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SERIES Q: SWITCHING AND SIGNALLING, AND ASSOCIATED MEASUREMENTS AND TESTS

Signalling requirements and protocols for the NGN – VoLTE/ViLTE network signalling

Signalling architecture of distributed infrastructure ENUM networking for IMS

Recommendation ITU-T Q.3643

International Telecommunication Union

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Recommendation ITU-T Q.3643

Signalling architecture of distributed infrastructure ENUM networking for IMS

Summary

Recommendation ITU-T Q.3643 defines the framework and signalling architecture for distributed ENUM networking in support of IMS interconnection. Based on the signalling architecture of a distributed ENUM model, this Recommendation specifies the signalling procedures of ENUM profile management and ENUM resolution. Additionally, the signalling requirements and protocols to be applied for interfaces of distributed ENUM networking are addressed.

History

Edition	Recommendation	Approval	Study Group	Unique ID*
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Distributed, ENUM, IMS, signalling architecture.

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FOREWORD

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1 Scope

This Recommendation presents the signalling architecture of distributed ENUM networking in support of IMS interconnection. Based on a distributed framework of the ENUM server, this Recommendation specifies the signalling requirements for the functional entities, signalling procedures and protocols to be applied for interfaces, security considerations, etc.

NOTE 1 – This Recommendation defines the signalling architecture, signalling procedures and signalling requirements for a distributed ENUM model in support of IMS interconnection. The ENUM hierarchical model is addressed in [b-GSMA PRD IR.67] and [b-GSMA PRD NG.105].

NOTE 2 – The focus of this Recommendation is on infrastructure ENUM addressed in [b-IETF RFC 5067].

NOTE 3 – The national ITU-T E.164 numbering resource used in the distributed ENUM model is assigned by a national administration to the operator and should comply with all relevant national and international telecommunication regulatory, legal and licensing requirements.

2 References

The following ITU-T Recommendations and other references contain provisions which, through reference in this text, constitute provisions of this Recommendation. At the time of publication, the editions indicated were valid. All Recommendations and other references are subject to revision; users of this Recommendation are therefore encouraged to investigate the possibility of applying the most recent edition of the Recommendations and other references listed below. A list of the currently valid ITU-T Recommendations is regularly published. The reference to a document within this Recommendation does not give it, as a stand-alone document, the status of a Recommendation.

[ITU-T E.164] Recommendation ITU-T E.164 (2010), *The international public telecommunication numbering plan.*

[IETF RFC 3403] IETF RFC 3403 (2002), *Dynamic Delegation Discovery System (DDDS) Part Three: The Domain Name System (DNS) Database.*

[IETF RFC 3404] IETF RFC 3404(2002), *Dynamic Delegation Discovery System (DDDS) Part Four: The Uniform Resource Identifiers (URI).*

[IETF RFC 6116] IETF RFC 6116 (2011), *The E.164 to Uniform Resource Identifiers (URI) Dynamic Delegation Discovery System (DDDS) Application (ENUM).*

[IETF RFC 7230] IETF RFC 7230 (2014), *Hypertext Transfer Protocol (HTTP/1.1): Message Syntax and Routing.*

[IETF RFC 7231] IETF RFC 7231 (2014), *Hypertext Transfer Protocol (HTTP/1.1): Semantics and Content.*

[IETF RFC 7232] IETF RFC 7232 (2014), *Hypertext Transfer Protocol (HTTP/1.1): Conditional Requests.*

[IETF RFC 7235] IETF RFC 7235 (2014), *Hypertext Transfer Protocol (HTTP/1.1): Authentication.*

[W3C SOAP] W3C (2007), Simple Object Access Protocol.

3 Definitions

3.1 Terms defined elsewhere

None.

3.2 Terms defined in this Recommendation

None.

4 Abbreviations and acronyms

This Recommendation uses the following abbreviations and acronyms:

DES	Distributed ENUM server
DNS	Domain Name System
ENUM	E.164 Number
GRX	GPRS Roaming Exchange
HTTP	Hypertext Transfer Protocol
I-ENUM	Infrastructure ENUM
IMS	IP Multimedia Core Network Subsystem
IPX	Inter-network Packet Exchange
NAPTR	Naming Authority Pointer
O&M	Operation and Maintenance
SIP	Session Initiation Protocol
SOAP	Simple Object Access Protocol
URI	Uniform Resource Identifier

5 Conventions

In this Recommendation:

The phrase "is recommended" indicates a requirement which is recommended but which is not absolutely required. Thus, this requirement need not be satisfied to claim conformance.

In the body of this document and its appendices, the word "should" sometimes appears, in which case it is to be interpreted, respectively, as the phrase "is recommended".

6 Framework for distributed ENUM networking

Figure 6-1 depicts the framework for distributed ENUM networking in support of IMS interconnection.

A distributed ENUM server (DES) serves for inter-operator IMS session establishment and provides the mapping of ITU-T E.164 numbers [ITU-T E.164] to URIs. The DES stores the ENUM data profile of the host operator and the ENUM data profiles obtained from the relevant operators that have interconnection agreements with the host operator. The DES performs ENUM data self-management functions of the ENUM data profile such as ENUM NAPTR record adding, ENUM NAPTR record modification and ENUM NAPTR record cancellation, etc. In addition, the DES is responsible for responding to queries for ENUM translation in support of the IMS interconnection.

Even though a DES for a designated operator logically stands alone, it can be merged into the operator level ENUM server physically in accordance with the operator's policy.

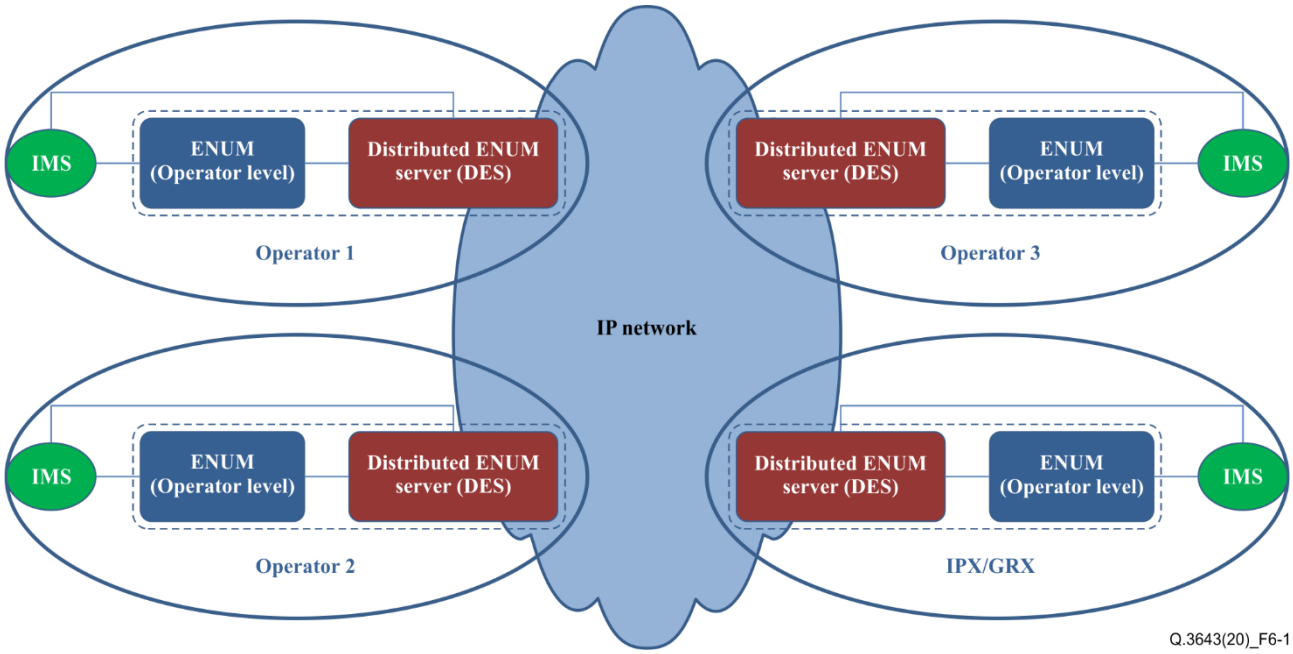

Figure 6-1 – Framework for distributed ENUM networking

7 Signalling architecture of distributed ENUM networking

Figure 7-1 depicts the signalling architecture of distributed ENUM networking.

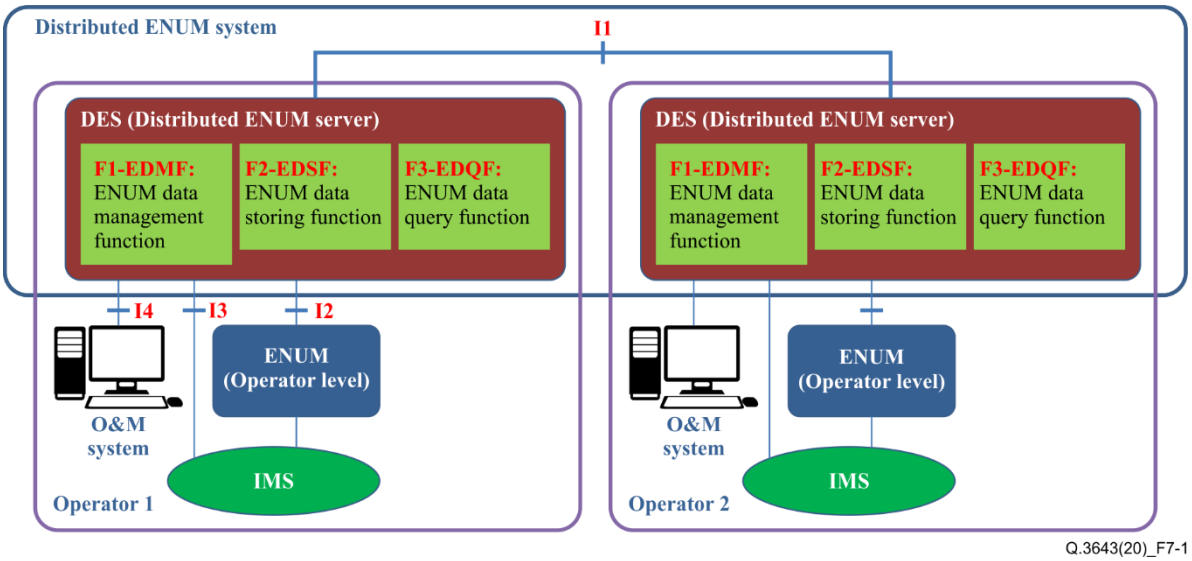

Figure 7-1 – Signalling architecture of distributed ENUM networking

In a distributed ENUM networking environment, a DES is responsible for ENUM translation in support of IMS interconnection. The DES stores the ENUM data profile, performs ENUM data profile management and responds to the ENUM mapping queries initiated by the operator level ENUM server or the IMS SIP proxies.

An ENUM mapping query is initiated and sent to an operator level ENUM server by an IMS SIP proxy. In iterative mode, when obtaining the pointers to DES, the SIP proxy sends the ENUM query to the DES through reference point I3 accordingly. In recursive mode, the operator level ENUM

server is responsible for the response of the ENUM queries within the IMS domain and forwarding the inter-domain ENUM queries to the DES through reference point I2, which is between the DES and operator level ENUM server.

The update of an ENUM data profile for a designated operator is initiated by a terminal of operation and management (O&M) system. The O&M system sends the requests to the host DES via reference point I4, which is between the DES and O&M system. The host DES updates the ENUM profile and broadcasts the requests to the relevant DESs via reference point I1 between two DESs. The relevant DESs which have the interconnection agreements with the host operator update the data profile accordingly and respond to the host DES.

7.1 Functions

The following functions are contained in a DES:

7.1.1 ENUM data management function (F1-EDMF)

The ENUM data management function (F1-EDMF) performs basic ENUM data management and maintenance functions, which include the adding of ENUM NAPTR records, ENUM NAPTR record modification and ENUM NAPTR record cancellation, etc.

When an F1-EDMF receives a request of updating the ENUM data from the O&M system, it updates the ENUM data profile of the host operator and broadcasts the request to the relevant DESs which have the interconnection agreements with the host operator accordingly.

7.1.2 ENUM data storing function (F2-EDSF)

The ENUM data storing function (F2-EDSF) stores the ENUM data profile for IMS interconnection. The F2-EDSF consists of the data profile of the host operator and the data profiles obtained from the operators with interconnection agreements. The key features of the ENUM data profile include the identifier of the operator, the IP address of the DES, the data block of ENUM NAPTR records, etc.

Figure 7-2 depicts an example of the key features of the ENUM data profile contained in a DES. The ENUM data profile for host operator A consists of the host operator ID, source I-ENUM server address, ENUM mapping data block and interconnection agreed operator ID, etc. The ENUM data profile for the operator with interconnection agreements X/Y/Z consists of the interconnection agreed operator ID, destination I-ENUM server IP address and the ENUM mapping data blocks, etc.

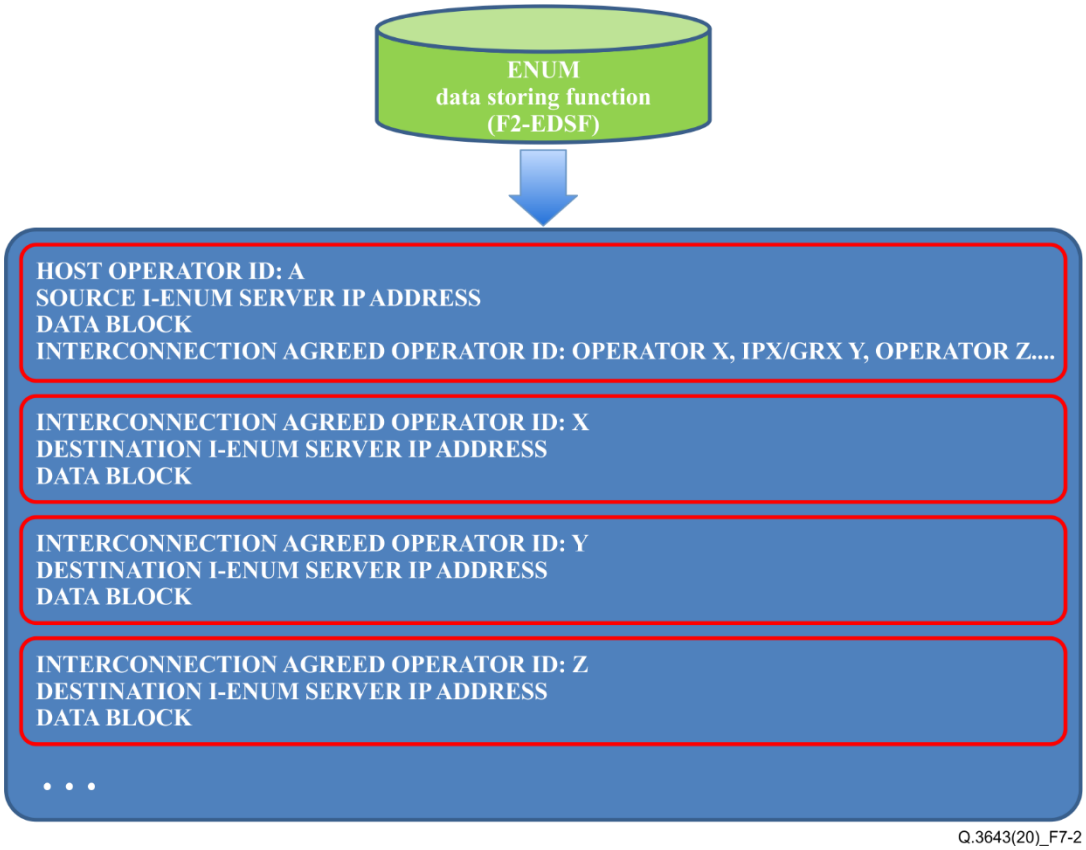

Figure 7-2 – Key features of the ENUM data profile contained in the DES

7.1.3 ENUM data query function (F3-EDQF)

The ENUM data query function (F3-EDQF) is responsible for responding to the queries for ENUM translation originated by an IMS SIP proxy.

With regard to the ENUM mapping procedure, the iterative mode and recursive mode are required to support in a distributed ENUM networking environment.

7.2 Reference points

The following reference points are identified in a distributed ENUM server environment.

7.2.1 Reference point I1

Reference point I1 is between two DESs.

Reference point I1 delivers ENUM data profile and ENUM data profile management information to DESs of other operators with interconnection agreements. The ENUM data profile is managed by the O&M system terminal of the host operator and the updating data profile request is broadcast to the DESs of relevant operators with interconnection agreements. The ENUM data profiles for the specific operator in relevant DESs are updated accordingly.

7.2.2 Reference point I2

Reference point I2 is between the DES and operator level ENUM server.

Reference point I2 transfers the query and response for ENUM translation in recursive mode.

7.2.3 Reference point I3

Reference point I3 is between the DES and IMS SIP proxy.

Reference point I3 transfers the query and response for ENUM translation in iterative mode.

7.2.4 Reference point I4

Reference point I4 is between the DES and O&M system.

Reference point I4 transfers the request and response for ENUM data profile management, which include the ENUM NAPTR record adding, ENUM NAPTR record modification and ENUM NAPTR record cancellation, etc.

8 Signalling procedures for distributed ENUM networking

8.1 Signalling procedures on DES node management

8.1.1 DES node enrolment to a distributed ENUM system

Figure 8-1 shows the DES node enrolment procedure when the DES of a newly involved operator A gets ENUM data profiles from other operators or IPX/GRX, which have the interconnection agreement with operator A.

After getting the ENUM data profile from an operator or IPX/GRX X, Y and Z, the DES of operator A contains the required ENUM mapping data profiles of all the operators which have interconnection agreements with operator A. In this circumstance, the DES of operator A is able to provide the resolution from ITU-T E.164 numbers to SIP URI when establishing a session between an IMS user of operator A and another user of relevant operators or IPX/GRX, e.g. X, Y or Z.

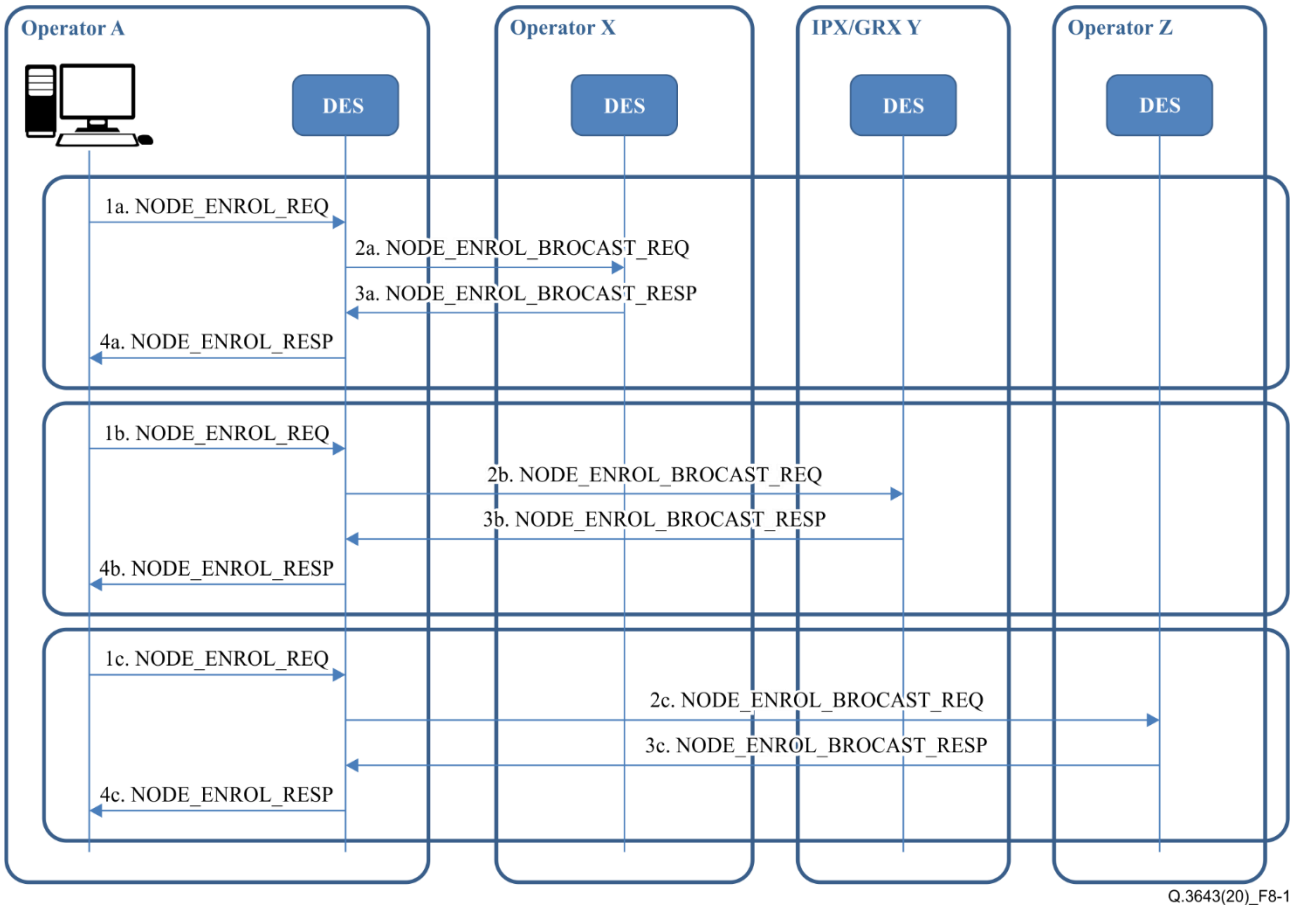

Figure 8-1 – DES node enrolment to a distributed ENUM system

The following steps are performed:

1. The terminal of the O&M system of host operator A initiates a node enrolment request to the DES of host operator A for getting the ENUM mapping data profile from operator X, which has the interconnection agreement with operator A.

2. The DES of host operator A forwards the request to operator X.

3. After receiving the confirmation of its O&M system, the DES of operator X sends the response to operator A providing the requested ENUM mapping data profile of operator X.

4. The DES of host operator A stores the ENUM mapping data profile of operator X and sends the response to the terminal of the O&M system indicating the completion of getting data from operator X.

1b-4b. Operator A performs the procedure of DES node enrolment and gets the ENUM mapping data profile from IPX/GRX Y.

1c-4c. Operator A performs the procedure of DES node enrolment and gets the ENUM mapping data profile from operator Z.

8.1.2 DES node leaving from a distributed ENUM system

Figure 8-2 shows the DES node leaving procedure when operator A decides to end the interconnection agreement with the operator or IPX/GRX X, Y and Z.

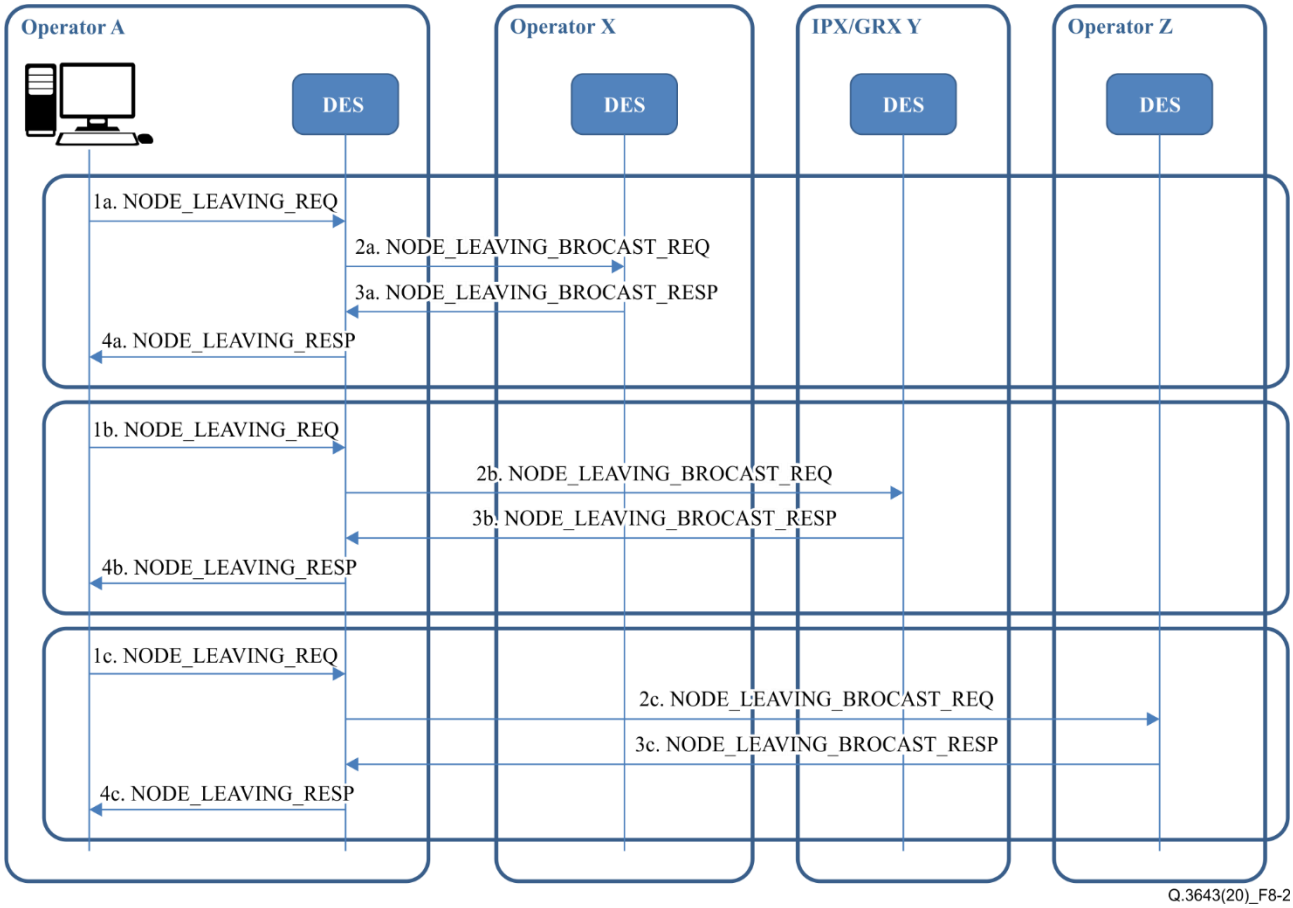

Figure 8-2 – DES node leaving from a distributed ENUM system

The following steps are performed:

1. The terminal of the O&M system of host operator A initiates a node leaving request to the DES of host operator A for leaving from the distributed ENUM system and deleting the relevant ENUM mapping data profile contained in the DES of operator X.

2. The DES of host operator A forwards the request to operator X.

3. After receiving the confirmation of its O&M system, the DES of operator X deletes the ENUM mapping data profile of operator A accordingly, and sends the response to operator A indicating that the request of leaving is successfully done.

4. The DES of host operator A deletes the ENUM mapping data profile of operator X and sends the response to the terminal of the O&M system indicating the completion of the DES node leaving.

1b-4b. Operator A performs the procedure of the DES node leaving from interconnection with IPX/GRX Y.

1c-4c. Operator A performs the procedure of the DES node leaving from interconnection with operator Z.

8.2 Signalling procedures on ENUM data management

8.2.1 DES adds NAPTR records

Figure 8-3 shows the ENUM data management procedure when the DES of operator A adds ENUM NAPTR records and broadcasts the request of adding NAPTR records to other operators or IPX/GRX, which have the interconnection agreement with operator A.

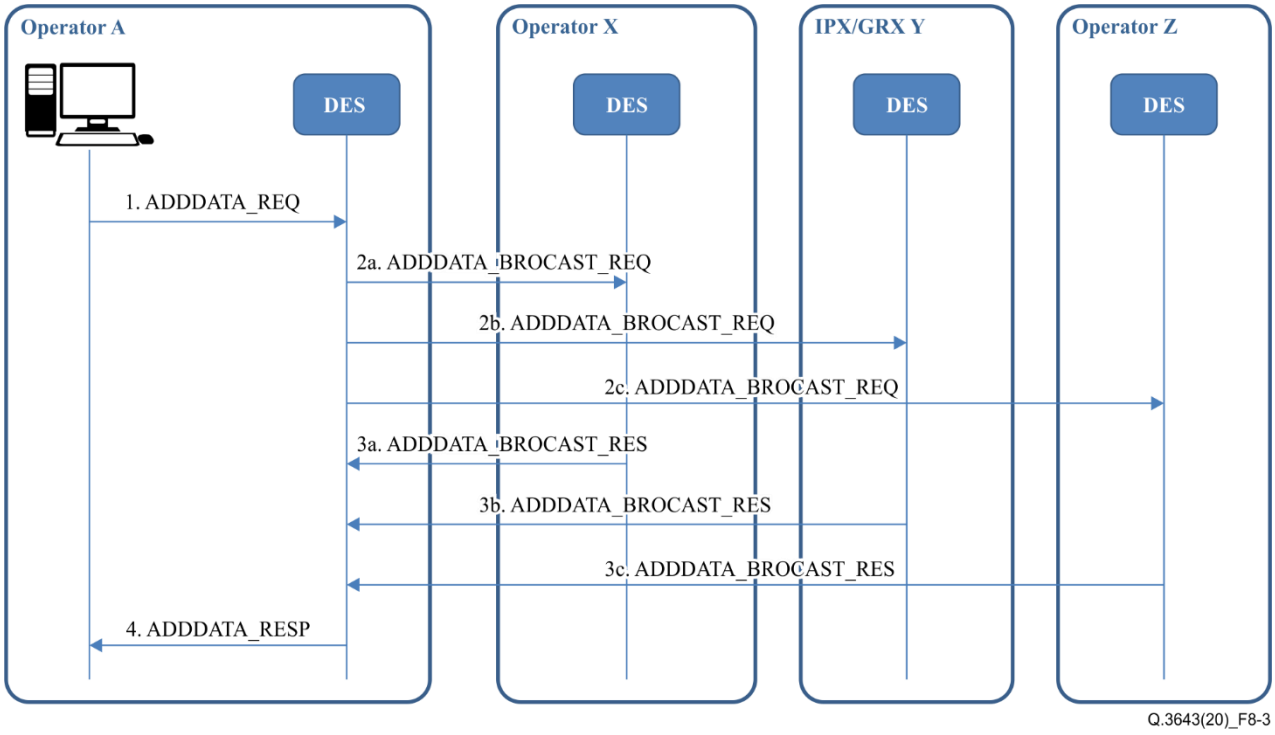

Figure 8-3 – DES of operator A adds NAPTR records

The following steps are performed:

1. The terminal of the O&M system of host operator A initiates a request to add NAPTR records of the ENUM mapping data profile of the DES of operator A.

2a-2c. The DES of host operator A broadcasts the request of adding ENUM NAPTR records to operators X, IPX/GRX Y and operator Z.

3a-3c. The DES of operators X, IPX/GRX Y and operator Z add the NAPTR records accordingly, and send the response to operator A indicating that the request of adding ENUM NAPTR records is successfully done.

4. The DES of host operator A sends the response to the terminal of the O&M system indicating the completion of adding the NAPTR records of the ENUM mapping data profile of the DES of operator A.

8.2.2 DES modifies NAPTR records

Figure 8-4 shows the self-management procedure when the DES of operator A modifies key features of existing ENUM NAPTR records and broadcasts the request of the modification of NAPTR records to other operators or IPX/GRX, which have the interconnection agreement with operator A.

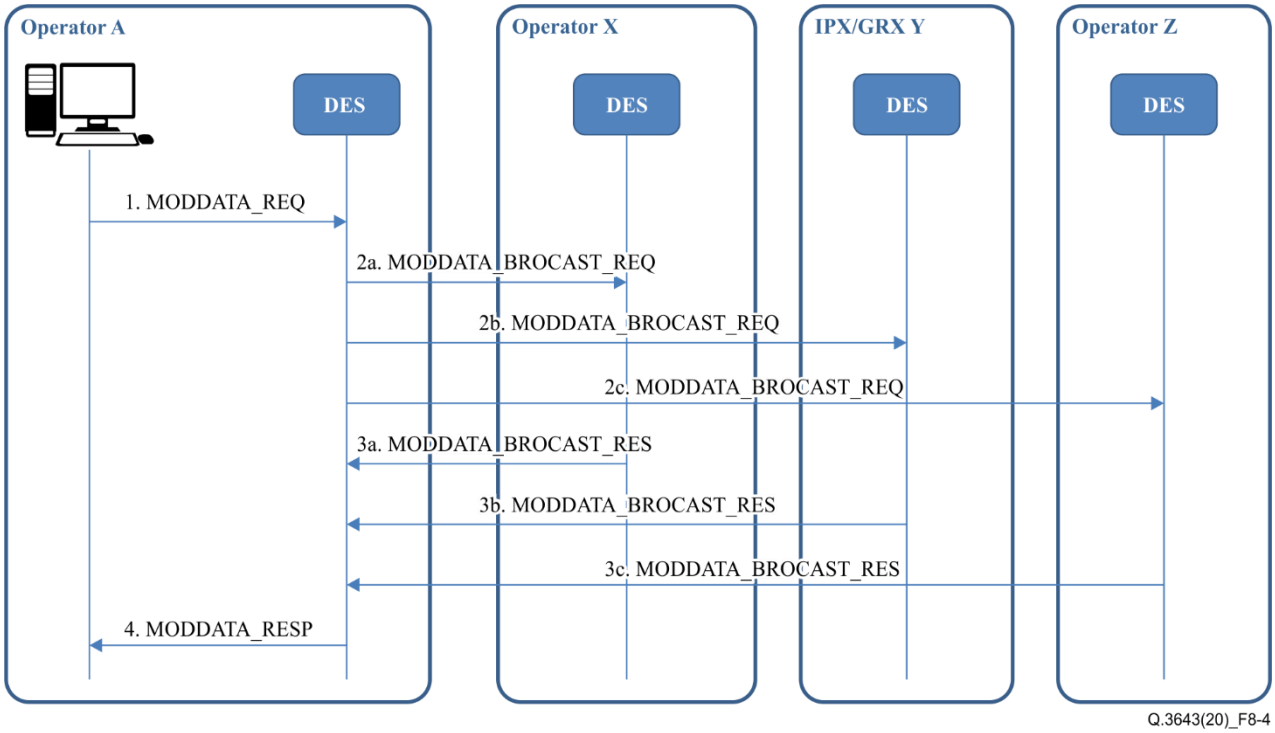

Figure 8-4 – DES of operator A modifies NAPTR records

The following steps are performed:

1. The terminal of the O&M system of host operator A initiates a request to modify NAPTR records of the ENUM mapping data profile of the DES of operator A.

2a-2c. The DES of host operator A broadcasts the request of modifying existing ENUM NAPTR records of operator A to operators X, IPX/GRX Y and operator Z.

3a-3c. The DES of operators X, IPX/GRX Y and operator Z modify the requested ENUM NAPTR records of operator A accordingly, and send the response to operator A indicating that the request of modifying ENUM NAPTR records is successfully done.

4. The DES of host operator A sends the response to the terminal of the O&M system indicating the completion of modifying the NAPTR records of operator A.

8.2.3 DES cancels NAPTR records

Figure 8-5 shows the self-management procedure when the DES of operator A cancels existing ENUM NAPTR records and broadcasts the request of cancellation of NAPTR records to other operators or IPX/GRX, which have the interconnection agreement with operator A.

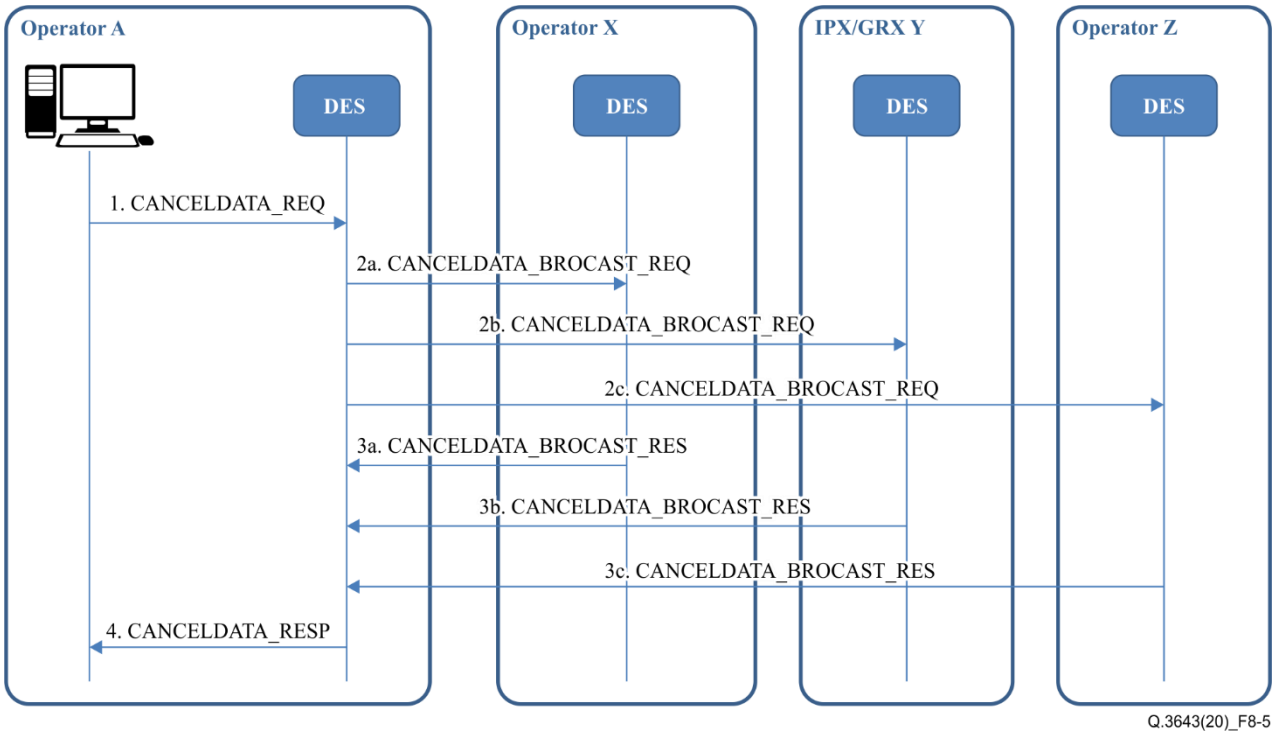

Figure 8-5 – DES of operator A cancels NAPTR records

The following steps are performed:

1. The terminal of the O&M system of host operator A initiates a request to cancel existing NAPTR records of the ENUM mapping data profile of the DES of operator A.

2a-2c. The DES of host operator A broadcasts the request of cancellation of existing ENUM NAPTR records of operator A to operators X, IPX/GRX Y and operator Z.

3a-3c. The DES of operators X, IPX/GRX Y and operator Z cancel the requested ENUM NAPTR records of operator A accordingly, and send the response to operator A indicating that the request of cancellation of existing ENUM NAPTR records of operator A is successfully done.

4. The DES of host operator A sends the response to the terminal of the O&M system indicating the completion of cancellation of existing NAPTR records of operator A.

8.3 Resolution procedure in distributed ENUM networking

8.3.1 Resolution procedure in iterative mode

Figure 8-6 shows the ENUM resolution procedure in iterative mode. A caller of operator A dials the ITU-T E.164 number and initiates an IMS session to a callee of operator Z.

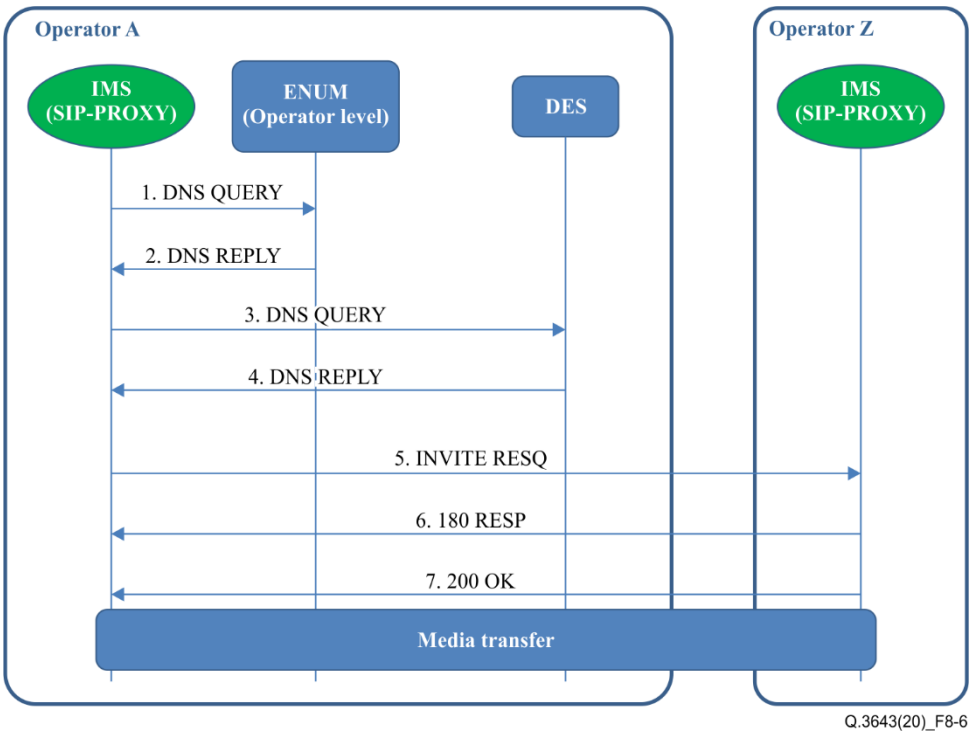

Figure 8-6 – ENUM resolution procedure in iterative mode

The following steps are performed:

1. An ENUM mapping query containing the ITU-T E.164 number of the callee is initiated and sent to an operator level ENUM server by an IMS SIP proxy of operator A.

2. The ENUM server of the operator level replies to the IMS SIP proxy providing the pointers to the DES of operator A.

3. The IMS SIP proxy sends the ENUM query to the DES of operator A accordingly.

4. The DES of operator A translates the ITU-T E.164 number to a SIP URI and sends the resolution results to the IMS SIP proxy.

5. In accordance with the resolution results, the IMS SIP proxy sends the INVITE request to an IMS SIP proxy of operator Z accordingly.

6. The IMS SIP proxy of the terminating operator Z sends a 180 response to the originating network indicating that the callee is free to answer the call and is alerted.

7. The IMS SIP proxy of the terminating operator Z sends 200 ok to the originating network indicating that the callee answered the phone. The media information of the caller and callee is transferred accordingly.

8.3.2 Resolution procedure in recursive mode

Figure 8-7 shows the ENUM resolution procedure in recursive mode. A caller of operator A dials the ITU-T E.164 number and initiates an IMS session to a callee of operator Z.

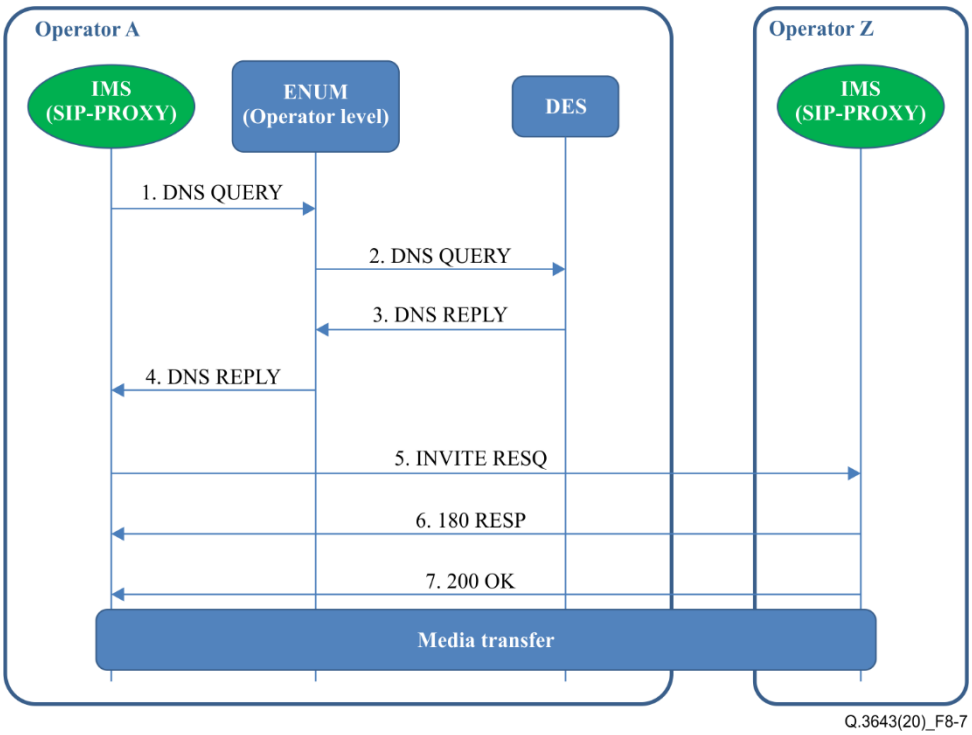

Figure 8-7 – ENUM resolution procedure in recursive mode

The following steps are performed:

1. An ENUM mapping query containing the ITU-T E.164 number of the callee is initiated and sent to an operator level ENUM server by an IMS SIP proxy of operator A.

2. The ENUM server of operator level cannot map the ITU-T E.164 number assigned to operator Z to a SIP URI and forwards the query to the DES of operator A.

3. The DES of operator A translates the ITU-T E.164 number to a SIP URI and sends the resolution results to the ENUM server of the operator level.

4. The ENUM server of the operator level IMS SIP proxy sends the resolution results to the IMS SIP proxy accordingly.

5-7. Refer to steps 5-7 of resolution procedure in iterative mode in clause 8.3.1.

9 Signalling requirements for distributed ENUM networking

9.1 Signalling requirements for distributed ENUM server

The distributed ENUM server supports the signalling procedures on self-management and ENUM resolution defined in clause 8.

When receiving an ENUM data profile management request from the O&M system the originating DES should broadcast the request to the destination DESs which have the interconnection agreements with the host operator. The distributed ENUM server supports the ENUM data profile management procedures including ENUM NAPTR records adding, ENUM NAPTR records modification and ENUM NAPTR records cancellation, etc.

When receiving a broadcast ENUM data profile management request from an originating DES the destination DES should perform the authentication of the identification of the originating operator and the address of the originating DES. If the identification and address of the originating DES are valid, the DES should update the ENUM profile of the originating operator accordingly and send the response to the originating DES indicating that the broadcast request of managing the ENUM

data profile is successfully done. Otherwise the destination DES should reject the management request and send a response to the originating DES indicating the reason of failure.

9.2 Signalling requirements for O&M systems

The O&M system supports the signalling procedures on self-management defined in clauses 8.1 and 8.2.

When the administrator of the distributed ENUM server triggers an ENUM profile management request through the terminal of the O&M system, the O&M system should send an ENUM profile management request to the interconnection ENUM server. The O&M system presents the result of the management request to the administrator when receiving the successful or failure response from the DES.

9.3 Signalling requirements for operator level ENUM server

The operator level ENUM server supports the signalling procedures on ENUM resolution in clause 8.3.

The operator level ENUM server supports the iterative mode and recursive mode of the E.164 number resolution procedure.

In iterative mode, when receiving an ENUM mapping query containing the ITU-T E.164 number, the operator level ENUM server replies to the IMS SIP proxy providing the pointers to the DES of the host operator.

In recursive mode, when receiving an ENUM mapping query containing the ITU-T E.164 number, the operator level ENUM server forwards the query to the DES of the host operator and forwards the receiving response to the IMS SIP proxy.

9.4 Signalling requirements for the IMS SIP proxy

The IMS SIP proxy supports the signalling procedures on ENUM resolution in clause 8.3.

The IMS SIP proxy supports the iterative mode and recursive mode of the ITU-T E.164 number resolution procedure.

In iterative mode, when receiving the pointers to the DES of the host operator, the IMS SIP proxy sends the ENUM mapping query to the DES of the host operator.

In recursive mode, the IMS SIP proxy receives the ENUM mapping result from the operator level ENUM server and routes the session to the destination operator accordingly.

10 Protocols for distributed ENUM networking

In support of the signalling procedures for self-management and ITU-T E.164 number resolution, the reference points in the distributed ENUM model support the following protocols.

Reference point I1 delivers ENUM data profile and ENUM data profile management information between two DESs. Reference point I4 transports the requests and responses for ENUM data profile management between the DES and O&M system. I1 and I4 support the Hypertext Transfer Protocol [IETF RFC 7230], [IETF RFC 7231], [IETF RFC 7232], [IETF RFC 7235] and Simple Object Access Protocol (SOAP) [W3C SOAP].

Reference point I2 transports the query and response for ENUM translation in recursive mode between the DES and operator level ENUM server. Reference point I3 transports the query and response for ENUM translation in iterative mode between the DES and IMS SIP proxy. I2 and I3 support domain name system (DNS) and ENUM relevant specifications, including [IETF RFC 3403], [IETF RFC 3404] and [IETF RFC 6116].

11 Security considerations

Security considerations are not addressed in this Recommendation.

Bibliography

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