RESEARCH AND ACADEMIC COMPUTER NETWORK

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Telephone and Number Mapping WG
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Cost optimization based on ENUM entries – research project.

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SENSE OF TELECOMMUNICATION
NASK

In establishing of an optimal telecommunication connection the biggest obstacles are as follows:

- 1. Calling Party selects the only one known way of connection initiation, e.g. by using the local phone directory there is the only one telephone number of the contact.
- 2. Calling Party does not try to initiate a connection in an optimal way (for instance in the cheapest way using VoIP). Instead of that, calling party selects such form of contact that can assure the largest probability of establishing a connection (in most cases it is a mobile phone number).
- 3. Calling Party does not have knowledge about current price-lists (telecommunication rates), thus contacts other party in the first available way.

conception

Cost optimization based on Enterprise-ENUM

IETF Internet Draft

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Cost optimization based on Enterprise-ENUM

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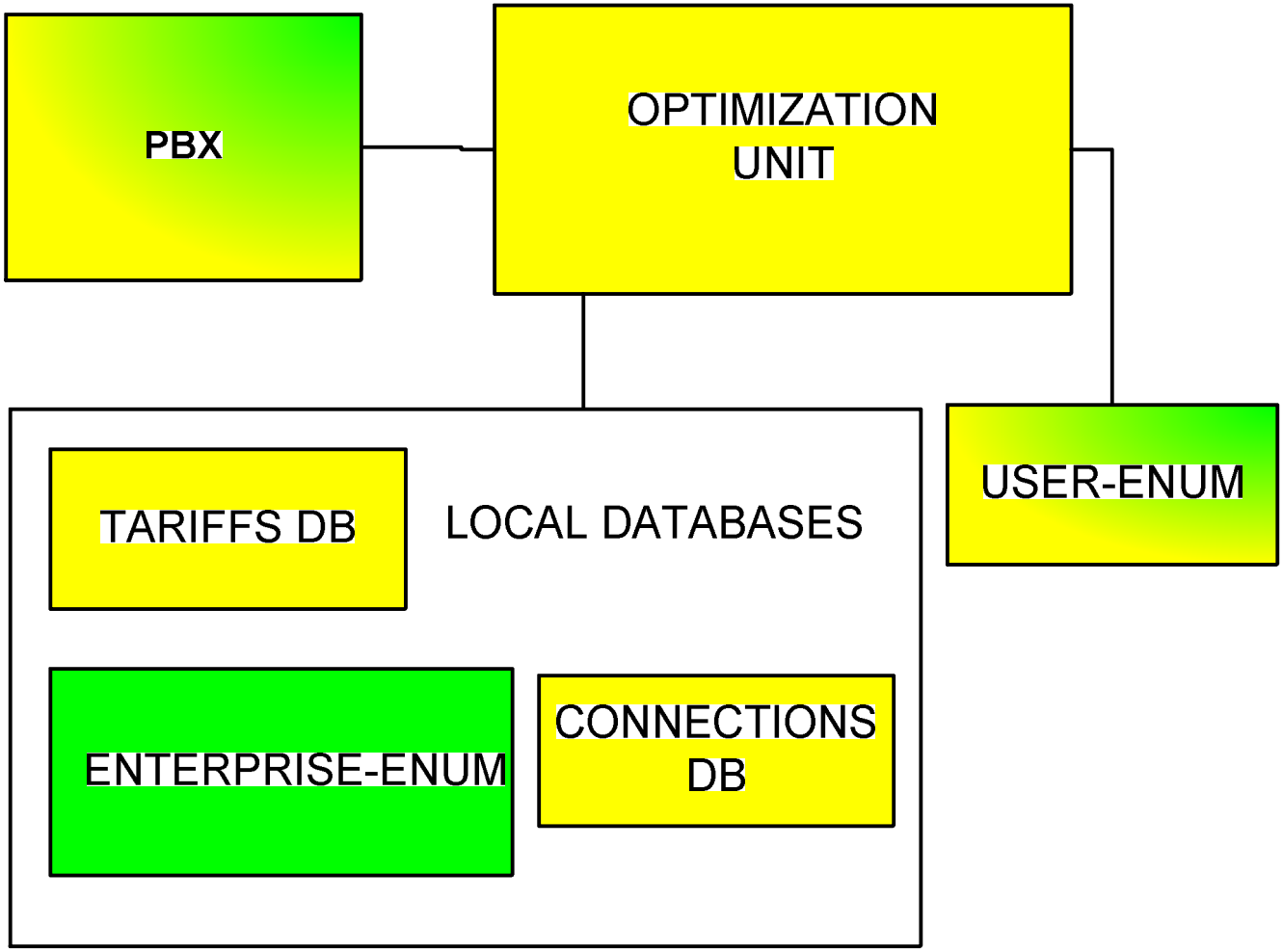

Cost optimization based on Enterprise-ENUM

Parts of the solution

- **PBX (i.e. ASTERISK)**
- **Optimization unit**
- **DNS interface**
- **User-ENUM (public DNS tree)**
- **Enterprise ENUM (private/local DNS tree)**
- **Tariffs' database (up-to-date, valid telecom. rates)**
- **Connections' database (history of the user's connections)**

Connections Database

Connections Database stores information about the executed connections containing:

- **Called Party identifier (telephone number or SIP address)**
- **Exact time of the beginning of a conversation**
- **Exact time of the end of a conversation**
- **Reference to the position in the price list (Tariff Database)**
- **Information about eventual remaining limit from subscription (time of "free" phone conversation within subscription, data transfer within subscription etc.)**
- **Quality of the connection**
- **Calling Party Identifier (telephone number or SIP address)**
- **Flag showing whether a given number was taken for analysis by Optimization Module.**

Tariff Database

Tariff Database stores information about current telecommunications tariffs given by operators providing communications services within signed agreements.

Tariff Database does not have to store an information concerning other costs – subscription fees which are not dependant from actually executed services, activation or discontinuation of service (end of service) fees.

In the Tariff Database can be stored the following information:

- **Identifier of the Telecom Operator**
- **Name of the tariff**
- **Way of timing (quantity of seconds per a tariff unit)**
- **Accounting period (optional)**
- **Quantity of pre-paid tariff units included into subscription (with regard to the way of timing) and information about specific way of timing of units included into subscription (for example, what happens with units which haven't been used in certain accounting period and remain untapped)**
- **Peak hours (period of time within 24 hours and definition of days of a week when pick hours oblige, for example within the working days)**
- **Hours beyond peak hours (remarks as above)**
- **Other hours (for instance night hours) or division into 24 sections of hour sections within 24 hours**
- **Cost of connection within a defined time periods, divided into:**
  - Connections within the network of one particular Operator
  - Connections with other networks
  - Connections with selected numbers (numbers enumerated in the contract with operator) or „corporate" connections
  - Connections to operator's services (i.e. voice mail, call centers, news services)
  - Connections to other services rated in a different way than left services.

NAPTR's extensions

Cost optimization based on Enterprise-ENUM

NAPTR extensions

- **[ORDER] Preferences of the calling party**
  - It's NOT the preference of the called party stored in user-ENUM
  - It is based on the analyses of data stored in the CONNECTIONS DATABASE & TARIFFS DATABASE
- **[PREFERENCE] Probability of the connection**
  - the probability value is based on the analyses of the data stored in the CONNECTIONS DATABASE
  - [PREFERENCE] = 100 – probabilty(connection)
- **Additional flag: [QUALITY]**
  - Quality of the connection (for details see next slide)
- **Additional FLAG: „O"**
  - Indicates that NAPTRs are including the additional information (mentioned above)

[QUALITY] flag

- **[QUALITY] Overal quality indicator from the point of view of the Caller.**
  - Mentioned above indicator will be marked with a flag having value from 0 to 9 (range limited by RFC 3403), where "0" indicates not acceptable quality of connection, and "9" indicates an "ideal" connection (it means with a constant and acceptable delay, without lost of packets etc.).
  - The quality of connection can be determined on the basis of any parameter identifying the quality of connection; in particular for VoiP it could be the parameter MOS-LQ (Mean Opinion Score Listening Quality) or MOS-CQ (Mean Opinion Score Conversional-Quality). Parameters MOS-LQ and MOS-CQ are in the range from 1 to 5. For MOS-LQ and MOS-CQ the value [QUALITY] will be defined with following formula:
  - [QUALITY]=MOS-LQ *2-1 or [QUALITY]=MOS-CQ *2-1

examples

Cost optimization based on Enterprise-ENUM

Example of the User-ENUM

- *0.0.2.1.3.2.5.2.2.e164.arpa NAPTR 100 10 "up" "tel+E2U" "!^.*$!tel:+48225231200!"*
- *0.0.2.1.3.2.5.2.2.e164.arpa NAPTR 200 10 "up" "tel+E2U" "!^.*$!tel:+48225231204!"*
- *0.0.2.1.3.2.5.2.2.e164.arpa NAPTR 300 10 "up" "sip+E2U" "!^.*$!sip:204@obelix.nask.waw.pl!".*
- *0.0.2.1.3.2.5.2.2.e164.arpa NAPTR 300 20 "up" "mailto+E2U" "!^.*$!email: info@nask.biz!".*
- *0.0.2.1.3.2.5.2.2.e164.arpa NAPTR 300 30 "up" "tel+E2U" "!^.*$!tel:+48225231395!".*

Cost optimization based on Enterprise-ENUM

Example of the Enterprise-ENUM (part 1)

- *0.0.2.1.3.2.5.2.2.e164.arpa NAPTR 100 50 “5oup" "sip+E2U" "!^.*$!sip:204@obelix.nask.waw.pl!“.*
- *0.0.2.1.3.2.5.2.2.e164.arpa NAPTR 200 10 "9oup" "tel+E2U" "!^.*$!tel:+48225231200!“*
- *0.0.2.1.3.2.5.2.2.e164.arpa NAPTR 200 10 "9oup" "tel+E2U" "!^.*$!tel:+48225231204!"*
- *0.0.2.1.3.2.5.2.2.e164.arpa NAPTR 200 100 “oup" "tel+E2U" "!^.*$!tel:+48225231395!“.*
- *4.0.2.1.3.2.5.2.2.e164.arpa NAPTR 100 50 “5oup" "sip+E2U" "!^.*$!sip:204@obelix.nask.waw.pl!“.*
- *4.0.2.1.3.2.5.2.2.e164.arpa NAPTR 200 10 "9oup" "tel+E2U" "!^.*$!tel:+48225231200!“*

Cost optimization based on Enterprise-ENUM

Example of the Enterprise-ENUM (part 2)

- *4.0.2.1.3.2.5.2.2.e164.arpa NAPTR 200 10 "9oup" "tel+E2U" "!^.*$!tel:+48225231204!"*
- *4.0.2.1.3.2.5.2.2.e164.arpa NAPTR 200 100 “oup" "tel+E2U" "!^.*$!tel:+48225231395!“.*
- *0.0.2.1.3.2.5.2.2.e164.arpa NAPTR 100 50 “5oup" "sip+E2U" "!^.*$!sip:204@obelix.nask.waw.pl!“.*
- *5.9.3.1.3.2.5.2.2.e164.arpa NAPTR 200 10 "9oup" "tel+E2U" "!^.*$!tel:+48225231200!“*
- *5.9.3.1.3.2.5.2.2.e164.arpa NAPTR 200 10 "9oup" "tel+E2U" "!^.*$!tel:+48225231204!"*
- *5.9.3.1.3.2.5.2.2.e164.arpa NAPTR 200 100 “oup" "tel+E2U" "!^.*$!tel:+48225231395!“.*

algorithms

Cost optimization based on Enterprise-ENUM

Optimization Algorithms using Enterprise-ENUM database:

- **Enterprise-ENUM updating algorithm,**
- **Algorithm of record selection from Enterprise-ENUM database**

Before a connection will be established using records in DNS base, DNS base is filled with data resulted from activities of an optimization algorithm. Detailed information regarding functioning of algorithms will be presented below.

Cost optimization based on Enterprise-ENUM

Actualization algorithm of Enterprise-ENUM database

1. **Optimization Module selects first record from connections database (executed connection) and retrieves a contact (a telephone number, SIP addressee) to a subscriber.**
2. **For a given identifier, Optimization Module retrieves from "User-ENUM" Database the list of available NAPTR records.**

An example of retrieved NAPTR records:

0.0.2.1.3.2.5.2.2.e164.arpa NAPTR 100 10 "up" "tel+E2U" "!^.*$!tel:+48225231200!"

0.0.2.1.3.2.5.2.2.e164.arpa NAPTR 200 10 "up" "tel+E2U" "!^.*$!tel:+48225231204!"

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Cost optimization based on Enterprise-ENUM

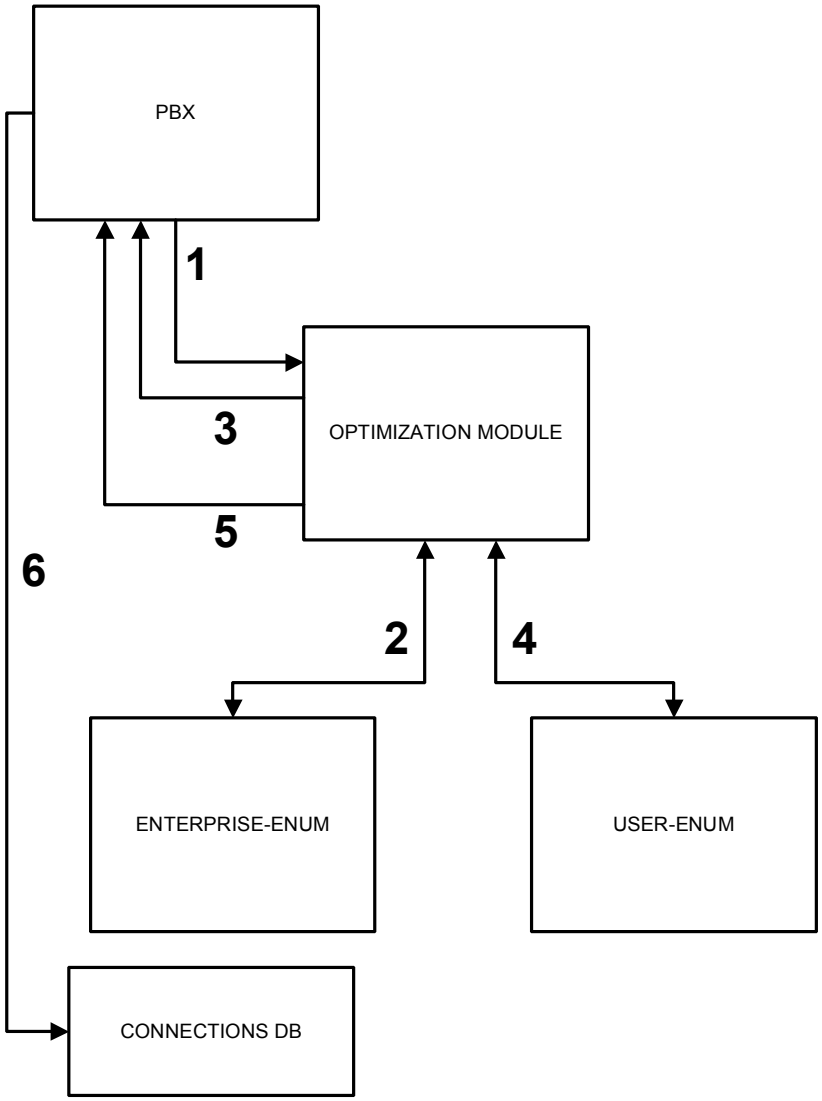
3. **Optimization Module retrieves from Connection Database history of all particular phone connections, performed by particular Subscriber (Called Party), regarding each identifier (phone number, SIP address) received in step 2 of this algorithm. As the result, there is a list of all contacts (history of calls) with a particular subscriber (Called Party) realized in every possible way, that were stored in the Connection database.**
4. **On the basis of data stored in the Connection Database and the Tariff Database, sequence of contacts to a particular subscriber (called party) is being determined (using the assigned methodology i.e. Bayesian networks, Hidden Markov Model, statistical methods), from the most effective to the least effective. The sequence is determined independently for cost, probability and quality.**

   This stage of an algorithm , as critical for the whole solution, is described in more details in the „Estimation of connections sequence”.

Cost optimization based on Enterprise-ENUM

- **5. All identifiers with determined parameters are saved in a zone file in the "Enterprise-ENUM" database in accordance with fields description (see subsection "Extensive meaning of NAPTR fields in Enterprise-ENUM"). For every identifier, Internet domain is created and for this domain NAPTR records are created, related with all other contacts (e.g. for 3 numeric contacts there are 3 domains and totally 9 NAPTR records being created)**

Cost optimization based on Enterprise-ENUM



Cost optimization based on Enterprise-ENUM

An exemplary record in the "Enterprise –ENUM" database corresponding with a list of retrieved contacts (record for email address is passed over; for each number identifier are created domains with assigned NAPTR records).

0.0.2.1.3.2.5.2.2.e164.arpa NAPTR 100 50 "5oup" "sip+E2U" "!^.$!sip:204@obelix.nask.waw.pl!".*
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Cost optimization based on Enterprise-ENUM

6. **Optimization Module marks all contacts (calls) stored in the Connection Database that has been completed with a given subscriber, in order to omit these records within the next loop of the algorithm.**
7. **Optimization Module searches for another possible contact from Connection Database and goes to step 2 of this algorithm. If there are no records to be retrieved from the Connection Database, algorithm ends, saving the results as a file of "Enterprise-ENUM" database.**

Cost optimization based on Enterprise-ENUM

Algorithm of record selection from Enterprise-ENUM database

1. **A switchboard transfers to Optimization Module a telephone number (contact) with which the calling party wants to be connected.**
2. **Optimization Module queries „Enterprise-ENUM". In response the Optimization Module receives a list of NAPTR records or information about the lack of record in DNS..**
3. **Simplified Optimization Module successively transmits to switchboard contacts (identifiers) which may be connected to, considering fields: ORDER and PREFERENCE. Simplified Optimization Module has no access to "Tariff Base" and "Connections Base"**
4. **In case of the lack of record in Enterprise-ENUM, Simplified Optimization Module queries User-ENUM database. In response, Simplified Optimization Module receives a list of NAPTR records or information about the lack of record in DNS.**

Cost optimization based on Enterprise-ENUM

5. **Simplified Optimization Module successively transmits to switchboard contacts (identifiers) which may be connected to, considering fields: ORDER and PREFERENCE. In case of lack of record in DNS, Simplified Optimization Module transmits reversibly to switchboard a telephone number which was transmitted to switchboard at the beginning of the process.**
6. **After the connection is completed, data concerning this connection (telephone number, parameter of quality of connection, duration of connection) are recorded in the Connections Base (optionally).**

Estimation of connections sequence

Fundamental element of „Actualization algorithm for Enterprise-ENUM" and of the whole problem of costs optimization using ENUM platform is a way of a cost estimation related to a given subscriber. An Actualization Algorithm has assumed in point 4, that on the base of data included in the Connections and the Tariff Base, using given method, a sequence of contacts to a given subscriber (by whom a connection is terminated from the point of view of the calling party) is set.

The algorithm operates on data retrieved from the Connections Base (history of connections) concerning accomplished and not accomplished connections with certain subscriber, taking into consideration the following parameters:

- Contact (telephone number compliant with E. 164 or an address)
- Exact time of the beginning of phone conversation (in case when an estimation will be carried out with division into given intervals of time)
- Exact time of the end of phone conversation
- Total time of phone conversation (optionally)
- Parameter defining the quality of connection (it may be whichever of many possible ways of an estimation of quality of connection)
- Identifier of user initializing a connection (E.164 telephone number or SIP address)

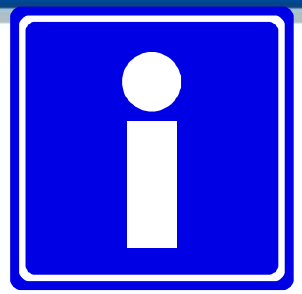
Cost optimization based on Enterprise-ENUM

Basing on this an independent estimation of following parameters of connections can be carried out, concerning:

- **time of connection**
- **probability of correct connection**
- **quality of connections**

An estimation may be carried out using different methods, for example.:

- **Bayesian networks**
- **Meta- Bayesian Networks**
- **Hidden Markov Model**
- **Casual Networks**



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