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Hybrid lookup for radio services

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Foreword

This Technical Specification (TS) has been produced by Joint Technical Committee (JTC) Broadcast of the European Broadcasting Union (EBU), Comité Européen de Normalisation ELECtrotechnique (CENELEC) and the European Telecommunications Standards Institute (ETSI).

NOTE: The EBU/ETSI JTC Broadcast was established in 1990 to co-ordinate the drafting of standards in the specific field of broadcasting and related fields. Since 1995 the JTC Broadcast became a tripartite body by including in the Memorandum of Understanding also CENELEC, which is responsible for the standardization of radio and television receivers. The EBU is a professional association of broadcasting organizations whose work includes the co-ordination of its members' activities in the technical, legal, programme-making and programme-exchange domains. The EBU has active members in about 60 countries in the European broadcasting area; its headquarters is in Geneva.

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Modal verbs terminology

In the present document "**shall**", "**shall not**", "**should**", "**should not**", "**may**", "**need not**", "**will**", "**will not**", "**can**" and "**cannot**" are to be interpreted as described in clause 3.2 of the ETSI Drafting Rules (Verbal forms for the expression of provisions).

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1 Scope

The present document defines the methodology for discovering an Authoritative FQDN for a radio service, including discovery using DNS queries to radiodns.org, a root domain name server operated by RadioDNS. The present document also defines the construction of a unique ServiceIdentifier parameter and bearerURI for a radio service.

This version includes the addition of client identification.

NOTE: Specifications for applications built upon the RadioDNS methodology can be found at http://radiodns.org/developers/documentation/.

2 References

2.1 Normative references

References are either specific (identified by date of publication and/or edition number or version number) or non-specific. For specific references, only the cited version applies. For non-specific references, the latest version of the referenced document (including any amendments) applies.

Referenced documents which are not found to be publicly available in the expected location might be found at https://docbox.etsi.org/Reference/.

NOTE: While any hyperlinks included in this clause were valid at the time of publication, ETSI cannot guarantee their long term validity.

The following referenced documents are necessary for the application of the present document.

[1] ETSI EN 300 401: "Radio Broadcasting Systems; Digital Audio Broadcasting (DAB) to mobile, portable and fixed receivers".

[2] ETSI ES 201 980: "Digital Radio Mondiale (DRM); System Specification".

[3] ETSI TS 102 386: "Digital Radio Mondiale (DRM); AM signalling system (AMSS)".

[4] National Radio Systems Committee NRSC-5-B:2008: "In-band/on-channel Digital Radio Broadcasting Standard".

[5] ETSI TS 102 818: "Digital Audio Broadcasting (DAB); Digital Radio Mondiale (DRM); XML Specification for Electronic Programme Guide (EPG)".

[6] IETF RFC 1035 (1987): "Domain Names - Implementation and Specification".

[7] IETF RFC 3761 (2004): "The E.164 to Uniform Resource Identifiers (URI) Dynamic Delegation Discovery System (DDDS) Application (ENUM)".

[8] IEC 62106:2015: "Specification of the Radio Data System (RDS) for VHF/FM sound broadcasting in the frequency range from 87,5 MHz to 108,0 MHz".

[9] IEC 62106-9:2021: "Radio Data System (RDS) - VHF/FM sound broadcasting in the frequency range from 64,0 MHz to 108,0 MHz - Part 9: RBDS - RDS variant used in North America".

[10] ISO 3166-1: "Codes for the representation of names of countries and their subdivisions - Part 1: Country codes".

[11] Void.

[12] ETSI TS 101 756: "Digital Audio Broadcasting (DAB); Registered Tables".

[13] IETF RFC 2818: "HTTP over TLS".

[14] IETF RFC 7235: "Hypertext Transfer Protocol (HTTP/1.1): Authentication".

[15] SY-IDD-1020s: "HD Radio™ Air Interface Design Description, Station Information, Service Transport".

2.2 Informative references

References are either specific (identified by date of publication and/or edition number or version number) or non-specific. For specific references, only the cited version applies. For non-specific references, the latest version of the referenced document (including any amendments) applies.

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The following referenced documents are not necessary for the application of the present document but they assist the user with regard to a particular subject area.

Not applicable.

3 Definition of terms, symbols and abbreviations

3.1 Terms

For the purposes of the present document, the following terms apply:

application: means of enhancing an associated radio service, using an IP connection, with additional content, functionality, or interactivity

authoritative FQDN: internet domain for a service provider

bearer: method of carriage of the service

bearerURI: unique identifier for the service to be used in SPI SI documents

char: single character

client identifier: non-unique identifier sent by a client to a service provider

hexadecimal: representation of a number in base-16 using the characters 0-9, a-f

nibble: four-bit aggregation, or half an octet

RadioDNS FQDN: internet domain constructed only for the purposes of querying DNS

service: radio service or data service

ServiceIdentifier: string that uniquely identifies a radio service within the scope of an Authoritative FQDN

service provider: organization providing RadioDNS Hybrid Radio applications

string: zero or more characters in the range 0-9, a-z

3.2 Symbols

Void.

3.3 Abbreviations

For the purposes of the present document, the following abbreviations apply:

AM Amplitude Modulation
AMSS Amplitude Modulation Signalling System

ASF	Advanced Systems Format
CNAME	DNS Canonical NAME record
DAB	Digital Audio Broadcasting
DNS	Domain Name System
DRM	Digital Radio Mondiale
ECC	Extended Country Code
EId	Ensemble Identifier
FCC	Federal Communications Commission
FIG	Fast Information Group
FM	Frequency Modulation
FQDN	Fully Qualified Domain Name
GCC	Global Country Code
HTTP	HyperText Transfer Protocol
IBOC	In-Band On-Channel
ID	IDentifier
IP	Internet Protocol
MSG	MeSsaGe
PI	Programme Identification
RBDS	Radio Broadcast Data System
RDS	Radio Data System
SCIdS	Service Component Identifier within a Service
SI	Service Information
SId	Service Identifier
SPI	Service and Programme Information
SPS	Supplemental Program Service
SRV	DNS SeRVice record
TLS	Transport Layer Security
TTL	Time To Live
URI	Uniform Resource Identifier
URL	Uniform Resource Locator
VHF	Very High Frequency

4 Introduction

It is possible to supplement uni-directional radio services with applications that can take advantage of bi-directional communication using the IP protocol. These applications may enhance the radio services with which they are associated with additional content or functionality, or enable interactivity.

Radio devices should be aware of what IP delivered applications are available for each radio service it receives. Standardizing the methodology to locate these applications allows a manufacturer to support IP delivered applications directly on the device.

The present document standardizes the methodology for locating the Authoritative Fully Qualified Domain Name (FQDN) for radio services using the following radio systems: FM with RDS [8] or RBDS [9], DAB/DAB+ [1], DRM [2], AM with AMSS [3], and IBOC [4].

The present document standardizes a methodology to locate applications based upon the existing DNS methodology [6]. A RadioDNS FQDN is created from known broadcast parameters, and DNS is used to resolve this RadioDNS FQDN to a CNAME record containing the Authoritative FQDN for the service provider.

The basis for this methodology broadly follows that used to map E.164 format telephone numbers to domains [7].

The present document also standardizes how to locate the Authoritative FQDN without the use of DNS lookup.

The Authoritative FQDN for a service can be acquired through a series of processes, shown in figure 1.

The present document also standardizes how devices identify themselves when connecting to service providers.

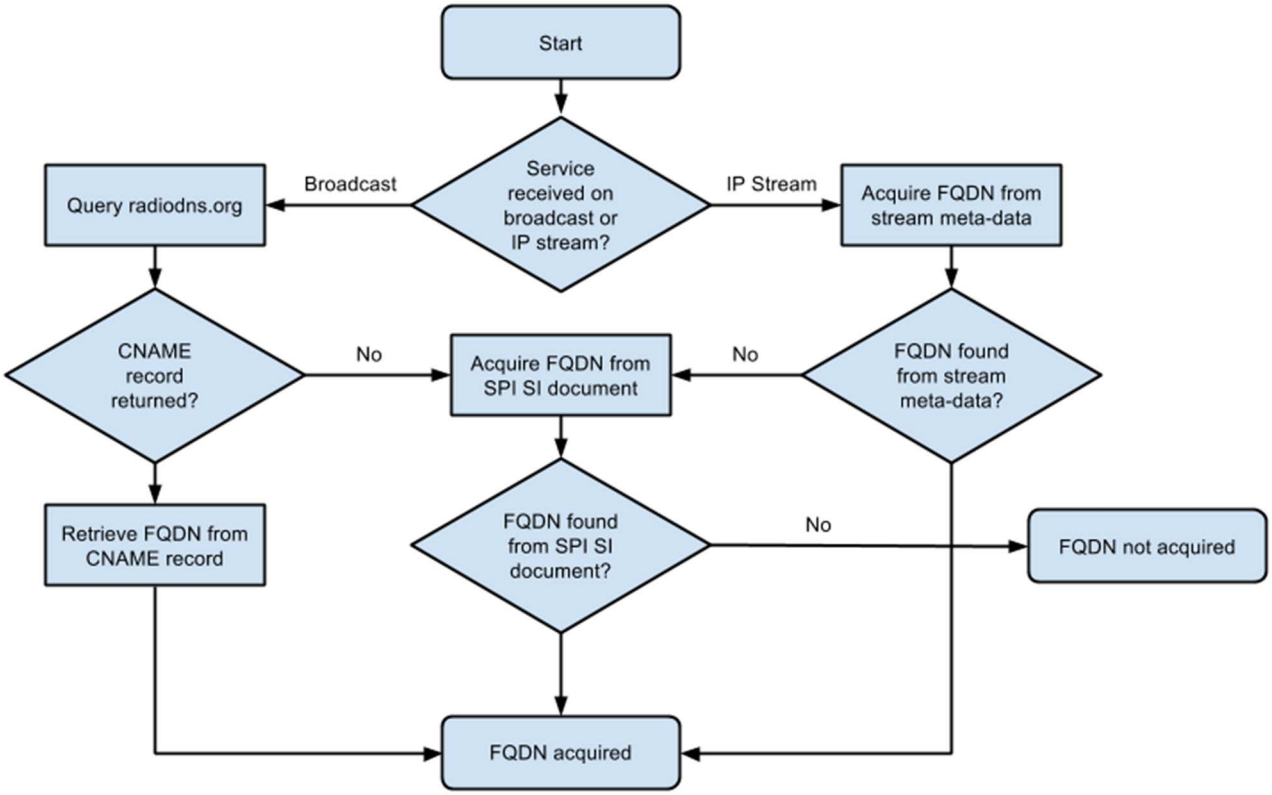

Figure 1: Process to acquire Authoritative FQDN for a service

The service is also given a ServiceIdentifier parameter, which is unique within the scope of an Authoritative FQDN.

The service may also be given a bearerURI parameter, which allows location of the service when placed in an SPI SI document.

Clause 5 describes how to resolve the Authoritative FQDN and construct the ServiceIdentifier and bearerURI for broadcast radio services.

Clause 6 describes how to resolve the Authoritative FQDN and ServiceIdentifier and construct the bearerURI for streaming radio services.

Clause 7 describes how to resolve the Authoritative FQDN and ServiceIdentifier from an SPI SI document.

Methods for discovery of the SPI SI document are defined in ETSI TS 102 818 [5].

5 Authoritative FQDN resolution, ServiceIdentifier and bearerURI construction for broadcast services

5.1 RadioDNS FQDN, ServiceIdentifier and bearerURI construction

5.1.1 FM with RDS/RBDS

5.1.1.1 RDS/RBDS parameters

The FM system supports identification of a radio service through transmission of meta-data by using RDS [8] or RBDS [9].

The parameters are defined in table 1.

Table 1: RDS/RBDS parameter description

Parameter	Description	Value	Status
gcc	The Global Country Code (GCC) of the country of origin of the service (see annex A).	3-char hexadecimal	mandatory
pi	Received RDS/RBDS Programme Identification (PI) code.	4-char hexadecimal	mandatory
frequency	Frequency on which the service broadcast is received, formatted to 5 characters in units of 100 KHz. Frequencies below 100 MHz shall be supplied with a leading zero, for example 95,8 MHz would be represented as "09580", 104,9 MHz as "10490".	5-char string	mandatory

NOTE: During the development of RadioDNS, it was permitted to compile the RadioDNS FQDN using the ISO 3166-1 [10] alpha-2 country code as an alternative to the GCC. However, since the GCC can be derived from location information and the PI code, only the GCC has been standardized.

5.1.1.2 Construction of RadioDNS FQDN

The RadioDNS FQDN for a VHF/FM service is compiled as follows:

```
<frequency>.<pi>.<gcc>.fm.radiodns.org
```

Some examples of RadioDNS FQDNs constructed from broadcast parameters are shown in table 2.

Table 2: Example of RadioDNS FQDN construction for RDS/RBDS

GCC	PI	Frequency (MHz)	RadioDNS FQDN
ce1	c586	95,8	09580.c586.ce1.fm.radiodns.org
de0	d1e0	103,9	10390.d1e0.de0.fm.radiodns.org

5.1.1.3 Construction of ServiceIdentifier

The ServiceIdentifier for a VHF/FM service is compiled as follows:

```
fm/<gcc>/<pi>/<frequency>
```

Some examples of ServiceIdentifiers constructed from broadcast parameters are shown in table 3.

Table 3: Example of RadioDNS ServiceIdentifier construction for RDS/RBDS

GCC	PI	Frequency (MHz)	RadioDNS ServiceIdentifier
ce1	c586	95,8	fm/ce1/c586/09580
de0	d1e0	103,9	fm/de0/d1e0/10390

5.1.1.4 Construction of bearerURI

The bearerURI for a VHF/FM service is compiled as follows:

```
fm:<gcc>.<pi>.<frequency>
```

The <frequency> element may be replaced by the asterisk ("*") character to signify any frequency. In this case the PI code alone shall be used by the device to locate the source.

Some examples of FM bearerURIs constructed from broadcast parameters are shown in table 4.

Table 4: Example of RadioDNS bearerURI construction for RDS/RBDS

GCC	PI	Frequency (MHz)	RadioDNS bearerURI
ce1	c586	95,8	fm:ce1.c586.09580
de0	d1e0	103,9	fm:de0.d1e0.10390
ce1	c201	many	fm:ce1.c201.*

5.1.2 Digital Audio Broadcasting (DAB/DAB+)

5.1.2.1 DAB/DAB+ parameters

The parameters are defined in table 5.

Table 5: DAB parameter description

Parameters	Description	Value	Status
gcc	The Global Country Code (GCC) of the country of origin of the service (see annex A)	3-char hexadecimal	mandatory
eid	The Ensemble Identifier (EId) of the service	4-char hexadecimal	mandatory
sid	The Service Identifier (SId) of the service	4- or 8-char hexadecimal	mandatory
scids	The Service Component Identifier within the Service (SCIdS) of the service component	1-char hexadecimal	mandatory
uatype	The User Application Type (UAtype) of the data component	3-char hexadecimal	mandatory for data components, otherwise omitted

For data services (or data components of audio services) the **uatype** parameter is also mandatory.

5.1.2.2 Construction of RadioDNS FQDN

The RadioDNS FQDN for a DAB/DAB+ service is compiled as follows:

```
[<uatype>.]<scids>.<sid>.<eid>.<gcc>.dab.radiodns.org
```

Some examples of RadioDNS FQDNs constructed from broadcast parameters are shown in table 6.

Table 6: Example of RadioDNS FQDN construction for DAB

GCC	EId	SId	SCIdS	UAType	RadioDNS FQDN
de0	100c	d220	0		0.d220.100c.de0.dab.radiodns.org
ce1	c18c	cc86	0		0.cc86.c18c.ce1.dab.radiodns.org
ce1	c185	e1c00098	0	004	004.0.e1c00098.c185.ce1.dab.radiodns.org

5.1.2.3 Construction of ServiceIdentifier

The ServiceIdentifier for a DAB/DAB+ service is compiled as follows:

```
dab/<gcc>/<eid>/<sid>/<scids>[/<uatype>]
```

The <separator> element is application specific. The inclusion of <uatype> is mandatory for data services or data components of audio services.

Some examples of ServiceIdentifiers constructed from broadcast parameters are shown in table 7.

Table 7: Example of RadioDNS ServiceIdentifier construction for DAB

GCC	EId	SId	SCIdS	UAType	RadioDNS ServiceIdentifier
de0	100c	d220	0		dab/de0/100c/d220/0
ce1	c18c	cc86	0		dab/ce1/c18c/cc86/0
ce1	c185	e1c00098	0	004	dab/ce1/c185/e1c00098/0/004

5.1.2.4 Construction of bearerURI

The bearerURI for a DAB/DAB+ service is compiled as follows:

```
dab:<gcc>.<eid>.<sid>.<scids>[.<uatype>]
```

The inclusion of `<uatype>` is mandatory for data services or data components of audio services.

Some examples of bearerURIs constructed from broadcast parameters are shown in table 8.

Table 8: Example of RadioDNS bearerURI construction for DAB

GCC	EId	SId	SCIdS	UAType	RadioDNS bearerURI
de0	100c	d220	0		dab:de0.100c.d220.0
ce1	c18c	cc86	0		dab:ce1.c18c.cc86.0
ce1	c185	e1c00098	0	004	dab:ce1.c185.e1c00098.0.004

5.1.3 Digital Radio Mondiale (DRM)

5.1.3.1 DRM parameters

The parameters are defined in table 9.

Table 9: DRM parameter description

Parameters	Description	Value	Status
sid	The Service Identifier (SId) of the service	6-char hexadecimal	mandatory
appdomain	The application domain of the data component	1-char hexadecimal	mandatory for data components, otherwise omitted
uatype	The user application type of the data component	3-char hexadecimal	mandatory for data components, otherwise omitted

The SId value for DRM is intended to be suitably unique internationally so as to not require region identification.

5.1.3.2 Construction of RadioDNS FQDN

The RadioDNS FQDN for a Digital Radio Mondiale service is compiled as follows:

```
[<uatype>.<appdomain>]<sid>.drm.radiodns.org
```

Some examples of RadioDNS FQDNs constructed from broadcast parameters are shown in table 10.

Table 10: Example of RadioDNS FQDN construction for DRM

SId	App Domain	UAType	RadioDNS FQDN
e1c238			e1c238.drm.radiodns.org
f07256	1	00d	00d.1.f07256.drm.radiodns.org
a13002			a13002.drm.radiodns.org

5.1.3.3 Construction of ServiceIdentifier

The ServiceIdentifier for a Digital Radio Mondiale service compiled as follows:

```
drm/<sid>[/<appdomain>/<uatype>]
```

Some examples of ServiceIdentifiers constructed from broadcast parameters are shown in table 11.

Table 11: Example of RadioDNS ServiceIdentifer construction for DRM

SId	App Domain	UAType	RadioDNS ServiceIdentifer
e1c238			drm/e1c238
f07256	1	00d	drm/f07256/1/00d
a13002			drm/a13002

5.1.3.4 Construction of bearerURI

The bearerURI for a Digital Radio Mondiale service is compiled as follows:

```
drm:<sid>[.<appdomain>.<uatype>]
```

Some examples of bearerURIs constructed from broadcast parameters are shown in table 12.

Table 12: Example of RadioDNS bearerURI construction for DRM

SId	App Domain	UAType	RadioDNS bearerURI
e1c238			drm:e1c238
f07256	1	00d	drm:f07256.1.00d
a13002			drm:a13002

5.1.4 AM Signalling System (AMSS)

5.1.4.1 AMSS parameters

The parameters are defined in table 13.

Table 13: AMSS parameter description

Parameters	Description	Value	Status
sid	The Service Identifier (SId) of the service	6-char hexadecimal	mandatory

The SId value for AMSS is intended to be suitably unique internationally so as to not require region identification.

5.1.4.2 Construction of RadioDNS FQDN

The RadioDNS FQDN for an AM service with AMSS is compiled as follows:

```
<sid>.amss.radiodns.org
```

5.1.4.3 Construction of ServiceIdentifier

The ServiceIdentifier for an AM service with AMSS is compiled as follows:

```
amss/<sid>
```

5.1.4.4 Construction of bearerURI

The bearerURI for an AM service with AMSS is compiled as follows:

```
amss:<sid>
```

5.1.5 IBOC

5.1.5.1 IBOC parameters

The parameters are defined in table 14.

Table 14: IBOC parameter description

Parameters	Description	Value	Status
tx	Transmitter Identifier Service broadcast identifier	5-char hexadecimal	mandatory
cc	Country Code Service broadcast country code	3-char hexadecimal	mandatory
mId	The identifier for a multicast Supplemental Program Service (SPS) channel	1-char hexadecimal	mandatory for supplemental services, otherwise omitted

The `tx` value is the FCC facility code of the transmitter in the United States of America, or a unique identifier supplied by the licensors of the IBOC technology in other places.

The `cc` value is the hexadecimal representation of the encoded country ID [15].

EXAMPLE: The value of `cc` for the United States of America is `0x292`.

The `mId` is only defined if the bearer describes a Supplemental Program Service (SPS), defined as a supplemental "multicast" service to the main service. For a bearer describing the Main Program Service (HD-1), this value is omitted. For a bearer describing the first SPS channel (HD-2), `mId` shall be 2, for the second SPS channel (HD-3), `mId` shall be 3, and so on.

5.1.5.2 Construction of RadioDNS FQDN

The RadioDNS FQDN for an IBOC service is compiled as follows:

```
[<mId>.]<tx>.<cc>.hd.radiodns.org
```

Table 15: Example of RadioDNS FQDN construction for IBOC

tx	cc	mId	RadioDNS FQDN
07A26	292		07a26.292.hd.radiodns.org
07A26	292	2	2.07a26.292.hd.radiodns.org

5.1.5.3 Construction of ServiceIdentifier

The ServiceIdentifier for an IBOC service is compiled as follows:

```
hd/<cc>/<tx>[/<mId>]
```

Table 16: Example of RadioDNS ServiceIdentifier construction for IBOC

tx	cc	mId	RadioDNS ServiceIdentifier
07A26	292		hd/292/07a26
07A26	292	2	hd/292/07a26/2

5.1.5.4 Construction of bearerURI

The bearerURI for an IBOC service is compiled as follows:

```
hd:<cc>.<tx>[.<mId>]
```

Table 17: Example of RadioDNS bearerURI construction for IBOC

tx	cc	mId	RadioDNS bearerURI
07A26	292		hd:292.07a26
07A26	292	2	hd:292.07a26.2

5.2 Resolution of Authoritative FQDN

The RadioDNS FQDN, constructed from the broadcast parameters, is used to acquire the Authoritative FQDN. Making a DNS query with a RadioDNS FQDN will return a single CNAME record containing the Authoritative FQDN of the service provider. If no CNAME is returned, then the service has not been registered.

EXAMPLE: Consider an FM service identified by the RadioDNS FQDN:

```
09580.c479.ce1.fm.radiodns.org
```

Using the nslookup tool would yield the following lookup result:

```
canonical name = rdns.musicradio.com
```

Therefore, for this service, the Authoritative FQDN is:

```
rdns.musicradio.com
```

The broadcast parameters should be continuously monitored. If any broadcast parameter changes (for example, a change to the RDS/RBDS PI code), the process of resolving the Authoritative FQDN should be repeated using the new broadcast parameters.

The TTL (Time To Live) parameters of the Authoritative FQDN shall be queried and respected.

Upon expiry of the TTL, the process of resolving the Authoritative FQDN shall be repeated.

If the Authoritative FQDN has changed, then all active applications shall be notified and each application shall repeat its own process for connecting to resources using the updated Authoritative FQDN.

NOTE: The process of resolving the Authoritative FQDN to a CNAME is identical for both IPv4 and IPv6 transports.

6 Authoritative FQDN, ServiceIdentifier resolution and bearerURI construction for IP-streamed services

6.1 General

An Authoritative FQDN may also be provided for IP-streamed services, by sending the value as part of the in-stream metadata of the IP stream. This is defined as the parameter **fqdn**.

Since no broadcast parameters exist for such services, an additional parameter is required to provide disambiguation so that the particular RadioDNS application can determine the exact service being used. This is defined as the parameter **sid**.

The **sid** shall be unique across all services using the same Authoritative FQDN for application discovery, with a maximum character limit of 16 characters in the range [a-z][0-9]. The exact use of this parameter is specific to the RadioDNS application being used.

For any streaming protocol where the **fqdn** and **sid** parameters are sent as in-stream metadata at regular intervals, the values shall be monitored after they have been initially acquired. If these values are found to change at any point, the old values will be deemed to have expired, and the process of resolving the Authoritative FQDN shall be repeated.

If the Authoritative FQDN has changed, then all active applications shall be notified and each application shall repeat its own process for connecting to resources using the updated Authoritative FQDN.

6.2 Inclusion of parameters into stream metadata

6.2.1 Streaming transports

6.2.1.1 SHOUTcast

SHOUTcast uses a client-server model, with each component communicating via a network protocol that intermingles audio or video data with metadata such as song titles and the station name. It uses HTTP as a transport protocol.

NOTE: Additional information is available from https://forums.radiotoolbox.com/viewtopic.php?t=74.

The parameters should be contained within the initial HTTP Response at the start of the stream, using the HTTP response header **icy-url**, which has a defined usage within the SHOUTcast specification. Its value should be of the form:

```
http://<fqdn>/<sid>
```

If a Service Provider wishes to also support the intended functionality of this parameter to provide a URL to a website, it is recommended that HTTP requests to this URL are handled appropriately (such as delivering a web-page, or returning an HTTP 302 response to re-direct the browser to an alternative URL).

6.2.1.2 ASF

Advanced Systems Format (ASF) is a container format that is part of the Windows Media framework. It typically defines a payload containing multiple streams of data, e.g. audio and a metadata stream.

An additional stream shall be created, solely containing the **fqdn** and **sid**, declared as Custom Metadata using key/value pairs for attributes with the following keys:

- **radiodns-fqdn** for the **fqdn**
- **radiodns-sid** for the **sid**

It is recommended that the values be programmatically specified as a null-terminated Unicode string, using the default platform language.

NOTE: If using Windows Media Encoder, this can be entered in as Custom Metadata when setting up the stream.

6.2.1.3 Flash Audio

Flash Audio is a container format for audio and video streams.

The parameters shall be implemented as a non-persistent Remote Shared Object available on the URI of the Flash Audio stream itself. The object shall be read-only for clients.

NOTE: Guidance is available from http://help.adobe.com/en_US/FlashPlatform/reference/actionscript/3/flash/net/SharedObject.html.

The object shall be named: **radiodns**

And have the following named string properties:

- **fqdn** for the **fqdn**
- **sid** for the **sid**

Clients shall listen for changes to these properties and update accordingly.

6.2.2 Metadata intervals

It is desirable that the client receives initial or updated parameters with as short a delay as possible. The cycle time of the metadata parameters will directly affect the speed at which connecting clients can access applications.

It is recommended that service providers ensure that connecting clients receive the parameters within 5 seconds.

6.3 Construction of bearerURI

The bearerURI for an IP-based service is constructed from the URL for the stream source.

EXAMPLE: `http://media-ice.musicradio.com/Capital`

6.4 Construction of ServiceIdentifier

The ServiceIdentifier for an IP-based service is constructed as follows:

`id/<fqdn>/<sid>`

7 Authoritative FQDN and ServiceIdentifier resolution from SPI SI

An Authoritative FQDN may also be provided in an SPI SI document [5]. In this case, the **fqdn** and **sid** parameters (see clause 6) are provided as attributes of the **radiodns** element:

- radiodns/@fqdn carries the **fqdn**
- radiodns/@serviceIdentifier carries the **sid**

EXAMPLE 1: `<radiodns fqdn="www.heart.co.uk" serviceIdentifier="bristol"/>`

The methods by which the SPI SI document can be acquired for the service are specified in ETSI TS 102 818 [5].

The ServiceIdentifier when derived from an SI document is constructed as follows:

- `id/<fqdn>/<sid>`

EXAMPLE 2: `id/www.heart.co.uk/bristol`

If the SPI SI document is either updated or expires through any applicable mechanism, the old parameters shall be discarded, and the process of resolving the Authoritative FQDN shall be repeated.

If the Authoritative FQDN has changed, then all active applications shall be notified and each application shall repeat its own process for connecting to resources using the updated Authoritative FQDN.

8 Implementation requirements

8.1 Service provider implementation

For broadcast services, a service provider shall support clause 5, Authoritative FQDN resolution for broadcast services. In addition, for services transmitted via FM with RDS/RBDS or DAB, the service provider shall transmit the ECC via RDS Group 1A or DAB FIG 0/9 respectively. For DAB or DRM services, the service provider may also support clause 7, Authoritative FQDN resolution from SPI SI. For IBOC services, the service provider shall transmit the Country Code and FCC Facility ID via the Station ID Number message (MSG ID = 0000). In the United States of America, the FCC Facility ID shall be populated by the FCC facility code of the transmitter. Outside of the United States of America, this shall be populated by a unique identifier supplied by the licensors of the IBOC technology.

For IP-streamed services, a service provider shall provide values for the **fqdn** and **ServiceIdentifier** parameters using at least one of the following:

- clause 6, Authoritative FQDN resolution for IP-streamed Services;
- clause 7, Authoritative FQDN resolution from SPI SI.

8.2 Device Implementation

For broadcast services, a device shall support clause 5, Authoritative FQDN resolution for broadcast services. For DAB or DRM services, the device may also support clause 7, Authoritative FQDN resolution from SPI SI.

For IP-streamed services, a device shall support the acquisition of values for the **fqdn** and **ServiceIdentifier** parameters from at least one of the following:

- clause 6, Authoritative FQDN resolution for IP-streamed Services;
- clause 7, Authoritative FQDN resolution from SPI SI.

9 Client identification

9.1 Introduction

A service provider's application may wish to identify connecting clients by using a client identifier. This enables it to provide a varying response to the client; for example, to provide more detailed or personalized responses to clients that present a client identifier, and less detailed or more generic responses to clients that do not.

The exact details on what this can be applied to are defined in the specification for that particular application.

The service provider's application may signal support for client identification by defining specific SRV records, as defined in the specification for that application.

The service provider shall return an error if it is determined that the presented client identifier is invalid or unrecognized, and shall always return a valid response if no device identifier is provided.

The method of allocation, distribution and management of client identifiers by a service provider is not defined by the present document.

Client identifiers shall be kept private to the client and shall not be made accessible to anything beyond that client, either through a user interface, or via any external connections.

9.2 Client identifier format

A client identifier is a string of between 16 and 128 characters, drawn from the allowed characters:

```
[a-zA-Z0-9]
```

It is strongly recommended that a client stores an acquired client identifier against the Authoritative FQDN(s) it has determined it applies to.

9.3 Client Identifier Presentation

9.3.1 Introduction

The common behaviour is defined as:

- A client shall determine whether the service provider's application supports the use of a client identifier, using the defined SRV records.
- A client may present a client identifier when supported by the service provider's application.
- A client shall only present the client identifier associated with the Authoritative FQDN of the application it is requesting resources from, or connecting to.
- A client shall only present the client identifier for supported resources as given in the application specification. For all other resources, the client shall not present the client identifier.

9.3.2 Use of TLS

Implementation of the use of a client identifier shall require the use of Transport Layer Security (TLS) [13] encryption for any requests or connections that present the client identifier to an application and for any resulting responses or connections from the application to the client.

The appropriate version (or versions) of TLS will vary over time, based on the widespread deployment and known security vulnerabilities.

9.3.3 Protocol guidance

This clause contains specific guidance for a client to present the relevant client identifier over common protocols. In the present document, only a single protocol is defined: HTTPS.

Guidance for additional protocols specific to an application, or additional and more specific guidance may be given in the application specifications.

When requesting resources over HTTPS, a client shall present the relevant client identifier using the HTTP 1.1 authentication framework [14]. This defines a method of authentication for HTTP resources using an extensible set of challenge-response schemes.

The present document defines an additional authentication scheme to be used for the purposes of client identification, as follows:

In client presentation of credentials:

- the scheme name is **ClientIdentifier**;
- the credentials are defined in the "token68" syntax defined in IETF RFC 7235 [14], section 2.1, with the value computed from the client identifier string.

EXAMPLE 1: For example, to present a client identifier of **ABCD123456**, the client would use the following header field in the request for the resource:

```
Authorization: ClientIdentifier ABCD123456
```

When the service provider receives a request from the client with a valid client identifier, the service provider shall return an "HTTP 200 (OK)" response code, along with the resource contents in the response body.

EXAMPLE 2:

```
HTTP/1.1 200 OK
…
```

When the service provider receives a request from the client without a client identifier, the service provider shall return an "HTTP 401 (Unauthorized)" response code. This should also include the HTTP response header "WWW-Authenticate. The "WWW-Authenticate" response header indicates to the client that they are being challenged to provide a valid client identifier.

EXAMPLE 3:

```
HTTP/1.1 401 Unauthorized
WWW-Authenticate: ClientIdentifier
```

In challenges:

- the scheme name is **ClientIdentifier**;
- the authentication parameter **realm** is optional;
- the authentication parameter **charset** is optional;
- no other authentication parameters are defined. Unknown parameters shall be ignored by recipients, and new parameters can only be defined by revising the present document;
- both the scheme and the parameter names shall be matched case-insensitively.

When the service provider receives a request from the client with a client identifier that the service provider deems invalid or that is not recognized, the service provider shall return an "HTTP 403 (Forbidden)" response code.

EXAMPLE 4:

```
HTTP/1.1 403 Forbidden
```

On receiving this response, the client shall not repeat the same request.

9.4 Service provider reception

The common behaviour is defined as:

- a service provider's application shall ignore a presented client identifier if it does not intend to make use of it;
- a service provider's application shall return a valid response if the client identifier is not presented;
- a service provider shall signal that its application supports client identification through the use of SRV records determined by the application specification, should it wish to do this;
- a service provider's application shall return an error if the client identifier is invalid;
- a service provider's application shall return a valid response if the client identifier is valid;
- a service provider's application may vary its response based on a provided valid client identifier.

Annex A (normative): Deriving the GCC for a service

A.0 Introduction

The GCC is derived from the received ECC, see clause A.1. However, receivers need to cope with the situation that the ECC is not transmitted, or when the acquisition time is extended, see clause A.2.

A.1 Deriving the GCC using ECC

The Global Country Code (GCC) shall be constructed by concatenating the Country Code and the Extended Country Code (ECC) of the service.

For FM RDS/RBDS or DAB/DAB+ audio services, the Country Code of the service is given by the **first** nibble of the RDS/RBDS PI code or DAB SId respectively. The ECC of the service is provided in the RDS Group 1A Block 3 Variant 0 [8] or the DAB FIG 0/9 [1] respectively.

For DAB data services, the Country Code of the service is given by the **third** nibble of the DAB SId. The ECC of the service is provided in the **first** and **second** nibbles of the DAB SId.

In all cases, the 1-character hexadecimal Country Code shall be combined with the 2-character hexadecimal ECC to create the 3-character hexadecimal GCC.

EXAMPLE 1: RDS PI code = C479, ECC = E1: GCC = C + E1 = CE1

EXAMPLE 2: DAB SId = D310, ECC = E0: GCC = D + E0 = DE0

EXAMPLE 3: DAB SId = E1F59B37: GCC = F + E1 = FE1

A.2 Deriving the GCC without ECC

It is strongly recommended that receivers implement the process specified in figure A.1 using table A.1 and use it to derive the GCC if the ECC is not received promptly.

The process uses the Country Code of the service (derived from either the RDS/RBDS PI code or the DAB SId) and the ISO 3166-1 alpha-2 country code [10] of the current location of the receiver, and returns the GCC of the service. The process accounts for border areas, where a receiver may be located in a different country to the country of origination of the service.

NOTE: In the case of Canada and the United States, the RDS Country Code B is shared between the two countries. RDS PI Codes beginning B1 and B8 to BF are allocated to the United States, and PI Codes beginning B2 to B7 are allocated to Canada. It is necessary to consider the first two nibbles of the RDS PI code when constructing the GCC.

Sources of information such as GPS/GSM/GeoIP can provide the ISO 3166-1 [10] alpha-2 country code for the **current location** of the receiver. The returned GCC shall be used when creating the RadioDNS FQDN and ServiceIdentifier.

Table A.1 has been constructed from several sources, which may change over time to reflect changing geo-political situations. The sources are:

- ISO 3166-1 alpha-2 Country Codes [10]
- Tables 3 to 7 in clause 5.4 of ETSI TS 101 756 [12]
- List of Countries and Territories by Land and Maritime Borders (Wikipedia: http://en.wikipedia.org/wiki/List_of_countries_and_territories_by_land_and_maritime_borders)

Table A.2 lists bordering countries that have been removed from table A.1, either because they are widely separated by water and it is unlikely that radio signals would cross between the countries, or because there is a very small and distant territorial presence claimed as part of the main territory (oceanic islands).

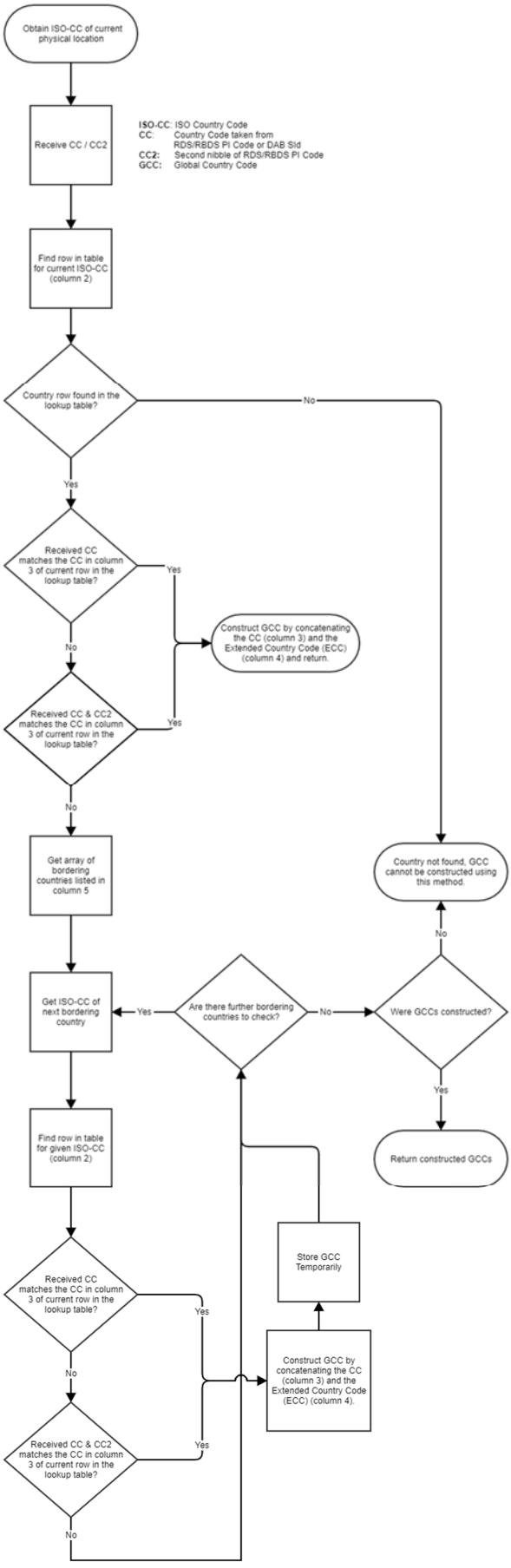

Figure A.1: Process for GCC construction

Table A.1: Look-up table for GCC construction

Country	ISO 3166-1 [10] 2-alpha code	Country Code	ECC	Bordering countries look-up (CC:ISO 3166-1 [10] code)
Afghanistan	AF	A	F0	C:CN; 8:IR; 4:PK; 5:TJ; E:TM; B:UZ
Albania	AL	9	E0	C:HR; 1:GR; 5:IT; 3:MK; D:RS
Algeria	DZ	2	E0	D:LY; 5:ML; 4:MR; 1:MA; 8:NE; E:ES; 7:TN; 3:EH
American Samoa	AS	X	XX	4:WS; 3:TO
Andorra	AD	3	E0	F:FR; E:ES
Angola	AO	6	D0	C:CG; 1:NA; E:ZM
Anguilla	AI	1	A2	2:AG; 8:NL; F:VI
Antigua and Barbuda	AG	2	A2	A:KN; 1:AI; 5:MS; F:FR
Argentina	AR	A	A2	1:BO; B:BR; C:CL; 6:PY; 9:UY; 4:FK
Armenia	AM	A	E4	B:AZ; C:GE; 8:IR; 3:TR
Aruba	AW	3	A4	B:DO; E:VE
Australia	AU	1; 2; 3; 4; 5; 6; 7; 8	F0	C:ID; 9:PG; A:SB
Austria	AT	A	E0	2:CZ; D:DE; 1:DE; B:HU; 5:IT; 9:LI; 5:SK; 9:SI; 4:CH
Azerbaijan	AZ	B	E3	A:AM; C:GE; 8:IR; 7:RU; 3:TR; E:TM
Bahamas	BS	F	A2	1:US; 2:US; 3:US; 4:US; 5:US; 6:US; 7:US; 8:US; 9:US; A:US; B:US; D:US; E:US
Bahrain	BH	E	F0	8:IR; 2:QA; 9:SA
Bangladesh	BD	3	F1	B:MM; 5:IN
Barbados	BB	5	A2	F:GY; C:VC; 6:TT; E:VE
Belarus	BY	F	E3	9:LV; C:LT; 8:PL; 7:RU; 6:UA
Belgium	BE	6	E0	F:FR; D:DE; 1:DE; 7:LU; 8:NL; C:GB
Belize	BZ	6	A2	1:GT; 2:HN; F:MX
Benin	BJ	E	D0	B:BF; 3:GH; 8:NE; F:NG; D:TG
Bermuda	BM	C	A2	
Bhutan	BT	2	F1	C:CN; 5:IN
Bolivia	BO	1	A3	A:AR; B:BR; C:CL; 6:PY; 7:PE
Bosnia and Herzegovina	BA	F	E4	C:HR; 1:ME; D:RS
Botswana	BW	B	D1	1:NA; A:ZA; E:ZM; 2:ZW
Brazil	BR	B	A2	A:AR; 1:BO; 2:CO; F:GY; 6:PY; 7:PE; 8:SR; 9:UY; E:VE
British Indian Ocean Territory	IO	X	XX	B:MV
British Virgin Islands	VG	F	A5	8:PR; F:VI
Brunei	BN	B	F1	F:MY
Bulgaria	BG	8	E1	1:GR; 3:MK; E:RO; D:RS; 3:TR
Burkina Faso	BF	B	D0	E:BJ; C:CI; 3:GH; 5:ML; 8:NE; D:TG
Burma	MM	B	F0	3:BD; C:CN; 5:IN; 1:LA; 2:TH
Burundi	BI	9	D1	5:RW; D:TZ
Cambodia	KH	3	F2	1:LA; 2:TH; 7:VN
Cameroon	CM	1	D0	2:CF; 9:TD; C:CG; 7:GQ; 8:GA; F:NG
Canada	CA	C; B2; B3; B4; B5; B6; B7	A1	1:US; 2:US; 3:US; 4:US; 5:US; 6:US; 7:US; 8:US; 9:US; A:US; B1:US; B8:US; B9:US; BA:US; BB:US; BC:US; BD:US; BE:US; BF:US; D:US; E:US; F:GL; F:PM
Cape Verde	CV	6	D1	8:GM; 4:MR; 7:SN
Cayman Islands	KY	7	A2	9:CU; 3:JM
Central African Republic	CF	2	D0	1:CM; 9:TD; C:CG; C:SD
Chad	TD	9	D2	1:CM; 2:CF; D:LY; 8:NE; F:NG; C:SD
Chile	CL	C	A3	A:AR; 1:BO; 7:PE
China	CN	C	F0	A:AF; 2:BT; B:MM; 5:IN; 9:JP; D:KZ; D:KP; 3:KG; 1:LA; F:MN; E:NP; 4:PK; 8:PH; 7:RU; 5:TJ; 7:VN; F:HK; 6:MO
Christmas Island	CX	X	XX	C:ID
Colombia	CO	2	A3	B:BR; 8:CR; 3:EC; D:HT; 2:HN; 7:NI; 9:PA; 7:E:VE
Comoros	KM	C	D1	F:FR; 4:MG; 3:MZ; B:SC; D:TZ

Country	ISO 3166-1 [10] 2-alpha code	Country Code	ECC	Bordering countries look-up (CC:ISO 3166-1 [10] code)
Democratic Republic of the Congo	CD	X	XX	6:AO; 9:BI; 2:CF; C:CG; 5:RW; D:TZ; 4:UG; E:ZM
Republic of the Congo	CG	C	D0	6:AO; 1:CM; 2:CF; 8:GA
Cook Islands	CK	X	XX	1:KI
Costa Rica	CR	8	A2	2:CO; 3:EC; 7:NI; 9:PA
Cote d'Ivoire	CI	C	D2	B:BF; 3:GH; 9:GN; 2:LR; 5:ML
Croatia	HR	C	E3	F:BA; B:HU; 5:IT; 1:ME; D:RS; 9:SI
Cuba	CU	9	A2	D:HT; 2:HN; 3:JM; 7:KY
Curacao	CW	X	XX	B:DO; E:VE
Cyprus	CY	2	E1	F:EG; 1:GR; 4:IL; A:LB; 3:TR
Czech Republic	CZ	2	E2	A:AT; D:DE; 1:DE; 3:PL; 5:SK
Denmark	DK	9	E1	D:DE; 1:DE; F:NO; 3:PL; E:SE; C:GB
Djibouti	DJ	3	D0	E:ET; 7:SO; B:YE
Dominica	DM	A	A3	F:FR; E:VE
Dominican Republic	DO	B	A3	2:CO; D:HT; 3:AW; CW; 8:PR; E:TC
Ecuador	EC	3	A2	2:CO; 8:CR; 7:PE
Egypt	EG	F	E0	2:CY; 1:GR; 4:IL; 5:JO; D:LY; 9:SA; C:SD; 3:TR
El Salvador	SV	C	A4	1:GT; 2:HN; 7:NI
Equatorial Guinea	GQ	7	D0	1:CM; 8:GA; F:NG
Eritrea	ER	X	XX	3:DJ; 9:SA; C:SD; E:ET; B:YE
Estonia	EE	2	E4	6:FI; 9:LV; 7:RU; E:SE
Ethiopia	ET	E	D1	3:DJ; 6:KE; 7:SO; C:SD
Falkland Islands	FK	4	A2	A:AR
Faroe Islands	FO	9	E1	A:IS; F:NO; C:GB
Fiji	FJ	5	F1	9:NZ; 3:TO; F:VU
Finland	FI	6	E1	2:EE; F:NO; 7:RU; E:SE
France	FR	F	E1	3:AD; 6:BE; D:DE; 1:DE; 5:IT; 7:LU; B:MC; E:ES; 4:CH; C:GB
French Polynesia	PF	X	XX	1:KI
Gabon	GA	8	D0	1:CM; C:CG; 7:GQ
The Gambia	GM	8	D1	6:CV; 7:SN
Georgia	GE	C	E4	A:AM; B:AZ; 7:RU; 3:TR; 6:UA
Germany	DE	D;1	E0	A:AT; 6:BE; 2:CZ; 9:DK; F:FR; 7:LU; 8:NL; 3:PL; E:SE; 4:CH; C:GB
Ghana	GH	3	D1	E:BJ; B:BF; C:CI; F:NG; D:TG
Gibraltar	GI	A	E1	1:MA; E:ES
Greece	GR	1	E1	9:AL; 8:BG; 2:CY; F:EG; 5:IT; D:LY; 3:MK; 3:TR
Greenland	GL	F	A1	C:CA; A:IS; F:NO
Grenada	GD	D	A3	C:VC; 6:TT
Guam	GU	X	XX	E:FM
Guatemala	GT	1	A4	6:BZ; C:SV; 2:HN; F:MX
Guernsey	GG	X	XX	F:FR; C:GB
Guinea	GN	9	D0	C:CI; A:GW; 2:LR; 5:ML; 7:SN; 1:SL
Guinea Bissau	GW	A	D2	9:GN; 7:SN
Guyana	GY	F	A3	5:BB; B:BR; 8:SR; 6:TT; E:VE
Haiti	HT	D	A4	F:BS; 2:CO; 9:CU; B:DO; 3:JM; E:TC
Honduras	HN	2	A4	6:BZ; 2:CO; 9:CU; C:SV; 1:GT; F:MX; 7:NI
Hong Kong	HK	F	F1	
Hungary	HU	B	E0	A:AT; C:HR; E:RO; D:RS; 5:SK; 9:SI; 6:UA
Iceland	IS	A	E2	9:FO; F:GL
India	IN	5	F2	A:AF; 3:BD; 2:BT; B:MM; C:CN; E:NP; 4:PK; C:LK
Indonesia	ID	C	F2	1:AU; 2:AU; 3:AU; 4:AU; 5:AU; 6:AU; 7:AU; 8:AU; F:MY; 9:PG; A:SG
Iran	IR	8	F1	A:AF; A:AM; B:AZ; B:IQ; 1:KW; 6:OM; 4:PK; 2:QA; 9:SA; 3:TR; E:TM; D:AE
Iraq	IQ	B	E1	8:IR; 5:JO; 1:KW; 9:SA; 3:TR
Ireland	IE	2	E3	C:GB
Isle of Man	IM	X	XX	C:GB; 2:IE
Israel	IL	4	E0	2:CY; F:EG; 5:JO; A:LB
Italy	IT	5	E0	9:AL; 2:DZ; A:AT; C:HR; F:FR; 1:GR; D:LY; 3:SM; 9:SI; E:ES; 4:CH; 7:TN; 4:VA
Jamaica	JM	3	A3	2:CO; 9:CU; D:HT; 7:KY

Country	ISO 3166-1 [10] 2-alpha code	Country Code	ECC	Bordering countries look-up (CC:ISO 3166-1 [10] code)
Japan	JP	9	F2	C:CN; E:KR; 8:PH; 7:RU
Jersey	JE	X	XX	F:FR; C:GB
Jordan	JO	5	E1	F:EG; B:IQ; 4:IL; 9:SA
Kazakhstan	KZ	D	E3	C:CN; 3:KG; 7:RU; E:TM; B:UZ
Kenya	KE	6	D2	E:ET; 7:SO; D:TZ; 4:UG
Kiribati	KI	1	F1	7:NR
North Korea	KP	D	F0	C:CN; 9:JP; E:KR; 7:RU
South Korea	KR	E	F1	C:CN; 9:JP; D:KP
Kuwait	KW	1	F2	8:IR; B:IQ; 9:SA
Kyrgyzstan	KG	3	E4	C:CN; D:KZ; 5:TJ; B:UZ
Laos	LA	1	F3	B:MM; 3:KH; C:CN; 2:TH; 7:VN
Latvia	LV	9	E3	F:BY; 2:EE; C:LT; 7:RU; E:SE
Lebanon	LB	A	E3	2:CY; 4:IL
Lesotho	LS	6	D3	A:ZA
Liberia	LR	2	D1	C:CI; 9:GN; 1:SL
Libya	LY	D	E1	2:DZ; 9:TD; F:EG; 1:GR; 5:IT; 8:NE; C:SD; 7:TN
Liechtenstein	LI	9	E2	A:AT; 4:CH
Lithuania	LT	C	E2	F:BY; 9:LV; 3:PL; 7:RU; E:SE
Luxembourg	LU	7	E1	6:BE; F:FR; D:DE; 1:DE
Macau	MO	6	F2	
Republic of Macedonia	MK	3	E4	9:AL; 8:BG; 1:GR; D:RS
Madagascar	MG	4	D0	C:KM; F:FR; 3:MZ; B:SC
Malawi	MW	F	D0	3:MZ; D:TZ; E:ZM
Malaysia	MY	F	F0	B:BN; C:ID; 8:PH; A:SG; 2:TH; 7:VN
Maldives	MV	B	F2	5:IN; C:LK
Mali	ML	5	D0	2:DZ; B:BF; C:CI; 9:GN; 4:MR; 8:NE; 7:SN
Malta	MT	C	E0	5:IT; D:LY
Marshall Islands	MH	X	XX	1:KI; E:FM; 7:NR
Mauritania	MR	4	D1	2:DZ; 6:CV; 5:ML; 1:MA; 7:SN; 3:EH
Mauritius	MU	A	D3	F:FR; B:SC
Mayotte	YT	X	XX	C:KM; 4:MG
Mexico	MX	F	A4	6:BZ; 1:GT; 1:US; 2:US; 3:US; 4:US; 5:US; 6:US; 7:US; 8:US; 9:US; A:US; B:US; D:US; E:US
Federated States of Micronesia	FM	E	F3	9:PG
Moldova	MD	1	E4	E:RO; 6:UA
Monaco	MC	B	E2	F:FR
Mongolia	MN	F	F3	C:CN; 7:RU
Montenegro	ME	1	E3	9:AL; F:BA; C:HR; 5:IT; D:RS
Montserrat	MS	5	A4	2:AG; F:FR; A:KN; E:VE
Morocco	MA	1	E2	2:DZ; 8:PT; E:ES; 4:MR; 3:EH
Mozambique	MZ	3	D2	C:KM; 4:MG; F:MW; A:ZA; 5:SZ; D:TZ; E:ZM; 2:ZW
Namibia	NA	1	D1	6:AO; B:BW; A:ZA; E:ZM
Nauru	NR	7	F1	1:KI
Nepal	NP	E	F2	5:IN; C:CN
Netherlands	NL	8	E3	6:BE; D:DE; 1:DE; A:KN; C:GB; E:VE; 1:AI; F:VI
New Caledonia	NC	X	XX	9:PG; A:SB; F:VU
New Zealand	NZ	9	F1	
Nicaragua	NI	7	A3	8:CR; C:SV; 2:HN
Niger	NE	8	D2	2:DZ; E:BJ; B:BF; 9:TD; D:LY; 5:ML; F:NG
Nigeria	NG	F	D1	E:BJ; 1:CM; 9:TD; 7:GQ; 3:GH; 8:NE
Niue	NU	X	XX	3:TO
Norfolk Island	NF	X	XX	9:NZ
Northern Mariana Islands	MP	X	XX	9:JP
Norway	NO	F	E2	9:DK; 6:FI; A:IS; 7:RU; E:SE; C:GB; F:GL
Oman	OM	6	F1	8:IR; 4:P K; 9:SA; D:AE; B:YE
Pakistan	PK	4	F1	A:AF; C:CN; 5:IN; 8:IR; 6:OM
Palau	PW	X	XX	C:ID; E:FM; 8:PH
Panama	PA	9	A3	2:CO; 8:CR

Country	ISO 3166-1 [10] 2-alpha code	Country Code	ECC	Bordering countries look-up (CC:ISO 3166-1 [10] code)
Papua New Guinea	PG	9	F3	1:AU; 2:AU; 3:AU; 4:AU; 5:AU; 6:AU; 7:AU; 8:AU; C:ID; E:FM; A:SB
Paraguay	PY	6	A3	A:AR; 1:BO; B:BR
Peru	PE	7	A4	1:BO; B:BR; C:CL; 2:CO; 3:EC
Philippines	PH	8	F2	C:ID; 9:JP; F:MY; 7:VN; D:TW
Poland	PL	3	E2	F:BY; 2:CZ; 9:DK; D:DE; 1:DE; C:LT; 7:RU; 5:SK; E:SE; 6:UA
Portugal	PT	8	E4	1:MA; E:ES
Puerto Rico	PR	8	A3	B:DO; E:VE; F:VG
Qatar	QA	2	F2	E:BH; 8:IR; 9:SA; D:AE
Romania	RO	E	E1	8:BG; B:HU; 1:MD; D:RS; 3:TR; 6:UA
Russia	RU	7	E0	B:AZ; F:BY; C:CN; 2:EE; 6:FI; C:GE; D:KZ; 9:LV; C:LT; F:MN; F:NO; 3:PL; E:SE; 6:UA; 1:US; 2:US; 3:US; 4:US; 5:US; 6:US; 7:US; 8:US; 9:US; A:US; B:US; D:US; E:US
Rwanda	RW	5	D3	9:BI; D:TZ; 4:UG
Saint Barthélemy	BL	X	XX	2:AG; 8:NL; A:KN
Saint Helena Ascension and Tristan da Cunha	SH	A	D1	
Saint Kitts and Nevis	KN	A	A4	2:AG; 8:NL; E:VE; 5:MS
Saint Lucia	LC	X	XX	5:BB; F:FR; C:VC; E:VE
Saint Martin	MF	X	XX	8:NL; 1:AI
Saint Pierre and Miquelon	PM	F	A6	C:CA
Saint Vincent and the Grenadines	VC	C	A5	5:BB; D:GD; LC; 6:TT; E:VE
Samoa	WS	4	F2	3:TO
San Marino	SM	3	E1	5:IT
Saudi Arabia	SA	9	F0	E:BH; F:EG; 8:IR; B:IQ; 5:JO; 1:KW; 6:OM; 2:QA; C:SD; D:AE; B:YE
Senegal	SN	7	D1	6:CV; 8:GM; 9:GN; A:GW; 5:ML; 4:MR
Serbia	RS	D	E2	9:AL; F:BA; 8:BG; C:HR; B:HU; 3:MK; 1:ME; E:RO
Seychelles	SC	B	A4	C:KM; 4:MG; A:MU; D:TZ
Sierra Leone	SL	1	D2	9:GN; 2:LR
Singapore	SG	A	F2	C:ID; F:MY
Slovakia	SK	5	E2	A:AT; 2:CZ; B:HU; 3:PL; 6:UA
Slovenia	SI	9	E4	A:AT; C:HR; 5:IT; B:HU
Solomon Islands	SB	A	F1	1:AU; 2:AU; 3:AU; 4:AU; 5:AU; 6:AU; 7:AU; 8:AU; 9:PG; F:VU
Somalia	SO	7	D2	3:DJ; E:ET; 6:KE; B:YE
South Africa	ZA	A	D0	B:BW; 6:LS; 3:MZ; 1:NA; 5:SZ; 2:ZW
South Sudan	SS	X	XX	2:CF; E:ET; 6:KE; C:SD; 4:UG
Spain	ES	E	E2	2:DZ; 3:AD; F:FR; 5:IT; 1:MA; 8:PT; A:GI
Sri Lanka	LK	C	F1	5:IN; B:MV
Sudan	SD	C	D3	2:CF; 9:TD; F:EG; E:ET; D:LY
Suriname	SR	8	A4	B:BR; F:FR; F:GY
Svalbard	SJ	X	XX	7:RU; F:GL
Swaziland	SZ	5	D2	3:MZ; A:ZA
Sweden	SE	E	E3	9:DK; 2:EE; 6:FI; D:DE; 1:DE; C:LT; F:NO; 3:PL; 7:RU
Switzerland	CH	4	E1	A:AT; F:FR; 5:IT; 9:LI; D:DE; 1:DE
Taiwan	TW	D	F1	C:CN; 9:JP; 8:PH
Tajikistan	TJ	5	E3	A:AF; C:CN; 3:KG; B:UZ
Tanzania	TZ	D	D1	9:BI; C:KM; 6:KE; F:MW; 3:MZ; 5:RW; B:SC; 4:UG; E:ZM
Thailand	TH	2	F3	B:MM; 3:KH; 5:IN; C:ID; 1:LA; F:MY; 7:VN
Togo	TG	D	D0	E:BJ; B:BF; 3:GH
Tokelau	TK	X	XX	1:KI; 4:WS
Tonga	TO	3	F3	5:FJ; 9:NZ; 4:WS
Trinidad and Tobago	TT	6	A4	5:BB; D:GD; F:GY; E:VE
Tunisia	TN	7	E2	2:DZ; 5:IT; D:LY

Country	ISO 3166-1 [10] 2-alpha code	Country Code	ECC	Bordering countries look-up (CC:ISO 3166-1 [10] code)
Turkey	TR	3	E3	A:AM; B:AZ; 8:BG; 2:CY; F:EG; C:GE; 1:GR; 8:IR; B:IQ; E:RO; 7:RU; 6:UA
Turkmenistan	TM	E	E4	A:AF; 8:IR; D:KZ; B:UZ
Turks and Caicos Islands	TC	E	A3	F:BS; B:DO; D:HT
Tuvalu	TV	X	XX	5:FJ; 1:KI
Uganda	UG	4	D2	6:KE; 5:RW; SS; D:TZ
Ukraine	UA	6	E4	F:BY; B:HU; C:GE; 1:MD; 3:PL; E:RO; 7:RU; 5:SK; 3:TR
United Arab Emirates	AE	D	F2	8:IR; 6:OM; 2:QA; 9:SA
United Kingdom	GB	C	E1	6:BE; 9:DK; F:FR; D:DE; 1:DE; 2:IE; 8:NL
United States	US	1; 2; 3; 4; 5; 6; 7; 8; 9; A; B1; B8; B9; BA; BB; BC; BD; BE; BF; D;E	A0	B2:CA; B3:CA; B4:CA; B5:CA; B6:CA; B7:CA; C:CA; 9:CU; 1:KI; F:MX; 7:RU
United States Virgin Islands	VI	F	A5	8:NL; E:VE; 1:AI; F:VG
Uruguay	UY	9	A4	A:AR; B:BR
Uzbekistan	UZ	B	E4	A:AF; D:KZ; 3:KG; 5:TJ; E:TM
Vanuatu	VU	F	F2	5:FJ; A:SB
Vatican City	VA	4	E2	5:IT
Venezuela	VE	E	A4	5:BB; B:BR; 2:CO; A:DM; F:GY; 8:NL; C:VC; 6:TT; 3:AW; 8:PR
Vietnam	VN	7	F2	3:KH; C:CN; C:ID; 1:LA; F:MY; 8:PH; 2:TH
Wallis and Futuna	WF	X	XX	5:FJ; 4:WS; 3:TO
Western Sahara	EH	3	D3	2:DZ; 4:MR; 1:MA; E:ES
Yemen	YE	B	F3	3:DJ; 6:OM; 9:SA; 7:SO
Zambia	ZM	E	D2	6:AO; B:BW; F:MW; 3:MZ; 1:NA; D:TZ; 2:ZW
Zimbabwe	ZW	2	D2	B:BW; 3:MZ; A:ZA; E:ZM
NOTE: An "X" in column 3 and "XX" in column 4 indicate that no codes are allocated for this country and the broadcast is registered in an adjoining country.				

Table A.2: Countries considered non-bordering for the purposes of GCC construction

Country	ISO 3166-1 [10] 2-alpha code	Bordering Country removed from table A.1	Reason for removal
Albania	AL	Montenegro	> 200 km separation over land
Algeria	DZ	Italy	> 200 km separation over sea
Australia	AU	New Zealand	> 200 km separation over sea
Bahamas	BS	Cuba	> 200 km separation over sea
Bahamas	BS	Haiti	> 200 km separation over sea
Bahamas	BS	Turks and Caicos Islands	> 200 km separation over sea
Barbados	BB	France	> 200 km separation over sea
Brazil	BR	France	> 200 km separation over sea
Cayman Islands	KY	Colombia	> 200 km separation over sea
Cayman Islands	KY	Honduras	> 200 km separation over sea
China	CN	Taiwan	> 200 km separation over sea
China	CN	South Korea	> 200 km separation over sea
Colombia	CO	Dominican Republic	> 200 km separation over sea
Colombia	CO	Jamaica	> 200 km separation over sea
Colombia	CO	Peru	> 200 km separation over sea
Colombia	CO	Cayman Islands	> 200 km separation over sea
Cuba	CU	Bahamas	> 200 km separation over sea
Cuba	CU	Mexico	> 200 km separation over sea
Cuba	CU	United States	> 200 km separation over sea
Dominican Republic	DO	Venezuela	> 200 km separation over sea
Honduras	HN	Cayman Islands	> 200 km separation over sea
India	IN	Thailand	> 200 km separation over sea
India	IN	Maldives	> 200 km separation over sea
India	IN	Indonesia	> 200 km separation over sea
Indonesia	ID	Thailand	> 200 km separation over sea
Indonesia	ID	India	> 200 km separation over sea
Indonesia	ID	Vietnam	> 200 km separation over sea
Indonesia	ID	Philippines	> 200 km separation over sea
Iran	IR	Bahrain	> 200 km separation over sea
Italy	IT	Malta	> 100 km separation over sea
Italy	IT	Montenegro	> 200 km separation over sea
Japan	JP	North Korea	> 200 km separation over sea
Japan	JP	Taiwan	> 200 km separation over sea
Libya	LY	Malta	> 200 km separation over sea
Mexico	MX	Cuba	> 200 km separation over sea
Mexico	MX	Honduras	> 200 km separation over sea
Mozambique	MZ	France	> 200 km separation over sea
New Caledonia	NC	Australia	> 200 km separation over sea
New Caledonia	NC	Fiji	> 200 km separation over sea
New Zealand	NZ	Australia	> 200 km separation over sea
New Zealand	NZ	Tonga	> 200 km separation over sea
New Zealand	NZ	Fiji	> 200 km separation over sea
Nicaragua	NI	Colombia	> 200 km separation over sea
Norway	NO	Faroe Islands	> 200 km separation over sea
Philippines	PH	China	> 200 km separation over sea
Russia	RU	Japan	> 200 km separation over sea
Russia	RU	North Korea	> 200 km separation over sea
Russia	RU	Turkey	> 200 km separation over sea
Spain	ES	Western Sahara	> 100 km separation over sea
Sudan	SD	Saudi Arabia	> 200 km separation over sea
Sweden	SE	Latvia	> 100 km separation over sea
Turkmenistan	TM	Azerbaijan	> 200 km separation over sea
United Kingdom	GB	Faroe Islands	> 200 km separation over sea
United Kingdom	GB	Norway	> 200 km separation over sea
United States	US	Bahamas	> 100 km separation over sea
Venezuela	VE	Montserrat	> 200 km separation over sea
Venezuela	VE	Dominican Republic	> 200 km separation over sea
Venezuela	VE	Saint Kitts and Nevis	> 200 km separation over sea
Venezuela	VE	France	> 200 km separation over sea
Venezuela	VE	United States Virgin Islands	> 200 km separation over sea

Annex B (informative): Bibliography

- Microsoft™ Corporation (Revision 01.20.06, January 2012): "Advanced Systems Format (ASF) Specification".

History

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