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SERIES H: AUDIOVISUAL AND MULTIMEDIA SYSTEMS

Broadband, triple-play and advanced multimedia services – Ubiquitous sensor network applications and Internet of Things

Information technology – Automatic identification and data capture technique – Identifier resolution protocol for multimedia information access triggered by tag-based identification

Recommendation ITU-T H.642.3

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INTERNATIONAL STANDARD ISO/IEC 29177
RECOMMENDATION ITU-T H.642.3

Information technology – Automatic identification and data capture technique – Identifier resolution protocol for multimedia information access triggered by tag-based identification

Summary

Recommendation ITU-T H.642.3 | ISO/IEC 29177 specifies the identifier (ID) resolution protocol for multimedia information access triggered by tag-based identification. This ID resolution protocol is used to retrieve the location and access method of the multimedia information associated with an ID.

History

Edition	Recommendation	Approval	Study Group
1.0	ITU-T H.642.3	2012-06-29	16

Keywords

Identifier, IRP, resolution, tag-based identification.

FOREWORD

The International Telecommunication Union (ITU) is the United Nations specialized agency in the field of telecommunications, information and communication technologies (ICTs). The ITU Telecommunication Standardization Sector (ITU-T) is a permanent organ of ITU. ITU-T is responsible for studying technical, operating and tariff questions and issuing Recommendations on them with a view to standardizing telecommunications on a worldwide basis.

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Introduction

This Recommendation | International Standard specifies the identifier (ID) resolution protocol (IRP). This ID resolution protocol is used to retrieve the location and access method of the multimedia information associated with an ID.

Clause 6 provides an overview of the ID resolution protocol.

Clause 7 specifies the application-specific OID resolution process which will follow the general OID resolution process defined in Rec. ITU-T X.672 | ISO/IEC 29168-1.

Clause 8 specifies the ID resolution process.

There are alternative techniques to meet the use case addressed by this Recommendation | International Standard. One of those techniques is the use of the Electronic Product Code (EPC) and the Object Name Service (ONS). Those interested in this technique are encouraged to consult the documents in the Bibliography for further information.

INTERNATIONAL STANDARD

ITU-T RECOMMENDATION

Information technology – Automatic identification and data capture technique – Identifier resolution protocol for multimedia information access triggered by tag-based identification

1 Scope

This Recommendation | International Standard defines the identifier (ID) resolution protocol for multimedia information access triggered by tag-based identification which is described in Recommendations ITU-T F.771 and ITU-T H.621.

The identifier resolution protocol (IRP) in this Recommendation | International Standard consists of two processes: an application-specific object identifier (OID) resolution process which is specified in Rec. ITU-T X.672 | ISO/IEC 29168-1 and an identifier resolution process.

2 Normative references

The following Recommendations and International Standards contain provisions which, through reference in this text, constitute provisions of this Recommendation | International Standard. At the time of publication, the editions indicated were valid. All Recommendations and Standards are subject to revision, and parties to agreements based on this Recommendation | International Standard are encouraged to investigate the possibility of applying the most recent edition of the Recommendations and Standards listed below. Members of IEC and ISO maintain registers of currently valid International Standards. The Telecommunication Standardization Bureau of the ITU maintains a list of currently valid ITU-T Recommendations.

2.1 Identical Recommendations | International Standards

- Recommendation ITU-T X.668 (2009) | ISO/IEC 9834-9:2009, *Information technology – Open Systems Interconnection – Procedures for the operation of OSI Registration Authorities: Registration of object identifier arcs for applications and services using tag-based identification*.
- Recommendation ITU-T X.672 | ISO/IEC 29168-1, *Information technology – Open Systems Interconnection – Object Identifier Resolution System (ORS)*.

2.2 Additional references

- Recommendation ITU-T F.771 (2008), *Service description and requirements for multimedia information access triggered by tag-based identification*.
- Recommendation ITU-T H.621 (2009), *Architecture of a system for multimedia information access triggered by tag-based identification*.
- IETF RFC 1035:1987, *Domain names – Implementation and specification*.
- IETF RFC 3403:2002, *Dynamic Delegation Discovery System (DDDS) Part Three: The Domain Name System (DNS) Database*.

3 Definitions

For the purposes of this Recommendation | International Standard, the following definitions apply.

3.1 Imported definitions

3.1.1 This Recommendation | International Standard uses the following terms defined in Rec. ITU-T X.672 | ISO/IEC 29168-1:

a) application-specific OID resolution process;

b) general OID resolution process;

3.1.2 This Recommendation | International Standard uses the following terms defined in Rec. ITU-T F.771:

a) ID tag;

b) ID terminal.

3.2 Additional definitions

3.2.1 ID resolution protocol (IRP): A protocol used to find uniform resource locator (URL) of multimedia information associated with ID.

3.2.2 ID resolution server (IRS): A server that contains location and access method information of multimedia information and resolves an ID into URL of associated information.

3.2.3 mobile AIDC service: Use of a mobile AIDC application to provide a value to end users.

4 Abbreviations and acronyms

For the purposes of this Recommendation | International Standard, the following abbreviations and acronyms apply.

AIDC	Automatic Identification and Data Capture
C2U	Code to URL
DNS	Domain Name System
EPC	Electronic Product Code
FQDN	Fully Qualified Domain Name
HLC	High Level Code
ID	Identifier
IRP	ID Resolution Protocol
IRS	ID Resolution Server
MIDS	Multimedia Information Delivery Server
NAPTR	Naming Authority Pointer
NS	(DNS) Name Server
OID	Object Identifier
ONS	Object Name Service
ORS	OID Resolution System
RegExp	Regular Expression
RFID	Radio Frequency ID
TLC	Top Level Code
URL	Uniform Resource Locator

5 Overview of the ID resolution protocol

This clause defines an overall architecture of the ID resolution protocol (IRP) for multimedia information access triggered by tag-based identification based on the architecture described in clause 6 of Rec. ITU-T H.621, requirements described in clause 7.3 of Rec. ITU-T F.771, and the OID resolution system in Rec. ITU-T X.672 | ISO/IEC 29168-1.

Figure 1 shows the overall architecture of the IRP.

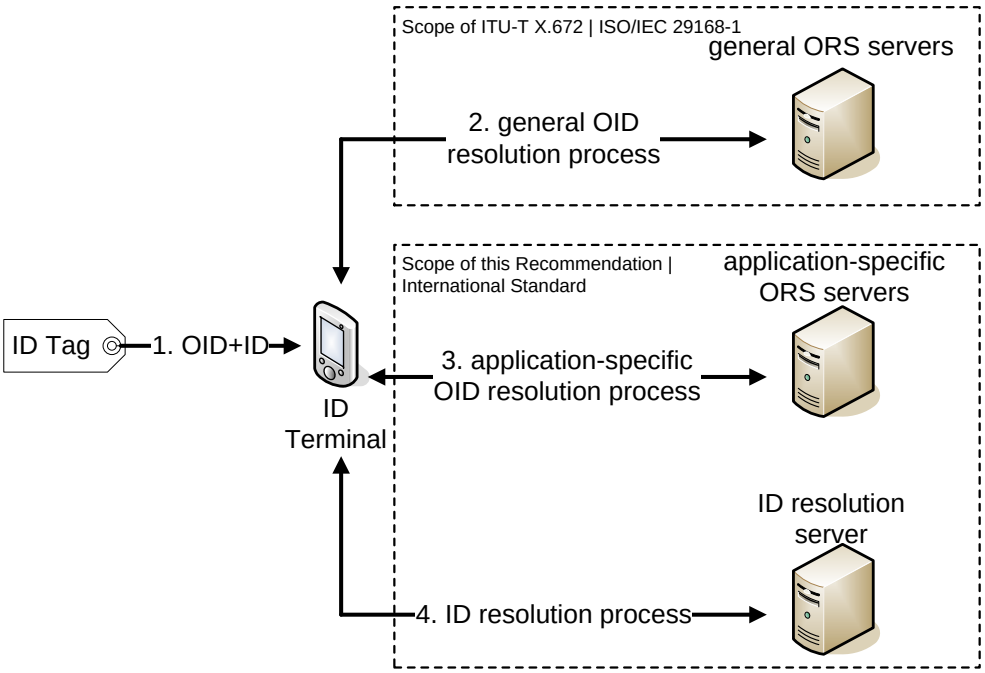

Figure 1 – Overall procedure of ID resolution

The overall ID resolution is composed of two processes: application-specific OID resolution process and ID resolution process. The general OID resolution process is out of the scope of this Recommendation | International Standard.

In the multimedia information access process triggered by tag-based identification, an ID terminal reads the ID from an ID tag such as a barcode and a radio frequency ID (RFID) (Step 1). The OID may be available directly from the tag or may be added by the tag reader and its software before the ID is passed to the ID terminal; or application software on the ID terminal may add an OID based on other context information.

If the ID terminal does not know how to process the ID, it first sends the OID to an OID resolution system (ORS) server. The ORS server sends back to the ID terminal ID processing information which contains a converting rule of ID into a specific format for the ID resolution protocol (Steps 2 and 3). If the ID terminal knows how to process the ID read from the ID tag, it can skip both the general and the application-specific OID resolution process.

The ID terminal then sends the ID in a suitable format for ID resolution to an ID resolution server (Step 4). The ID resolution server gets the ID as an input, and returns a URL of multimedia information contained in the multimedia information delivery server (MIDS).

Lastly, the ID terminal accesses the MIDS to obtain corresponding multimedia information.

This Recommendation | International Standard specifies the application-specific OID resolution process for multimedia information access triggered by tag-based identification and the ID resolution process for Steps 3 and 4 in Figure 1.

The general OID resolution process is defined in Rec. ITU-T X.672 | ISO/IEC 29168-1 and it will return some information which will be used in the application-specific OID resolution process for multimedia information access triggered by tag-based identification. An ID resolution process will follow this application-specific OID resolution process.

6 Application-specific OID resolution process

6.1 Overview

The application-specific OID resolution process works based on the domain name system (DNS) protocol defined in IETF RFC 1035 and the naming authority pointer (NAPTR) resource records defined in IETF RFC 3403.

The application-specific OID resolution process is initiated when the general OID resolution process returns an ORS service type "**`ORS+TINF`**". The returned NAPTR resource record with this service type contains a location address of application-specific ORS resolution server. An ID terminal should send a DNS query to this server with an OID as an input. The result of this application-specific OID resolution process is ID structure information in **`RegExp`** field of a responding NAPTR resource record.

6.2 OID transformation rules

The OID should be converted in the fully qualified domain name (FQDN) form to be sent to the application-specific OID resolution server. The transformation rule of OID into FQDN is defined as following three steps:

Step 1: separate each arc with period (".")

Step 2: reverse the order of the arcs

Step 3: add "**.oid-res.org.**" at the end of result from Step 2

For example, OID **{2 27 1}** will be converted as "**1.27.2.oid-res.org.**".

6.3 ID structure information

The ID structure information is stored in NAPTR resource records at the application-specific ORS server. The ID structure information is expressed in **RegExp** field of NAPTR resource record using POSIX regular expression. This rule is substitution syntax of ID into a certain format for ID resolution process.

For this purpose, following new **Service** field values of NAPTR resource record shall be defined.

IRP+FFT: Fixed Form Type identifier scheme. It indicates that **RegExp** field contains a rule for converting an ID into a certain format for ID resolution process and it needs no more query to an application-specific ORS server.

IRP+VFT: Variable Form Type identifier scheme. It indicates that **RegExp** field contains a rule for extracting some fields from an ID and it needs more query to an application-specific ORS server.

For example, the following NAPTR resource record is for FFT identifier scheme.

```
0 100 "U" "IRP+FFT" "!^(.{3})(.{5}).{3}$!\\2.\\1.anydomain.example.com.!".
```

Applying the above **RegExp** to an ID, of which total length is 11 bits, a text string is obtained in the form of "**nnnnn.nnn.anydomain.example.com.**" where **n** is either '0' or '1'.

Here is another example. The following NAPTR resource record is for VFT identifier scheme.

```
0 100 "U" "IRP+VFT" "!^(.{2}).{11}$!\\1!".
```

Applying the above **RegExp** to an ID, the first 2 bits of the ID is obtained which total length is 13 bits.

6.4 Operation of a client

Figure 2 shows the operation of a client in an application-specific OID resolution process.

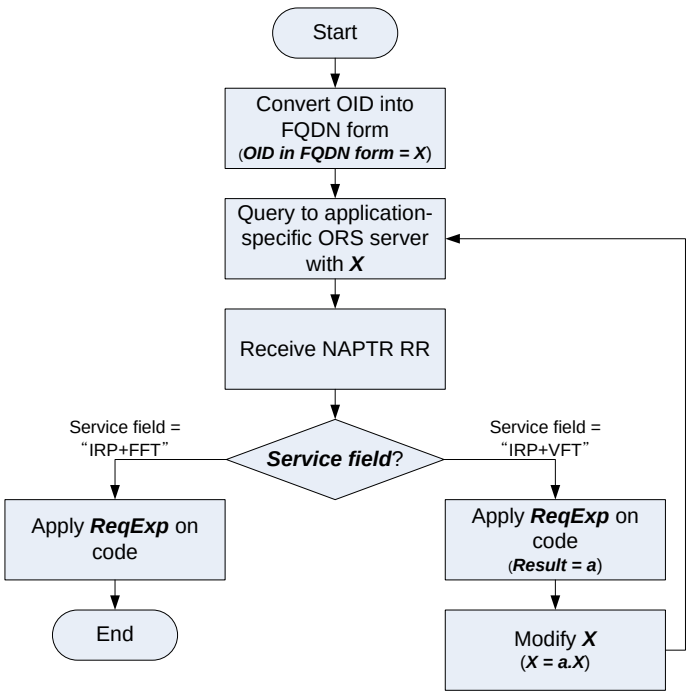

Figure 2 – Operation of application-specific OID resolution process

The client converts an OID into an FQDN form as defined in clause 7.1 and sends it to the application-specific ORS server. When the client receives a NAPTR resource record with the **Service** field value of "**IRP+FFT**", it applies the rule in **RegExp** field on the ID and obtains a new text value suitable for ID resolution process. When the client receives a NAPTR resource record with the **Service** field value "**IRP+VFT**", it applies the rule in **RegExp** field on the ID and obtains a new text value which is added to the front of the OID in FQDN form.

For example, if an OID in FQDN form is "**99.27.2.oid-res.org.**" and the substitution result of applying the **RegExp** field obtained by the query to application-specific ORS server to the ID value is "**5**", then new FQDN form "**5.99.27.2.oid-res.org.**" for the subsequent query will be generated.

6.5 Format of NAPTR resource record

The contents of a NAPTR resource record are formatted as in the example of Table 1.

Table 1 – Example of NAPTR resource record format

Order	Preference	Flags	Service	RegExp	Replacement
0	100	u	IRP+FFT	!^(.{2}).{11}$!\\1!	.

The application-specific OID resolution server operators should obey the following rules to configure the NAPTR resource record:

a) The order field should be zero.

b) The preference field should be non-negative integer.

c) The flags field should be set to "**u**", indicating that the **RegExp** field contains URL.

d) The service field should be set to "**IRP+VFT**" or "**IRP+FFT**" (see 7.2).

e) The **RegExp** field specifies an ID structure information. The value of this field should be the string **!^ID structure information!**

6.6 Operation of application-specific OID resolution servers

The application-specific OID resolution server should behave as a DNS server which is defined in IETF RFC 1035.

NOTE – An example configuration and operation of the application-specific OID resolution process is given in Annex A.

7 ID resolution process

7.1 Overview

The ID resolution process uses the DNS protocol as defined in IETF RFC 1035 and NAPTR resource records as defined in IETF RFC 3034.

The purpose of this process is to find location and access method information for the multimedia information associated with an ID by using the DNS. In order to use the DNS, the ID should be converted into an FQDN format that the DNS can understand.

DNS servers used for this ID resolution process may contain a delegation pointer to another DNS server in NS records or URL of multimedia information associated with ID in the NAPTR Resource Record.

The ID terminal reads an ID from an ID tag. It then knows how to convert the ID into the FQDN form, and it converts the ID into an FQDN form for sending it as part of a DNS query. If the user terminal does not know how to convert the ID into an FQDN form, it should initiate an OID resolution process as specified in Rec. ITU-T X.672 | ISO/IEC 29168-1.

The NAPTR type is used for the DNS query. This DNS query is sent to the default DNS server (local DNS server). If the default DNS server has a NAPTR resource record for that ID, it returns the NAPTR resource record which includes the URL of the multimedia information content. If the default DNS server does not have any NAPTR resource record for that ID, it sends a query to the ROOT DNS server and the ROOT DNS server returns the IP address of another DNS server which has been delegated from the delegation hierarchy of the ID. The default DNS server then sends another query to this new address. This procedure runs recursively until a NAPTR resource record can be obtained. When the default DNS server successfully receives a NAPTR resource record, it sends the NAPTR resource record back to the ID terminal and the ID resolution process is completed.

In the case of using EPC Tag Data in the EPC Tag Data Standard, the ID resolution process shall follow the Object Name Service (see document Object Name Service (ONS)).

7.2 Query to ID resolution server

This clause specifies the DNS query format. The ID in this query should be presented in an FQDN format and the query type should be set to "NAPTR".

The rule to convert an ID into an FQDN format is defined as follows:

STEP 1: Put dots (".") between each field, producing for example, **101010.101.11**

STEP 2: Convert binary digits into hexadecimal, producing for example, **2A.5.3**

STEP 3: Reverse the order, producing for example, **3.5.2A**

STEP 4: Append the string "**.anydomain.example.com.**", producing for example, **3.5.2A.anydomain.example.com.**

NOTE – The **anydomain.example.com** here means the domain name for a particular identifier scheme. Each identifier scheme should have a unique domain name to use ID resolution protocol in this Recommendation | International Standard. If OID resolution process is performed, this converting process automatically done by application-specific OID resolution process.

7.3 Response from ID resolution server

This clause specifies the DNS response format.

The URL of multimedia information associated with ID is contained in **RegExp** field. The rule for setting each field of NATPR resource record is specified in clause 7.4.

7.4 Configuration of NAPTR resource record

The content of a NAPTR resource record is formatted as in the example of Table 2.

Table 2 – Example of NAPTR resource record configuration

Order	Preference	Flags	Service	RegExp	Replacement
0	100	u	C2U	!^.*$!http://anydomain.example.com/example1.html!	.

ID resolution server operators should obey the following rules to configure the NAPTR resource record:

a) The order field should be zero.

b) The preference field should be a non-negative integer.

c) The flags field should be set to "**u**", indicating that the **RegExp** field contains a URL.

d) The service field should be set to "**C2U**".

e) The **RegExp** field specifies a URL of multimedia information. The value of this field should be the string **!^.*$!URL of multimedia content!**

NOTE – NAPTR record with '**C2U**' in **Service** field should contain a valid URL in the **RegExp** field.

7.5 Operation of a client

The client should use the following procedure to interpret the results returned by a DNS query:

STEP 1: From the results of the query, select those NAPTR resource records which have flag field value "**u**" and service field value "**C2U**". If there is no such record, stop.

STEP 2: From the result from STEP 1, select those records having the lowest value in the preference field.

STEP 3: From the result from STEP 2, select a record randomly.

STEP 4: Extract the URL from the record from STEP 3, by extracting the substring between the "**!^.*$!**" and the "**!**".

STEP 5: Get multimedia contents using the URL from STEP 4.

STEP 6: If STEP 5 is not successful, go back to STEP 3, using a different record from the STEP 2. If all records from STEP 2 have been tried, go back to STEP 2 using record from STEP 1 having the next lowest value in the preference field. If all records from STEP 1 have been tried, stop.

7.6 Operation of ID resolution servers

The ID resolution server should behave as the DNS server which is defined in IETF RFC 1035.

NOTE – An example configuration of ID resolution servers is available in Annex B.

Annex A

Configuration and operation of application-specific OID resolution process

(This annex forms an integral part of this Recommendation | International Standard.)

A.1 Assumptions

This example used the ID scheme in Figure A.1 and it is assumed that the OID for this ID scheme is **{2 27 99}** and that the domain name for the application-specific OID resolution server is "idscheme.example.com".

NOTE – Therefore, the result of the general OID resolution process will be "**!^.*$!99.27.2.idscheme.example.com!**

It is assumed also that "**.code.example.com.**" is the domain name for the particular ID scheme given as an example here.

1LC	2LC	CLASS	3LC / 4LC						
4 bits	16 bits	4 bits	8 bits	16 bits	16 bits	16 bits	16 bits	16 bits	16 bits
0001_2	16 bits	1001_2	3LC	4LC					
		1010_2	3LC		4LC				
		1011_2	3LC			4LC			
		1100_2	3LC				4LC		
		1101_2	3LC					4LC	
		1110_2	3LC						4LC

Figure A.1 – ID scheme for example

A.2 Configuration of NAPTR resource records

The application-specific OID resolution server should have the following resource records. These NAPTR resource records can be stored in the distributed servers.

NAPTR resource record 1:

```
99.27.2.idscheme.example.com.  IN  NAPTR  0  100  "U"  "IRP+VFT"  "!^  (.{4})(.{16})
(.{4}).{104}$!\\3!".
```

NAPTR resource record 2:

```
09.99.27.2.idscheme.example.com.  IN  NAPTR  0  100  "U"  "O2U+FFT"  "!^(.{4})(.{16})
(.{4})(.{8})(.{96})$!\\5.\\4.\\3.\\2.\\1.code.example.com!".
```

NAPTR resource record 3:

```
110.99.27.2.idscheme.example.com.  IN  NAPTR  0  100  "U"  "O2U+FFT"  "!^(.{4})(.{16})
(.{4})(.{24})(.{80})$!\\5.\\4.\\3.\\2.\\1.code.example.com!".
```

NAPTR resource record 4:

```
11.99.27.2.idscheme.example.com.  IN  NAPTR  0  100  "U"  "O2U+FFT"  "!^(.{4})(.{16})
(.{4})(.{40})(.{64})$!\\5.\\4.\\3.\\2.\\1.code.example.com!".
```

NAPTR resource record 5:

```
12.99.27.2.idscheme.example.com.  IN  NAPTR  0  100  "U"  "O2U+FFT"  "!^(.{4})(.{16})
(.{4})(.{56})(.{48})$!\\5.\\4.\\3.\\2.\\1.code.example.com!".
```

NAPTR resource record 6:

```
13.99.27.2.idscheme.example.com.  IN  NAPTR  0  100  "U"  "O2U+FFT"  "!^(.{4})(.{16})
(.{4})(.{72})(.{32})$!\\5.\\4.\\3.\\2.\\1.code.example.com!".
```

NAPTR resource record 7:

```
14.99.27.2.idscheme.example.com.  IN  NAPTR  0  100  "U"  "O2U+FFT"  "!^(.{4})(.{16})
(.{4})(.{88})(.{16})$!\\5.\\4.\\3.\\2.\\1.code.example.com!".
```

The NAPTR resource record 1 contains the rule for extracting specific fields. In the example, this rule will extract the 4 bits class field from the ID. The NAPTR resource record 2, 3, 4, 5, 6, and 7 contains the rule for converting an ID into an FQDN form for class A, B, C, D, E and F respectively.

A.3 Operation example

It is supposed that the client has obtained an OID as **{2 27 99}** and an ID as "**00001901000000000000000259FD720E**$_{HEX}$" from an ID tag, its reader or the reader software.

NOTE 1 – The first four bits, HLC is **0**$_{HEX}$, the next 16 bits, TLC is **0001**$_{HEX}$, the next four bits and Class is **9**$_{HEX}$.

STEP 1: When the client converts this OID **{2 27 99}** into an FQDN form as specified in clause 7.1, it produces "**99.27.2..oid-res.org.**" and sends it to the application-specific ORS server.

NOTE 2 – The OID arc is converted to "decimal" string as opposed to the case of converting the ID binary digits into "hexadecimal" string as specified in STEP 2 of clause 7.2.

STEP 2: The application-specific ORS server returns NAPTR resource record 1 (see clause A.2) and the client extracts **service** field and **RegExp** from the NAPTR resource record.

STEP 3: The client applies regular expression from STEP 2 to the ID and obtains the binary string "**1001**$_2$" for the third bit field, "**(.{4})**" and converts it to decimal number "**9**".

NOTE 3 – The first bit field "**(.{4})**" is "**0000**$_2$". The second bit field, "**(.{16})**" is "**0000000000000001**$_2$".

STEP 4: The client check **service** (= "**IRP+VFT**") field and adds "**9**" from STEP 3 in front of "**99.27.2.idscheme.example.com.**" and obtains "**9.99.27.2.idscheme.example.com.**".

STEP 5: The client sends the new FQDN form from STEP 4 to the application-specific ORS server.

STEP 6: The application-specific ORS server returns NAPTR resource record 2 (see clause A.2) and the client extracts **service** field and **RegExp**. The server returns NAPTR resource record 2 because the string, "**9**", attached in STEP 4 to the new FQDN used in the query indicates that the Class is "**9**", and thus the resolution for class A type identifier shall be performed. In this manner, resolution based on NAPTR can handle resolution based on the value of certain bit fields.

STEP 7: The client check **service** (= "**IRP+FFT**") field and applies the regular expression from STEP 6 to ID and converts each field to hexadecimal. The first bit field, "**(.{4})**" is "**0**$_{HEX}$". The second bit field, "**(.{16})**" is "**0001**$_{HEX}$". The third bit field "**(.{4})**" is "**9**$_{HEX}$". The fourth bit field, "**(.{8})**" is "**01**$_{HEX}$". The fifth field, "**(.{96})**" is "**00000000000000259FD720E**$_{HEX}$". Using these field values as expressed in hexadecimal notation after removing leading zeros, the client produces "**259FD720E.1.9.1.0.code.example.com**".

Annex B

Configuration and operation of ID resolution servers

(This annex forms an integral part of this Recommendation | International Standard.)

Figure B.1 shows an example configuration of ID resolution servers.

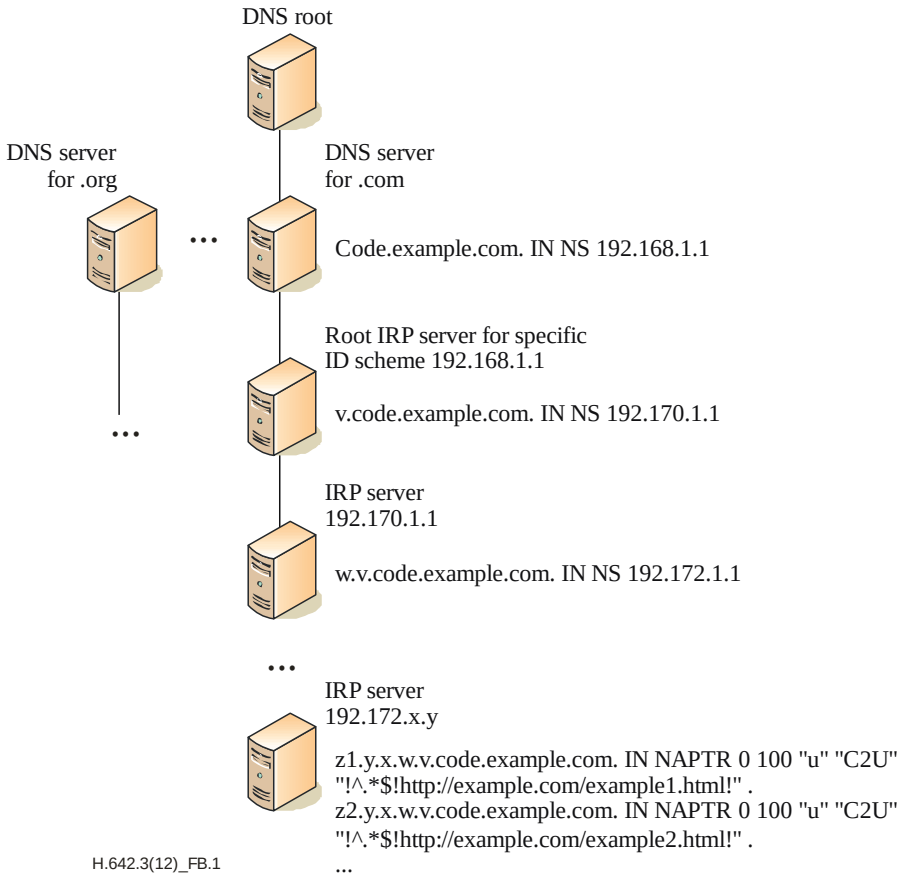

Figure B.1 – An example of delegation hierarchy of ID resolution servers

ID resolution servers are part of a global DNS infrastructure. An organization that manages and allocates a specific identifier scheme should operate an ID resolution server. There are many other organizations that manage and allocate some sub-blocks of this specific identifier scheme and these organizations should also operate ID resolution servers. The operation of ID resolution servers can be delegated to other organizations by contract.

The intermediate ID resolution servers have a delegation pointer to another name server in the NS records. The ID resolution server at the end of the DNS tree has NAPTR resource records which contains actual URL of multimedia contents.

The hierarchical structure in Figure B.1 is a logical view and multiple ID resolution servers can be implemented in one physical server.

Annex C

Bibliography

(This annex does not form an integral part of this Recommendation | International Standard.)

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