationwide reachability numbers

The ability to make ENUM registrations depends on the availability of the validation service for the corresponding number range. If the integrity of a number range appears to be endangered, FICORA should have the right to impose general restrictions on the approval of the respective number range for ENUM use.

3.4 Validation

The Tier 1 operator is responsible for ensuring that all delegations are authorised by the subscribers of the corresponding E.164 numbers. The working group has defined a password based authorisation mechanism that has to be implemented by the Tier 1 operator. The Tier 1 operator may also develop other validation mechanisms. The ENUM coordination group must approve all new validation mechanisms.

Password based validation as defined by the working group is a very strong validation and re-validation mechanism, but it requires telecommunications operators providing services for the corresponding E.164 numbers to provide passwords and validation servers. Therefore, large-scale usage of this mechanism requires co-operation of all significant telecommunications operators.

The working group suggests that co-operation should be achieved on a commercial basis. As a matter of fact, the current legislation³ does not impose on telecommunications operators any obligations to provide such services. Therefore, if co-operation is not achieved, the working group has identified three alternatives:

1. To develop new validation mechanisms
2. To introduce a new ENUM-only number range
3. To amend existing legislation

³ Communications Market Act (393/2003)

4 TIER 1 REQUIREMENTS

This chapter describes the Tier 1 operator's mandatory commercial phase function and interface requirements. The pilot group suggests that the Tier 1 operator must at least:

- Receive ENUM registration requests
- Validate the registrant's right to use the corresponding E.164 number
- Validate the correct function of the provided Tier 2 name servers
- Make, change and remove delegations
- Re-validate the right to use the corresponding E.164 number
- Remove the expired delegations
- Maintain WWW pages describing the service
- Fulfil the set availability, reliability, security and privacy requirements
- React and solve possible fault and misuse issues
- Fulfil other technical requirements

In addition, the Tier 1 operator has to report the required information to FICORA. The chosen Tier 1 operator must also provide registrars with the necessary support infrastructure for problems and inquiries. This infrastructure includes web sites, documentation as well as a registrars' service reachable by e-mail/telephone/fax. In addition, the Tier 1 operator should inform the losing registrar about the registrant's change of registrar.

4.1 Receipt of ENUM registration requests

The Tier 1 operator must ensure transparent, objective and non-discriminating delegation of ENUM domains for registrars. The Tier 1 operator has to be able to receive registration requests from registered ENUM registrars via an XML-RPC interface defined in Appendix 1. In addition, the Tier 1 operator has to provide the registrar function for ENUM registrants via a WWW registration interface.

When an ENUM registrant or registrar requests an ENUM domain delegation, the Tier 1 operator must review the application for completeness and verify that the telephone number corresponding to the ENUM domain applied for lies within the permitted number range.

If validation gives a positive answer, the Tier 1 operator must proceed according to Section 4.2. If validation gives a negative answer, the Tier 1 operator must proceed according to Section 4.11.

4.2 Validation of the registrant's right to use the corresponding E.164 number

The Tier 1 operator is responsible for ensuring that all delegations are authorised by the subscribers of the corresponding E.164 numbers. The working group has defined a password based authorisation mechanism that has to be implemented by the Tier 1 operator. Also other validation mechanisms may be used, after the ENUM coordination group has approved them.

Password based validation:

E.164 subscribers that want to register their corresponding ENUM domains can receive a validation password from their telecommunications operator. The Tier 1 operator has to be able to validate the ENUM domain by using the E.164 number and password.

To be able to perform validation, the Tier 1 operator needs to find the current operator serving the corresponding E.164 number or numbers. This can be done for instance by means of the national number portability database. After the current operator is identified, the Tier 1 operator must send a validation request to the corresponding operator using the interface defined in Appendix 2.

If validation gives a positive answer, the Tier 1 operator should proceed according to Section 4.3. If validation gives a negative answer, the Tier 1 operator must proceed according to Section 4.11.

To be able to send the request, the Tier 1 operator must have a contract with the operators providing the validation service. The Tier 1 operator may only accept contracts that provide validation for adequate number ranges. The issue is described in more detail in Chapter 6.

4.3 Tier 2 name server validation

The Tier 1 operator must validate that Tier 2 name servers exists and fulfil the technical requirements set in Chapter 6 for SOA records (MNAME field, zone contact and serial numbers).

If validation gives a positive answer, the Tier 1 operator must proceed according to Section 4.4. If validation gives a negative answer, the Tier 1 operator must proceed according to Section 4.11.

4.4 DNS operations: make, change and remove delegations

The Tier 1 operator is responsible for the following DNS operations: making new delegations and changing and removing the existing ones. These DNS updates must be automatic and dynamic and the Tier 1 operator must create a new log file entry from all DNS updates. The log file must include at least the following information: the operation, name of the entity or person who initiated the operation, time when it was initiated and completed, and addresses used in the operation.

The Tier 1 operator can only perform valid DNS operations. This means that before making any DNS operations, the Tier 1 operator has to check the validity and authorisation of the request. Also Tier 2 name servers have to be validated in the case of new or changed delegations.

The Tier 1 operator must inform the ENUM registrar if the operation is successful. If the operation fails, the Tier 1 operator must proceed according to Section 4.11.

4.5 Re-validation

The Tier 1 operator must be able to receive and process removal requests from validation entities using the XML-RPC interface described in Appendix 3. The Tier 1 operator must verify that the validation entity has the right to send the removal request for the domain in question. After the authorisation is verified, the Tier 1 operator must remove the domain as described in Section 4.6.

In addition, the Tier 1 operator must check the whole domain periodically to find out if the number is ported to an operator that does not provide validation service to the corresponding number range or if the registrant has not bought the validation service from the operator. The routine check can be done by querying the validation servers. Because, the Tier 1 operator does not have to store the password, the query can be made without the password, because in this case it is adequate to obtain information about whether or not the entry exists.

If validation gives a negative answer, the Tier 1 operator must proceed according to Section 4.6. If the validation fails, the Tier 1 operator must proceed according to Section 4.11.

4.6 Removal of expired delegations

The Tier 1 operator must remove the expired delegations when receiving a valid request from the validation entity or ENUM registrar responsible for the corresponding ENUM domain or if the re-validation described in Section 4.5 gives a negative answer.

In addition, the Tier 1 operator must notify the corresponding registered Tier 2 name service provider (the interface is described in Appendix 4) and ENUM registrar about the removal of an ENUM domain.

If the removal fails, the Tier 1 operator must proceed according to Section 4.11.

4.7 Maintenance of WWW pages describing the service

The Tier 1 operator must maintain a web site describing the service and providing a WWW registration interface for ENUM registrants.

Tier 1 operator's web site should provide a simple means of retrieving information on whether the domain for a certain telephone number has been delegated or not. Data on the registrant associated with the number shall not be revealed. If an ENUM delegation exists for the telephone number queried, the current registrar (name and contact information) for the ENUM domain shall be displayed as well.

4.8 Availability and performance

The 8.5.3.e164.arpa zone must operate on at least 2-3 different and physically separate name servers. Each of the name servers must be connected to the Internet by at least one upstream connection with sufficient capacity.

The operation of the DNS zone must be carried out exclusively on name servers dedicated to this purpose and owned or accessed directly by the Tier 1 operator. At least one of the name servers must be located in Finland. The name servers must be operated in protected IT center environments and integrated into a distributed monitoring and performance measurement system. The appropriate maintenance agreements must be concluded for name servers that cannot be maintained 24x7 by the operator itself.

The registry systems must be operated in a protected IT center environment with 24x7 monitoring and maintenance of the servers. The databases and applications must be backed up on external data media on a regular basis.

The responses in name service, XML-RPC and WWW interfaces must be real-time and fulfil the criteria presented in the Tier 1 operator application. The response time of the Tier 1 name servers must be under 20 ms in 90% of the cases and it must not exceed 100 ms. Registrar software must be able to process at least 150 simultaneous ENUM operations (make, change and remove delegations).

4.9 Security and privacy protection

The Tier 1 operator must actively maintain the security of the Tier 1 name servers, registry software and WWW pages. The Tier 1 operator must store all registry transactions to log file. The log file must include at least the following information: the operation, name of the entity or person who initiated the operation, time when it was initiated and completed, and addresses used in the operation.

The registry interface provided to registrars must be encrypted at transport level. Administrative access to the registry must be restricted to authorised registrars only, and the registry must be protected from unauthorized access by security measures at network level.

Tier 1 operator should also observe the Domain Name System Security Extensions (DNSSEC) deployment status and consider implementing DNSSEC when it seems to be appropriate.

4.10 Other technical requirements

The Tier 1 operator must ensure that the SOA record (Start of Authority) defining the configuration of the name server of the domain name complies with the following aspects:

- The MNAME field shall contain the name of the primary name server of the domain name.
- The Zone contact field shall contain a working e-mail address.
- The serial numbers and timers cannot differ essentially from published Internet standards and recommendations listed in Appendix 5.

4.11 Fault handling

The Tier 1 operator must be able to handle possible error situations and rejections. The ENUM pilot group has identified several such cases which are listed below. The list may not be exhaustive and the operator must be able to handle also other possible error situations and rejections. Different fault situations can be divided into the following categories:

4.11.1 Internal failures

Internal failures include all error situations caused by an internal malfunction (e.g. in Tier 1 registry or name service software). The pilot group has identified the following failure scenarios:

- **Tier 1 name service failures:** Tier 1 name service is the most critical part of the Tier 1 operator's service offering and all failures that prevent DNS queries to return the correct responses in real-time shall be considered critical. Tier 1 name service must have 24*7 maintenance to respond to possible fault situations. All fault situations in Tier 1 name service must be reported to FICORA as soon as possible.
- **Tier 1 registry failures:** Also Tier 1 registry failures are considered critical and the Tier 1 operator must have 24*7 maintenance to respond to possible fault situations. All fault situations in Tier 1 registry service must be reported to FICORA as soon as possible.
- **www page failures:** The faults in Tier 1 operator's WWW services must be reported and the Tier 1 operator must try to solve the problem at least within the next business day.

If the failure has occurred during a Tier 1 registry update, the Tier 1 operator must stop the processing of the change request and send a proper error report to the initiator of that request. The request must be processed within the next business day - even manually, if required.

4.11.2 External failures

These failures are related to the external services used in the delegation process. The ENUM pilot group has identified several such cases as listed below, but the Tier 1 operator must be able to handle also other possible failures.

- The current operator cannot be identified due to a missing response or an error message received from the number portability database.
- Validation cannot be performed due to a missing response or an error message received from the queried validation server.
- Tier 2 name serve cannot be validated due to a missing response or an error message received from the queried Tier 2 name server.

The Tier 1 operator may try the operation again, but if no correct response is received, the Tier 1 operator must reject the registration request and return an error message to the ENUM registrar. The cause of the rejection has to be returned in the error message.

If the external failure is faced in the routine re-validation check or if the removal request received from a validation entity is incorrect, the Tier 1 operator should try the operation again and if the re-validation check fails again the Tier 1 operator must report the fault to FICORA and check the problem offline. If no response is received within one week, the Tier 1 operator must remove the delegations and inform the corresponding ENUM registrant and registrar.

4.11.3 Rejections

Rejections include all error cases where the operation cannot be completed due to negative validation answer. In more detail, the ENUM pilot group has identified the following cases where operation has to be interrupted:

- Registration request is incorrect or the applied ENUM domain lies outside the permitted number range
- Validation request returns a negative answer or the number cannot be validated
- Tier 2 name server configuration is incorrect

In these cases, the Tier 1 operator must reject the registration request and return an error message to the ENUM registrar. The cause of the rejection has to be returned in the error message.

5 CHOOSING THE TIER 1 OPERATOR

Due to the DNS system overall architecture and design, the chosen Tier 1 operator has a natural monopoly over the national ENUM domain. Therefore, the operator should be chosen in a beauty contest using the criteria defined in this chapter. The ENUM pilot group suggests that the Tier 1 operator is chosen for a period of 3 to 4 years. Also a shorter period may be considered, if Tier 1 operator candidates request it.

The suggestion is that FICORA should found an ENUM coordination group to coordinate the commercial phase and to evaluate the received applications. However, the selection decision should be made by FICORA. The ENUM pilot group suggests that all applications should include the following information:

- Tier 1 registry and name service operation plan and financial plan
- Tariffs and pricing principles that are valid for the whole period

5.1 Selection criteria

The ENUM pilot group suggests that the Tier 1 operator applicants should be evaluated according to the following criteria:

- Services offered
- Service charge level per registration
- Service quality in terms of availability, reliability and security
- Mechanisms to achieve the planned service quality targets and to deal with possible problems

In addition, the following criteria should also be taken into account:

- The experience of running an independent operational organisation with function similar to that of the proposed registry
- Financial ability of the provider in case there is lesser or greater demand for ENUM registrations than anticipated
- Provider's understanding of the purpose and potential of ENUM and the ability to innovate and improve its operations.

It is strongly suggested that applicants try to answer these question as well as possible, because any lack of information can be considered as a weakness.

5.2 Contractual issues

It is suggested that FICORA should invite a new tender at least six months before the end of the contractual period and the new Tier 1 operator should be chosen at least four months before the end of the contractual period. The chosen Tier 1 operator must have the right to take part also in the next invitation to tender without restrictions.

If the contract between FICORA and the chosen Tier 1 operator ends and it is not extended, the Tier 1 operator must convey all data necessary for further operation to FICORA. In all cases, this data shall include the entire database for the 8.5.3.e164.arpa zone, especially the data on all active and suspended ENUM domain delegations – including any Tier 2 name service provider and

ENUM registrar information needed to ensure the continuous operation of the Tier 1 service. The data is to be conveyed at such time and in such form that it enables an interruption-free transition of operation to a third party, insofar as this is technically and economically feasible.

It is also suggested that the chosen Tier 1 operator should not have a right to compensation for investments when the Tier 1 contract ends. This should also apply in cases where FICORA exercises its right to premature rescission.

Technical and operational planning shall be left up to the Tier 1 operator, provided that the requirements described in this document are fulfilled and the commercial operation is started within a maximum of six months after conclusion of the Tier 1 operator agreement.

It is proposed that the chosen Tier 1 operator should have the right to terminate the contract as of the last day of each month with due adherence to a six-month notice period. The termination notice should be sent to FICORA in writing.

FICORA may also rescind the Tier 1 agreement prematurely and unilaterally for substantial reasons that would make it unacceptable to continue the contractual relationship. In this case, FICORA must inform the Tier 1 operator about the decision in writing. The possible reasons include any behaviour not in good faith by the Tier 1 registry, the opening of bankruptcy proceedings for the Tier 1 operator or any severe violation of the Tier 1 requirements. However, FICORA and the Tier 1 operator should first try to solve the problem.

In the case of premature rescission (except in cases where Finnish ENUM TLD is revoked beyond FICORA's control) or termination of this agreement, all previously delegated ENUM domains may be operated by the Tier 1 operator for a maximum period of three months after the end of the agreement.

6 TIER 2 OPERATOR REQUIREMENTS

Tier 2 name service providers are hosting and provisioning the actual NAPTR records. Tier 2 name services can be provided as a commercial service or the ENUM registrant can provide its own Tier 2 name service functionality. Tier 2 name service providers must ensure that the content of the NAPTR records can only be changed by the ENUM registrants or service providers authorised by the ENUM registrant and the Tier 2 name service provider.

A commercial Tier 2 name service provider must:

- Comply with the security and privacy protection requirements.
- Ensure that NAPTR records can only be added, changed or removed by entities authorised for these operations.
- Validate the form and content of the provisioned NAPTR records. The relevant RFCs are listed in Appendix 5.
- Ensure that the provision of the NAPTR records is correct. If the provision is incorrect, the Tier 1 operator is compelled to prevent and remove the incorrect delegations.
- Remove NAPTR records after the customer relationship with the ENUM registrant has ended
- Remove NAPTR records after having received a removal notice from the Tier 1 operator.
- Take frequent backups from the NAPTR records.

In addition, the SOA record (Start of Authority) defining the configuration of the name server of the domain name must comply with the following aspects:

- The MNAME field shall contain the name of the primary name server of the domain name.
- The Zone contact field shall contain a working e-mail address.
- The serial numbers and timers cannot differ essentially from published Internet standards and recommendations listed in Appendix 5.

7 ENUM REGISTRANT

ENUM registrant is the entity authorised to request ENUM delegation. In the commercial phase ENUM registrant can either be the subscriber of the corresponding E.164 number or a service provider authorised by the subscriber. The rule is strict, because the Finnish ENUM pilot follows the opt-in principle meaning that ENUM domains can be added and modified only with the express consent of the subscriber authorized to use the corresponding telephone number.

ENUM registrants shall have the right to choose a registrar and Tier 2 name service provider freely, regardless of their telecommunications operator. In particular, it is necessary to enable registrants to switch registrars without losing the service.

8 VALIDATION ENTITY REQUIREMENTS

Validation entities are responsible for the validation of the ENUM domain and currently only telecommunications operators can validate ENUM domains. In this document the validation process is based on a password that the ENUM registrant can receive from his/her telecommunications operator. In addition to giving the password, validation entities are required to maintain validation servers that can be used to check the authorisations of the delegation. The Tier 1 operator can also develop alternative validation mechanisms.

Telecommunications operators that want to provide ENUM validation service must fulfil the following requirements:

- The operator must maintain an up-to-date validation server and respond to the Operator.Authenticate requests defined in Appendix 2.
- The operator must send Tier1.PrefixRemoved notifications to the Tier 1 operator using the XML-RPC method described in Appendix 3 when registrant's right to use the corresponding E.164 number has ended.
- The operator must provide validation services to all of its subscribers with same conditions irrespective of whether the ENUM registrant buys the other ENUM related services from the operator or from another service provider.

However, operators have the right to choose the number ranges where the ENUM validation service is offered. This limitation is justified, because an operator may operate many separate telecommunications networks, for instance in different geographical locations, or a mobile network, that may also have separate customer care systems and therefore also different ENUM capabilities.

In addition, the operator may have more obligations for certain number ranges, such as those related to IN based call control and forwarding services. Some operators may be worried how ENUM will affect these obligations. For these reasons the ENUM pilot group believes that mandating operators to provide ENUM validation for all number ranges may considerably decrease operators' interest to provide ENUM validation or prevent the service launch totally.

9 DEFINITIONS

E.164 number	A telephone number consistent with the ITU-T E.164 Recommendation.
ENUM	ENUM is a technology that defines the transformation of E.164 numbers into DNS (Domain Name System) names. This ENUM domain name can be used to point associated contact information, e.g., IP-telephony, email, fax and web addresses, stored in NAPTR resource records. ENUM is defined in RFC 3761.
Registrant	ENUM registrant is the entity authorised to request ENUM delegations. ENUM registrant can either be the subscriber of the corresponding E.164 number or a service provider authorised by the subscriber.
Registrar	ENUM registrar is a thin front-end providing a constant ENUM domain registration service to ENUM registrants also in the situations where Tier 1 provider changes.
Tier 1	An ENUM DNS layer corresponding to E.164 country codes. The Finnish Tier 1 domain is 8.5.3.e164.arpa.
Tier 1 operator	The Tier 1 operator is a de-facto monopoly for Finnish ENUM domain and it is responsible for maintaining the Tier 1 registry and name service functions and to provide reliable validation process.
Tier 2	An ENUM DNS layer hosting NAPTR resource records.
Validation Entity	An ENUM entity that validates registrant's right to use the E.164 number corresponding to the ENUM domain in question.

10 ABBREVIATIONS

BSD	Berkeley Software Distribution
DNS	Domain Name System
DNSSEC	Domain Name System Security Extensions
ETSI	European Telecommunications Standards Institute
FICORA	Finnish Communications Regulatory Authority
IP	Internet Protocol
IT	Information Technology
MD5	Message-Digest algorithm defined in RFC 1321
MNAME	The name server that was the original or primary source of data for this zone
NAPTR	Naming Authority Pointer
NP DB	Number Portability Database
RFC	Request For Comments
RIPE NCC	RIPE Network Coordination Centre (a Regional Internet Registry)
RPC	Remote Procedure Call
SOA	Start of Authority
TLD	Top Level Domain
XML	Extensible Markup Language

11 APPENDIXES

11.1 Appendix 1: ENUM XML-RPC registration interface

Tier1.Update

Request an ENUM delegation for a prefix. The method requires the following arguments:

client_id	string	Identifies the client.
digest	string	The MD5 hash (see below)
prefix	string	Prefix to be delegated written as $^{[1-9][0-9]^+}\. * \$$, where the number of dots at the end (if any) indicate how many digits belong to the prefix.
password	string	Password obtained from the prefix owner.
ns1_hostname	string	ENUM name server 1
ns2_hostname	string	ENUM name server 2
email	string	Email address

The digest is a MD5 hash calculated using the formula:

MD5 (client_id + prefix + password + ns1_hostname + ns2_hostname + email + shared_secret)

where shared_secret is a client specific secret stored in Tier 1's database.

Returns:

status_code	int	Status code resulted from the operation.
status_string	string	String presentation of the result.

The possible status responses are:

200	OK
401	Unauthorized (client not known)
402	Unauthorized (digest mismatch)
403	Operator of prefix not known
404	Operator of prefix not participating in ENUM
405	Unauthorized (prefix/password mismatch)
500	Internal error -- try again later
501	Method is unknown
502	Parameter error

Security considerations:

The service providers should be pre-registered into Tier 1 operator's database. The database should store:

- IP addresses of the XML-RPC clients
- client_ids
- shared secret to be included in the MD5 digest

The request should only be accepted from the known IP address(es) and only if the MD5 hash recalculation matches the digest provided in the request.

Tier1.Remove

Request to remove the ENUM delegation for prefix. The method requires the following arguments:

client_id	string	Identifies the client.
digest	string	The MD5 hash (see below)
prefix	string	Prefix to be removed written as <code>^[1-9][0-9]+\.*\$</code> , where the number of dots at the end (if any) indicate how many digits belong to the prefix.
password	string	Password obtained from the prefix owner.

The digest is a MD5 hash calculated using the formula

MD5 (client_id + prefix + password + shared_secret)

where shared_secret is a client specific secret stored in Tier 1 operator's database.

Returns:

status_code	int	Status code resulted from the operation.
status_string	string	String presentation of the result.

The possible status responses are:

200	OK
401	Unauthorized (client not known)
402	Unauthorized (digest mismatch)
403	Operator of prefix not known
404	Operator of prefix not participating in ENUM
405	Unauthorized (prefix/password mismatch)
500	Internal error -- try again later
501	Method is unknown
502	Parameter error

Security considerations:

Same as for Tier1.Update.

Tier1.Remove should only be accepted, if the client_id matches the client that originally requested the delegation.

11.2 Appendix 2: XML-RPC authentication interface

Operator.Authenticate

Request for prefix authentication, originates only from the Tier 1 operator.

Arguments:

digest	string	The MD5 hash (see below)
prefix	string	Prefix to be authenticated without the '358' or '0' prefix. Digits after the prefix (if any) are marked with dots (.).
password	string	Password for the prefix

The digest is a MD5 hash calculated using the formula

MD5 (prefix + password + shared_secret)

where shared_secret is an operator specific secret stored in Tier 1 operator's database.

Returns:

status_code	int	Status code resulted from the operation
status_string	string	String presentation of the result

The possible status responses are:

200	OK
402	Unauthorized (digest mismatch)
405	Unauthorized (prefix/password mismatch)
500	Internal error -- try again later
501	Method is unknown
502	Parameter error

Security considerations:

The prefix owners (operators) should be registered into Tier 1 operator's database. The database should store

- hostname and URL of the XML-RPC service
- shared secret to be included in the MD5 digest

The XML-RPC server should accept connections only from Tier 1 operator's known IP address(es) and only if the MD5 hash recalculation matches the digest provided in the request.

11.3 Appendix 3: ENUM domain removal request interface

Tier1.PrefixRemoved

Request from an operator to inform the Tier 1 operator that the prefix is no longer used by that operator. The method requires the following arguments:

operator_code	string	Identifies the client
digest	string	The MD5 hash (see below)
prefix	string	Prefix that was removed written as $^{\wedge}[1-9][0-9]^{\wedge}+\backslash\cdot^{\wedge}\$$, where the number of dots at the end (if any) indicate how many digits belong to the prefix.

The digest is a MD5 hash calculated using the formula

MD5 (operator_code + prefix + shared_secret)

where shared_secret is an operator specific secret stored in Tier 1 operator's database.

Returns:

status_code	int	Status code resulted from the operation
status_string	string	String presentation of the result

The possible status responses are:

200	OK
402	Unauthorized (digest mismatch)
404	Operator not participating in ENUM
407	Unauthorized (prefix/operator mismatch)
500	Internal error -- try again later
501	Method is unknown
502	Parameter error

11.4 Appendix 4: Tier 2 notice interface

Tier2.Notice

Send notification to Tier 2 of the changes in the Tier 1. This is originated only from Tier 1 server.

Arguments:

digest	string	The MD5 hash (see below)
prefix	string	Prefix in question
notice_type	string	Type of notification
ns1_hostname	string	Primary Tier 2 server
ns2_hostname	string	Secondary Tier 2 server

The digest is a MD5 hash calculated using the formula

MD5 (prefix + shared_secret)

where shared_secret is a Tier 2 specific secret stored in Tier 1 operator's database.

The possible values for the notice_type field are:

- DELEGATED
- REMOVED

Returns:

status_code	int	Status code resulted from the operation
status_string	string	String presentation of the result

The possible status responses are:

200 OK
402 Unauthorized (digest mismatch)

Security considerations:

The Tier 2 name servers should be registered into Tier 1 operator's database. The database should store:

- hostname and URL of the XML-RPC service matching the name server(s)
- shared secret to be included in the MD5 digest

The XML-RPC server should accept connections only from Tier 1 operator's known IP address(es) and only if the MD5 hash recalculation matches the digest provided in the request.

11.5 Appendix 5: Internet standards and recommendations

Name Service:

- RFC1034, Domain names – concepts and facilities. P.V. Mockapetris
- RFC1035, Domain names – implementation and specification. P.V. Mockapetris
- RFC1912, Common DNS Operational and Configuration Errors. D. Barr
- RFC2181, Clarifications to the DNS Specification. R. Elz, R. Bush
- Ripe-192, Simple DNS Configuration Example. RIPE DNS Working Group
- Ripe-203, Recommendations for DNS SOA Values. P.Koch

NAPTR Records:

- RFC 3403, Dynamic Delegation Discovery System (DDDS) Part Three: The Domain Name System (DNS) Database, M. Mealling
- RFC 3761, The E.164 to Uniform Resource Identifiers (URI) Dynamic Delegation Discovery System (DDDS) Application (ENUM), P. Faltstrom and M. Mealling
- ENUM ID, ENUM Implementation Issues and Experiences, L. Conroy and K. Fujiwara
- ETSI TS 102 172, Minimum Requirements for the Interoperability of ENUM Implementations