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Reconfigurable Radio Systems (RRS);
System architecture for information exchange between different Geo-location Databases (GLDBs) enabling the operation of White Space Devices (WSDs)

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Contents

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Foreword

This draft European Standard (EN) has been produced by ETSI Technical Committee Reconfigurable Radio Systems (RRS), and is now submitted for the combined Public Enquiry and Vote phase of the ETSI standards EN Approval Procedure.

Proposed national transposition dates	
Date of latest announcement of this EN (doa):	3 months after ETSI publication
Date of latest publication of new National Standard or endorsement of this EN (dop/e):	6 months after doa
Date of withdrawal of any conflicting National Standard (dow):	6 months after doa

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 system architecture for the information exchange between different Geo-location Databases (GLDBs) enabling the operation of White Space Devices (WSDs) for the protection of the incumbent service. The architecture stems from the system requirements described in clause 7.1 of ETSI TS 102 946 [i.1].

System Architecture and High Level Procedures for Coordinated and Uncoordinated Use of TV White Spaces are described in ETSI TS 103 145 [i.4].

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.

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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.

[i.1] ETSI TS 102 946 (V1.1.1): "Reconfigurable Radio Systems (RRS); System requirements for Operation in UHF TV Band White Spaces".

[i.2] ECC Report 186 (2013): "Technical and operational requirements for the operation of white space devices under geo-location approach".

[i.3] ETSI EN 301 598 (V1.1.1): "White Space Devices (WSD); Wireless Access Systems operating in the 470 MHz to 790 MHz TV broadcast band; Harmonized EN covering the essential requirements of article 3.2 of the R&TTE Directive".

[i.4] ETSI TS 103 145 (V1.1.1): "Reconfigurable Radio Systems (RRS); System Architecture and High Level Procedures for Coordinated and Uncoordinated Use of TV White Spaces".

3 Definitions and abbreviations

3.1 Definitions

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

communication function: hardware/software module that provides communication services required by the interfaces between logical entities based on communications protocol stack

database function: software/hardware that stores necessary information provided by regulators for calculating available spectrum that a WSD in a CRS can operate on with protection to incumbent services as well as registration of the WSDs under regulatory requirements and for protecting incumbent services purposes

G-G Interface function: abstraction of the totality of those functional blocks inside a geo-location database realizing the G-G logical interface between GLDBs

G-G Logical interface: conceptual boundary between GLDBs for information exchange to enable the operation of a CRS with protection of the incumbent service

geo-location function: software/hardware that calculates location specific EIRP of a frequency band and that a WSD in a CRS can use based on the information on incumbents stored in database function

victim GLDB: GLDB whose incumbents can suffer interference from CRSs that are under the management of another GLDB (the querying GLDB)

3.2 Abbreviations

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

CEPT	Conférence Européenne des administrations des Postes et Télécommunications
CRS	Cognitive Radio System
DB-SAP	DataBase- Service Access Point
ECC	Electronic Communications Committee
EIRP	Effective Isotropic Radiated Power
GLDB	Geo-Location DataBase
GL-SAP	GeoLocation - Service Access Point
ID	IDentifier
IP	Internet Protocol
NRA	National Regulatory Authority
SAP	Service Access Point
TCP	Transmission Control Protocol
TV	TeleVision
UDP	User Datagram Protocol
WSD	White Space Device

4 Overview of WSD GLDBs architecture reference model

4.1 Introduction

This clause describes the general WSD GLDBs architecture as well as the reference model of the logical entity, the GLDB, involved in the scope. The architecture shows the relationship of logical entities and the logical interface as detailed in the following clauses. The reference model shows the abstract architecture of components of logical entities and the logical interface.

4.2 Architecture

Figure 4.1 shows the instance of the G-G logical interface. The interface is used for the information exchange between GLDBs for enabling the operation of White Space Devices (WSDs) for the protection of the incumbent service.

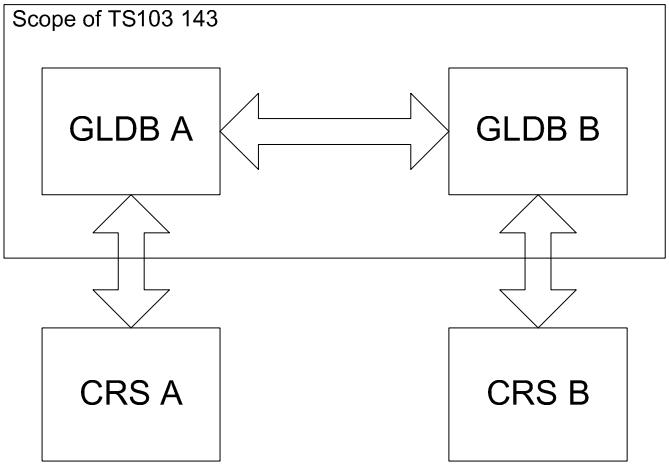

Figure 4.1: Architecture

4.3 Reference model of GLDB

Figure 4.2 shows an architectural view of a GLDB emphasizing the separation of GLDB into Database function, Geo-location function and G-G Interface function. A function can access the services provided by another function via a corresponding Service Access Point (SAP). A GLDB exchanges information with another GLDB by accessing communication services via the Com-SAP.

The DB-SAP is used by the G-G Interface function to access the services provided by the Database function such as registration of CRS and provision of incumbent information.

The GL-SAP is used by the G-G Interface function to access the services provided by the Geo-location function such as the calculation of location specific EIRP that a WSD in a CRS can use in a frequency band.

The Com-SAP is used by the G-G Interface function to access communication services provided by communication function for the information exchange with another G-G interface function.

Note that the G-G interface function inside the GLDB uses the services provided at the above three SAPs to realize the logical interface between different GLDBs.

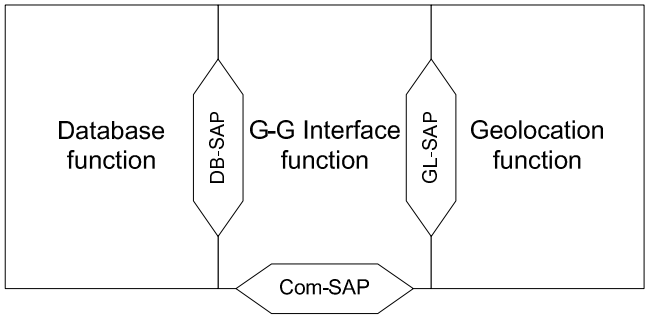

Figure 4.2: Reference model of GLDB

4.4 Reference model between GLDBs

Figure 4.3 shows an alternative view of the reference model for the information exchange between two GLDBs. A communication function is a hardware/software module that provides the communication services required by the interfaces between logical entities based on a communications protocol stack.

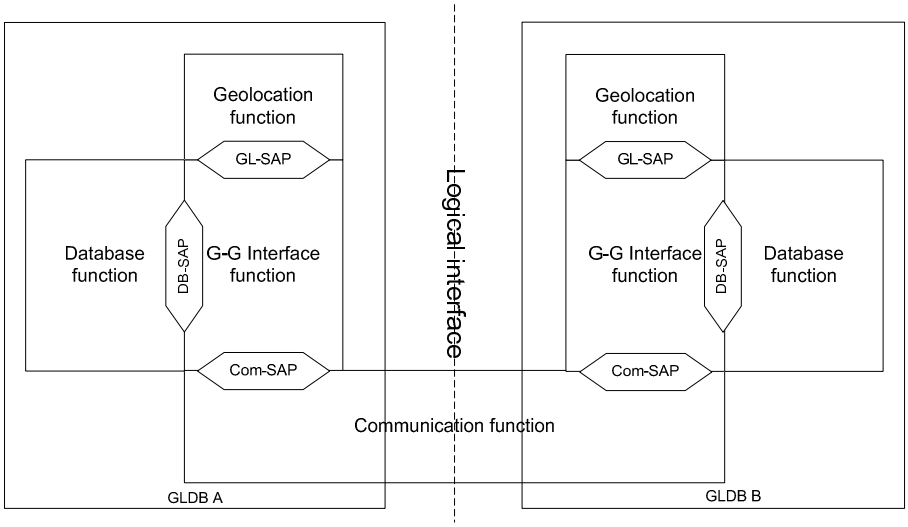

Figure 4.3: View of reference model for the information exchange between GLDBs using the G-G logical interface

5 Reference Points

5.1 Reference point: Logical interface between GLDBs

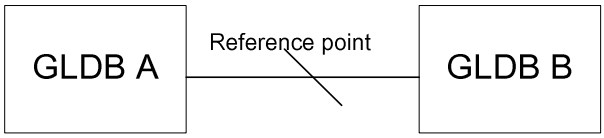

Figure 5.1: Reference point for information exchange between GLDBs

Figure 5.1 shows the reference point between GLDBs which is the G-G logical interface between the GLDBs for enabling the operation of White Space Devices (WSDs) for the protection of the incumbent service. Specifically, the reference point enables one GLDB to interface with other GLDBs in order to guaranty that the operations of CRS managed by one GLDB satisfy the protection requirements of incumbents such as the Terrestrial Broadcasting Service registered in different GLDBs as specified by respective regulations.

5.2 Reference point requirements

The following requirements do not mandate that GLDB implements any specific calculation methods.

- The reference point shall support information exchange between GLDB A and GLDB B to allow GLDB A to discover its affecting/neighbouring GLDB B.
- The reference point shall support information exchange between GLDB A and GLDB B to allow GLDB A to obtain necessary information to determine the available spectrum for a CRS managed by GLDB A while satisfying the protection requirements of incumbents registered in GLDB B under the regulatory domain of GLDB B.

- The reference point shall support information exchange between GLDB A and GLDB B to allow GLDB A to provide information about a CRS under its management to GLDB B to allow GLDB B to calculate the interference to incumbents registered in GLDB B.
- The reference point shall support information exchange between GLDB A and GLDB B to allow GLDB A to obtain information about the CRSs that are managed by GLDB B that affect the interference to incumbents registered in GLDB A. Those CRSs may create interference below the interference reference field strength at a given location probability of the incumbents that are registered in GLDB A. However, they may still contribute adversely when considering aggregate/cumulative interference (see also section A11.1.1.4 of ECC report 186 [i.2]).

6 High Level Procedures: Overview of information exchange between different GLDBs related Architecture

6.1 Basic Procedures

6.1.1 Incumbents information sharing procedure

Subject to regulatory agreements, a GLDB can send the information related to its registered incumbents to other GLDBs. This procedure populates the incumbent's information among GLDBs so that each GLDB can determine the available channels of CRSs independently of other GLDBs and protect the incumbents registered in different GLDBs. The procedure is shown in figure 6.1 and shall be as follows:

1) GLDB A sends an "Incumbent_Info_Update_Request" message to GLDB B, containing information of incumbents registered in GLDB A, to request GLDB B to update its information by including the incumbent information from GLDB A.
2) The GLDB B that receives the "Incumbent_Info_Update_Request" message shall update its incumbents' information by including the incumbents' information from GLDB A.
3) The GLDB B sends an "Incumbent_Info_Update_Response" message to inform the result of information update.

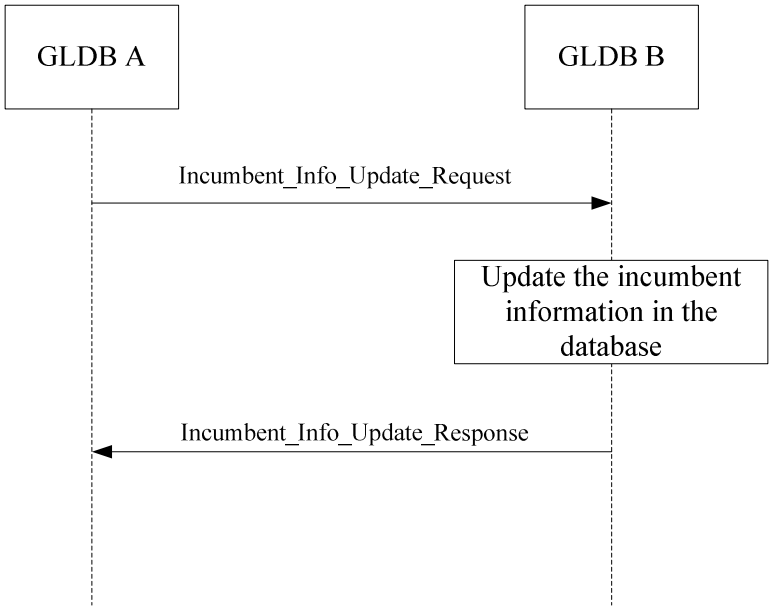

Figure 6.1: Incumbents information sharing procedure

This procedure is used for sharing information of all incumbents among GLDBs. The procedure for sharing information limited to the incumbents that can be subject to interference by CRSs managed by different GLDBs is given in clause 6.1.3. The procedure for discovering such GLDBs is given in clause 6.1.2.

6.1.2 Victim GLDB discovery procedure

Before providing information of available channels to a CRS, the managing GLDB shall check whether the use of such available channels by the CRS brings interference to incumbents registered in other GLDBs. To this end, the managing GLDB sends a "victim discovery request" to a list of potential victim GLDBs. This list of potential victim databases would be generated by a third party responsible for planning (e.g. CEPT in Europe) and would be given to each database operator. Such a list would avoid having to perform discovery with every database in Europe, for example, and only perform discovery with the databases which manage countries that have a geographical border in common, or that actually manage spectrum on the same band (as examples). The request message contains information of one or multiple CRSs' intended spectrum usage at a given location. Such location could be one single geo-location or multiple geo-locations forming a geographical area in which the CRSs intend to operate. The responding GLDB shall check whether the incumbents registered in the responding GLDB are within the interference range of the CRSs managed by the requesting GLDB which use the available channel. If this is the case, the responding GLDB is a victim GLDB of the requesting GLDB. Then, the responding GLDB sends a result to the requesting GLDB. The procedure is shown in figure 6.2 and shall be as follows.

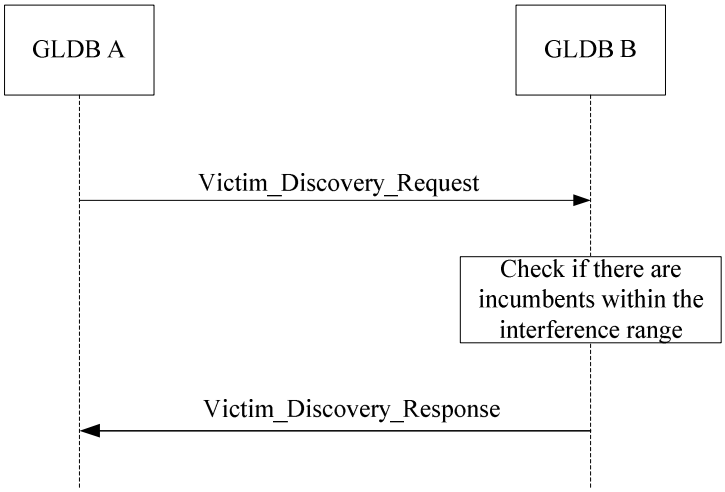

Figure 6.2: Victim GLDB

1) GLDB A sends a "Victim_Discovery_Request" message to GLDB_B by providing device and operating parameters for available channels of the CRS managed by the GLDB A.

2) The GLDB B, upon receiving the Victim_Discovery_Request message from GLDB A, checks if its incumbents are within the interference range. There are two types of interferences to be taken into account:

   - direct interference from the CRS to incumbents as shown in figure 6.2;

   - direct interference from the CRS together with interference coming from other existing CRSs that together bring a cumulative interference to incumbents (see clause A11.1.1.1.4 of ECC Report 186 [i.2]). GLDB B checks whether this cumulative interference would be harmful to the incumbents registered in its domain. If this is the case, then the GLDB B is a "victim GLDB".

3) The GLDB B sends a "Victim_Discovery_Response" message to GLDB A containing the result of victim GLDB discovery. The result indicates whether GLDB B is a victim GLDB of GLDB A.

6.1.3 CRS spectrum usage modification procedure

Once a GLDB is found to be a victim GLDB of the querying GLDB, the operating parameters for available channels of the CRS managed by the querying GLDB shall be modified. The modification can include changes on the available frequency bands, maximum permitted EIRP of certain frequency band and spectrum validity time. There are two variants of this procedure.

The first variant is a case where the two databases just exchange or synchronize incumbent information - this is done once at the beginning, or periodically. In this case, information exchange can initially be triggered by the querying GLDB when the querying GLDB intends to obtain incumbent information in order to define the operating parameters of CRSs managed by itself. The procedure is shown in figure 6.3 and shall be as follows:

1) The querying GLDB sends an "Affected_Incumbents_Info_Request" message to the victim GLDB requesting information of the incumbents located within the interference range of the CRS managed by the querying GLDB.

2) The victim GLDB sends an "Affected_Incumbents_Info_Response" message to the querying GLDB. The information includes the protection criteria of the affected incumbents as well as the current interference field strength from existing CRSs managed by the victim GLDB.

3) The querying GLDB modifies the available channels of the CRS managed by the querying GLDB in order to protect the incumbents registered in the victim GLDB.

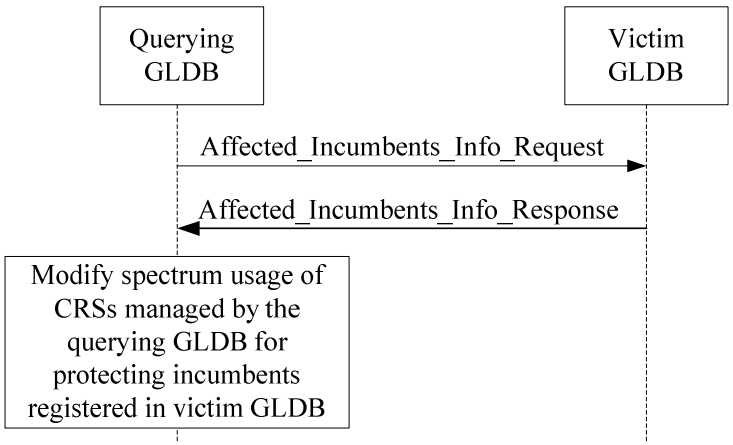

Figure 6.3: CRS spectrum usage modification procedure triggered by the querying GLDB (variant 1)

The procedure can also be triggered by the victim GLDB once its incumbent information changes. In this case the procedure shall be as follows (see also figure 6.4):

1) The victim GLDB sends an "Affected_Incumbents_Information" message of the incumbents within the interference range of the CRS managed by the querying GLDB once the incumbent information is changed. The information includes the protection criteria of the affected incumbents as well as the current interference field strength from existing CRSs managed by the victim GLDB.

2) The querying GLDB modifies the available channels of the managed CRSs in order to protect the incumbents registered in the victim GLDB.

3) The querying GLDB sends a "Modification_Confirmation" message to the victim GLDB to confirm that the modification has been accomplished.

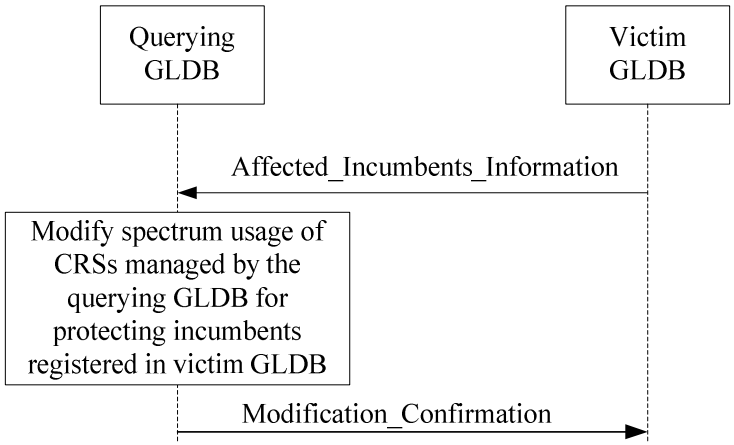

Figure 6.4: CRS spectrum usage modification procedure triggered by the victim GLDB (variant 1)

The second variant is the case where two databases actually exchange CRS information (i.e. the usage of a CRS by the querying GLDB is sent to the victim database and the modification made by the victim GLDB). Sending CRS restrictions, instead of the incumbent information allows this procedure to be used without the concern that private information is being exchanged between the two geographical regions managed by different GLDBs. The procedure can be triggered by the querying GLDB when a CRS that requests available channels from the querying GLDB has a possibility of interfering with an incumbent in the victim database. The victim GLDB provides to the querying database the update on the list of available channels and powers to protect the incumbents under the victim database management. The querying database then uses this information to generate the final list of channels and powers in such a way to protect both the victim incumbents and the querying database incumbents. The procedure is shown in figure 6.5.

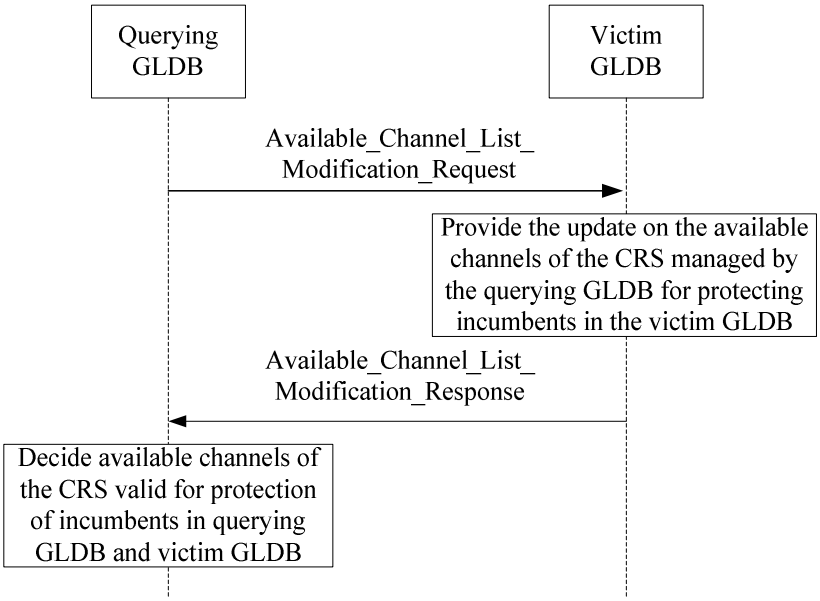

Figure 6.5: CRS spectrum usage modification procedure (variant 2)

The following steps shall be executed:

1) When it has determined that a requesting CRS can potentially interfere with an incumbent under the management of the victim GLDB, the querying GLDB sends an "Available_Channel_List_Modification_Request" message to the victim GLDB. The message contains the device parameters and operating parameters for available channels of the CRS that has requested available channel to the Querying GLDB but potentially interfere with the incumbents registered in the victim GLDB.

2) The victim GLDB provides the modification request for available channels based on the information of incumbents and CRS's in the victim GLDB.

3) The querying GLDB, after receiving the "Available_Channel_List_Modification_Response" messages from victim GLDB, modifies the operating parameters for the available channels of the CRS under its management to achieve protection of incumbents registered in different GLDBs (including the managing GLDB and the victim GLDBs). When there are multiple GLDBs that send the "Available_Channel_List_Modification_Response" messages, the querying GLDB modifies the operating parameters for the available channel of the CRS according to the protection requirements of all the Victim GLDBs.

The above procedures need not be executed each time a CRS requests channels from the querying GLDB. The querying GLDB can initiate the procedure only when it determines that the requesting CRS may cause interference to an incumbent in the victim GLDB. Such information (e.g. in the form of a range of areas where this may occur) would be provided in the victim GLDB discovery procedure.

6.1.4 CRS Operating Parameters checking procedure

Knowing the identification numbers of the CRS and its managing GLDB, a GLDB can obtain information on the channel usage of CRSs that are managed by other GLDBs. The procedure is shown in figure 6.6 and shall consist of the following steps:

1) The GLDB A sends a "Channel_Usage_Query" message to GLDB B including the IDs of those CRSs GLDB A is interested in. If no ID is specified, GLDB A is checking spectrum usage of all CRSs managed by GLDB B.

2) The GLDB B, as the responding GLDB, checks the operating parameters of the CRSs under its management.

3) GLDB B sends a "Channel_Usage_Response" message to GLDB A containing the operating parameters of those CRSs specified in the Channel_Usage_Query.

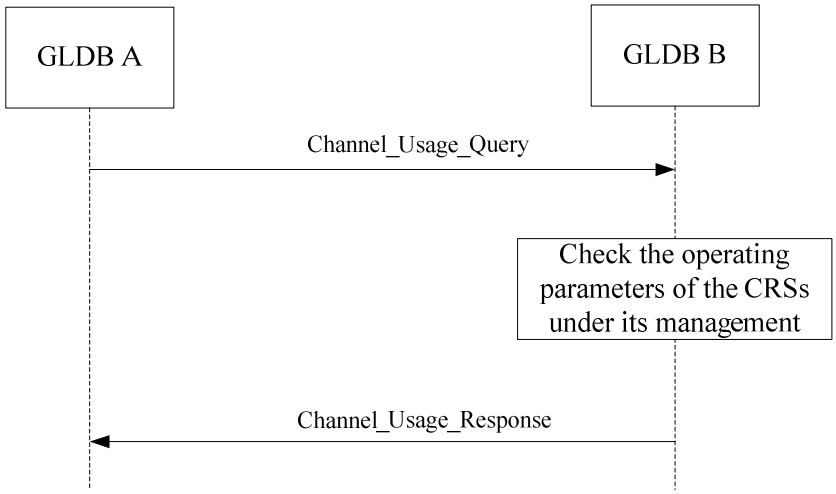

Figure 6.6: CRS operating parameters checking procedure

6.1.5 Procedure of CRS channel usage registration between GLDBs

A CRS selects channels to operate on from the list of available channels provided by the GLDB. GLDB A, after receiving selected channels from a CRS under its own management, provides such information to other GLDBs such that the other GLDBs can register the CRSs ID associated with their affected incumbents. A CRS may release channel occupancy before the channel validity time expires. In this scenario, the GLDB sends information of the released channel, including location and the amount of spectrum resource specified in frequency range and its associated released transmit power, to other GLDBs. The procedure is shown in figure 6.7 and shall consist of the following two steps:

1) The GLDB A, after receiving information on the selected channels from a CRS under its own management, sends a "Channel_Usage_Registration_Request" message to GLDB B.

2) The GLDB B, after receiving the "Channel_Selection_Registration_Request" message, sends a "Channel_Usage_Registration_Confirmation" message to GLDB A to confirm the registration.

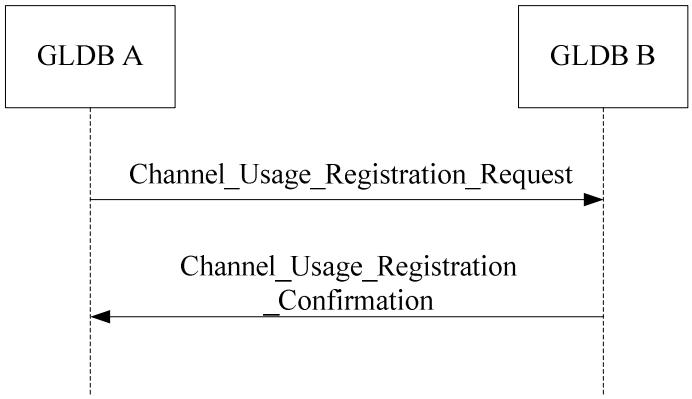

Figure 6.7: CRS channel usage registration procedure

6.1.6 Exchange the number of CRSs over a certain region

A GLDB may need to know the number of CRSs that are managed by other GLDBs so as to calculate the maximum allowable EIRP for a given CRS over a given region. The procedure of obtaining the number of CRSs is given in figure 6.8.

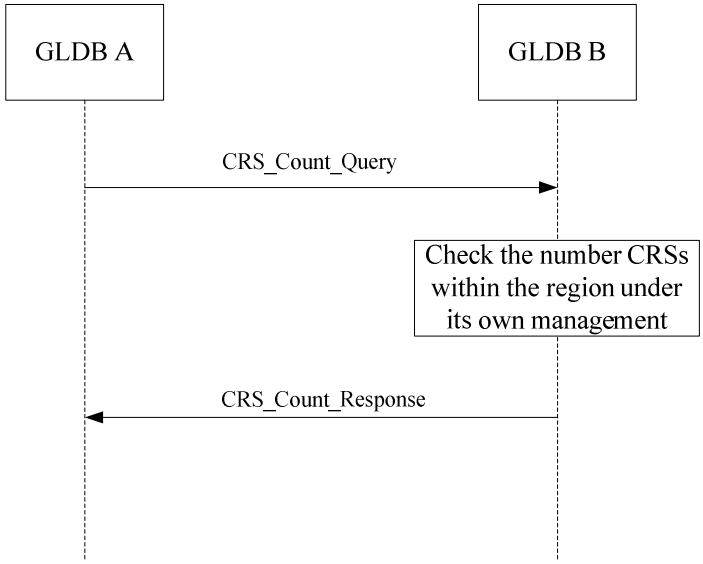

Figure 6.8: CRS number discovery procedure

The procedure shall consist of the following steps:

1) The GLDB A sends a "CRS_Count_Query" message to GLDB B in order to obtain the number of CRSs under the management of GLDB B over a given region.

2) The GLDB B that receives the "CRS_Count_Query" message checks the number of CRSs within the region under its own management.

3) The GLDB B sends a "CRS_Count_Response" message containing the number of CRSs under its own management to GLDB A.

6.1.7 Update the number of CRSs over a certain region

A GLDB may need to update the number of CRSs that are managed by other GLDBs so as to calculate the maximum allowable EIRP for a given CRS over a given region. The procedure is given in figure 6.9.

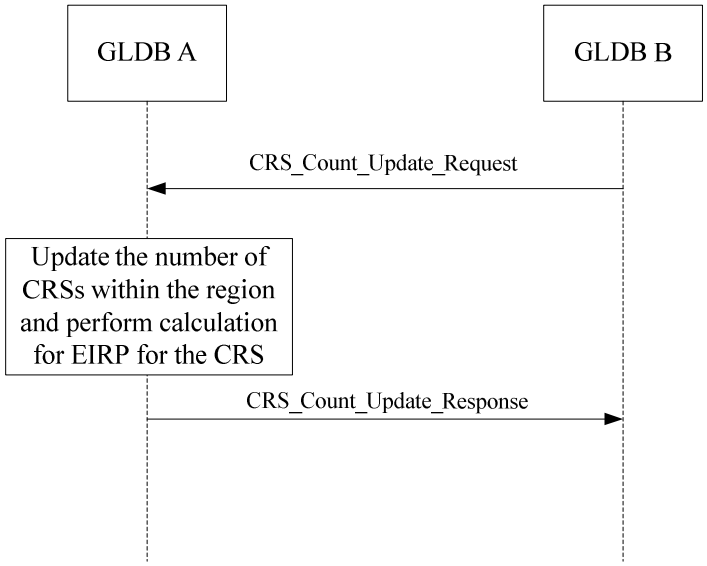

Figure 6.9: CRS number update procedure

The update procedure shall consist of the following steps:

1) The GLDB B sends a CRS_Count_Update_Request message to GLDB A to update the number of CRSs under the management of GLDB B over a given region.

2) The GLDB A that receives the CRS_Count_Update_Request message updates the number of CRSs within the region under consideration and perform calculation for EIRP for the CRS.

3) The GLDB A sends a CRS_Count_Update_Response message to confirm the result of updating the number of CRSs as a response to the request from GLDB B.

6.1.8 Sequence of exchange the number of CRSs over a certain region

The procedures described in clause 6.1.6 and clause 6.1.7 are combined as shown in figure 6.10.

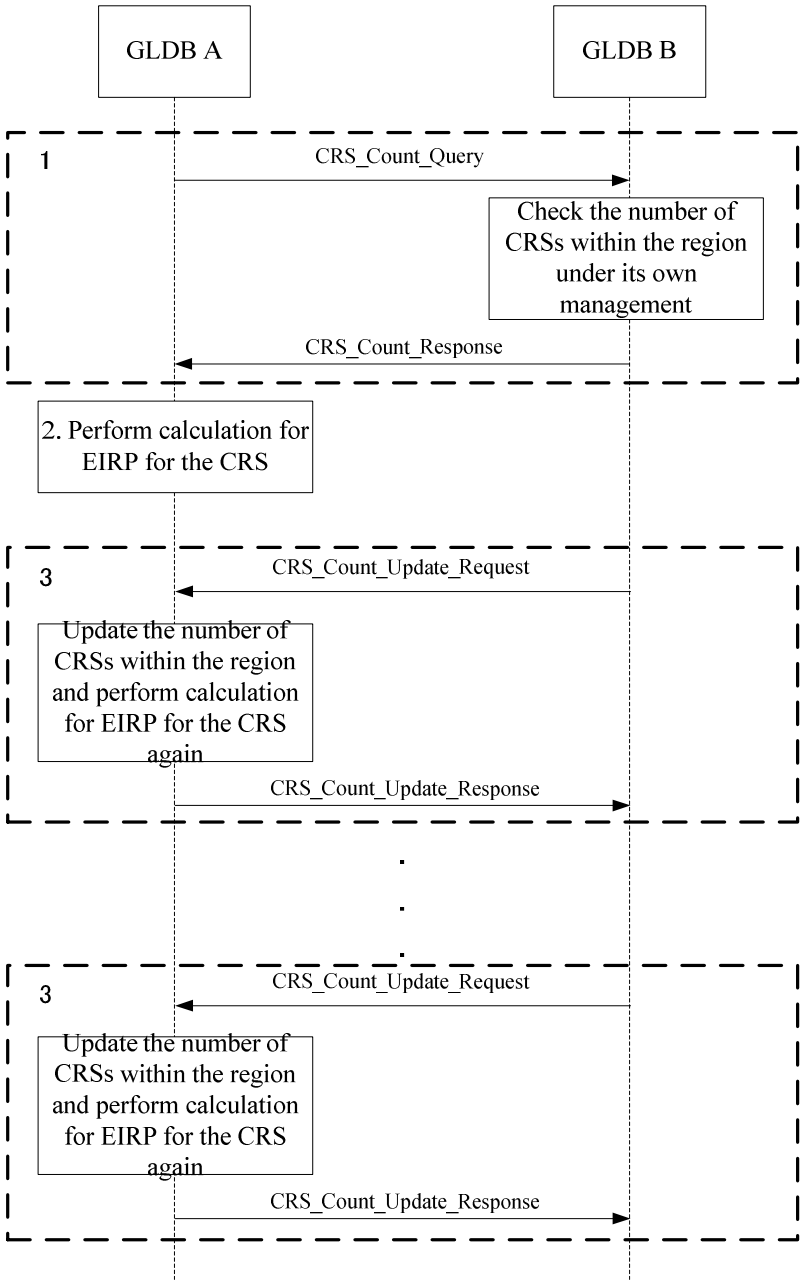

Figure 6.10: Complete procedure for the updating of CRSs over a certain region

1) The GLDB A obtains the total number of CRS with the procedure described in clause 6.1.6.

2) The GLDB A performs the calculation of the allowed EIRP for the given CRS.

3) Whenever the number of CRSs is changed in the region, GLDB B sends a "CRS_Count_Update_Request" as described in clause 6.1.7 and GLDB A recalcutates the allowed EIRP for the given CRS. After GLDB A performs the calculation, GLDB A sends a "CRS_Count_Update_Response" message as described in clause 6.1.7. The update messages can be periodic or occur only when the number of CRSs changes, depending on the specific implementation.

6.1.9 CRS transfer between GLDBs

The CRS can be transferred from the responsibility of one GLDB to another GLDB to avoid CRS spectrum usage interruption for making CRS registration and authentication again at the destination GLDB. The procedure of CRS transfer from one GLDB to another GLDB is shown in figure 6.11.

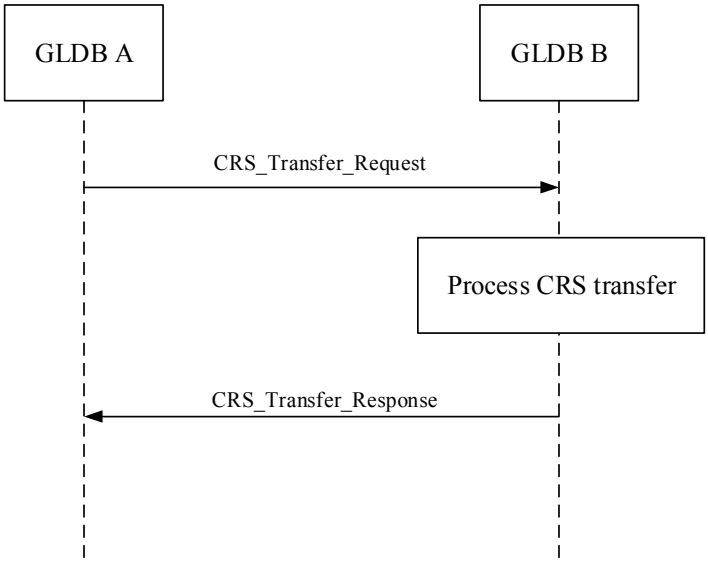

Figure 6.11: CRS transfer

The CRS transfer procedure shall consist of the following steps:

1) The GLDB A sends a "CRS_Transfer_Request" message to GLDB B to request transfer of a CRS under its management to GLDB B.

2) The GLDB B on receiving the "CRS_Transfer_Request" message processes the transfer request and registers the CRS to GLDB B.

3) The GLDB B sends a "CRS_Transfer_Response" message to confirm the result of transfer of a CRS as a response to the request by the GLDB A.

6.2 Flow charts for determining the available channels of a CRS

This clause shows the flow charts which give the operation sequences of a database in determining the operational parameters of a CRS. There are two variants of the operation sequences based on how incumbents' information is exchanged. figure 6.12 shows the case when databases synchronize their incumbent information. Figure 6.13 shows the case when the databases exchange information of incumbents that are affected by CRSs from other databases. The shaded steps are described in clause 6.1.

NOTE: Generic operational parameters are listed in ETSI EN 301 598 [i.3].

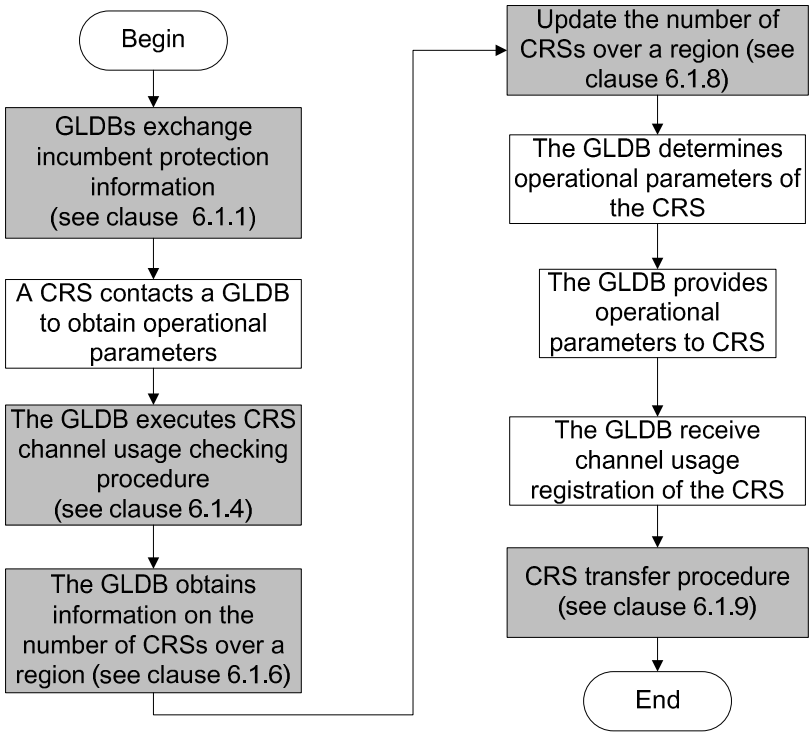

Figure 6.12: Flow chart for operational parameter determination when databases synchronize incumbents information

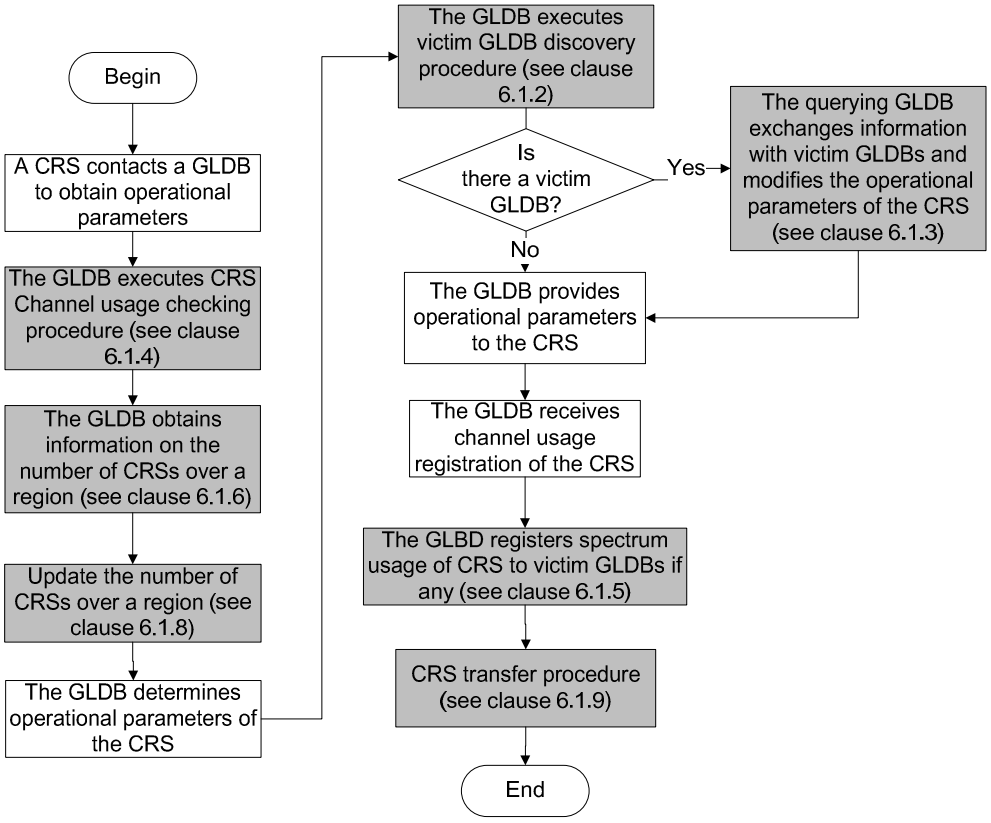

Figure 6.13: Flow chart of available channel determination when there are multiple unsynchronized databases of incumbents' information

7 Overview on GLDB Functional requirements

From the above described procedures the following functional requirements can be derived:

1) If incumbent's information is shared among GLDBs, a GLDB shall identify incumbents under the management of other GLDBs whose coverage area is potentially interfered by the CRS managed by the said GLDB.

2) If incumbent's information is not shared among GLDBs, a GLDB shall be able to identify victim GLDBs whose incumbents can suffer interference from CRSs that are under the management of the said GLDB.

3) When determining the operational parameters of a CRS, a GLDB shall take into account the protection requirements of potentially affected incumbents registered in other GLDBs.

4) GLDBs shall exchange transmit characteristics of a CRS, which may contribute to the aggregate interference experienced by the incumbents registered in those GLDBs other than this CRS's managing GLDB.

5) A GLDB shall obtain information of CRSs (such as locations and transmit characteristics) that are managed by other GLDBs which may potentially contribute to the aggregate interference experienced by incumbents registered in said GLDB.

6) When determining the operational parameters of a CRS, a GLDB shall take into account the transmit characteristics of existing CRSs managed by different GLDBs, whose transmission may contribute to aggregate interference experienced by incumbents protected by the said GLDB.

7) A GLDB shall provide the operational parameters of the CRSs under its management to another GLDB in order to guarantee protection of incumbents in the victim GLDBs.

Annex A (informative): Physical implementation examples of logical functions

A.1 Introduction

There will be several possible deployment scenarios for the calculation function of location specific WSD output power level. Clause A.2 shows the case when the calculation function is part of the geo-location database controlled by a regulatory body, while clause A.3 shows the case when this is a separate function (namely advanced geo-location function) from the geo-location database managed by a regulatory body (see also section 7.1.1 of ECC Report 186 [i.2]).

A.2 GLDB operated by different National Regulatory Authorities

Different national regulatory authorities may operate different GLDBs to manage spectrum usage of CRS in different regions to protect incumbents under their regulatory domains. These regulatory databases exchange information using the G-G Logical interface via a common communication protocols which provides transport services such as TCP/IP or UDP (see figure A.1).

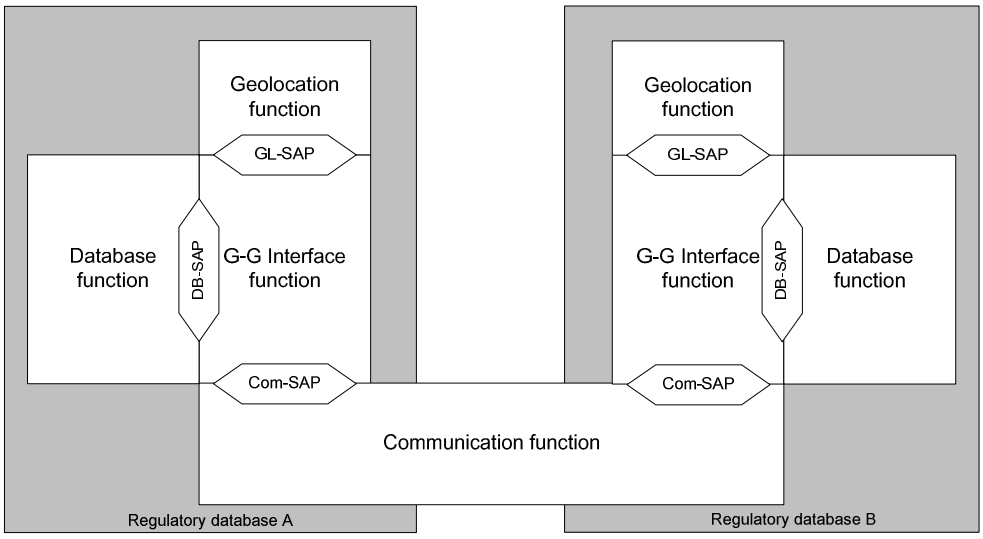

Figure A.1: Implementation example of regulatory databases

A.3 Third party geo-location function management

The geo-location function is operated by a third party authorized by a NRA. This third party database together with the regulatory database B as shown in figure A2 constitutes an instantiation of the logical entity GLDB. The third party database reuses the GL-SAP, G-G interface function as well as the Com-SAP to exchange information with regulatory database B via a common communication function which provides transport services.

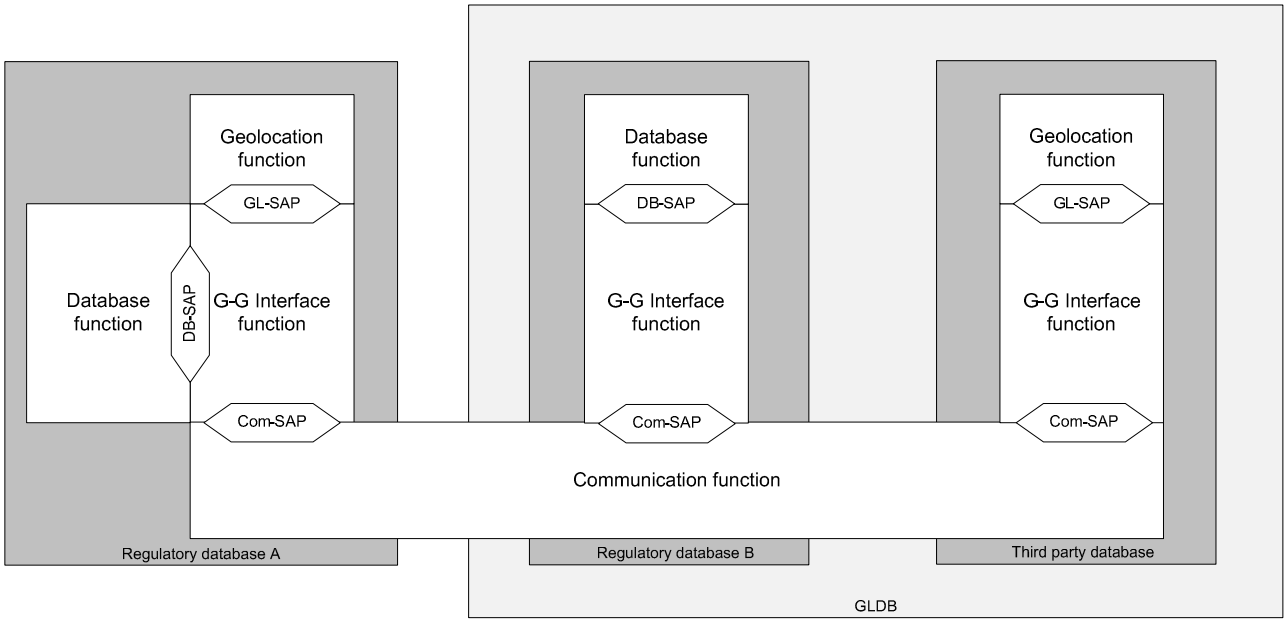

Figure A.2: Implementation example of third party database

History

Document history		
V1.1.1	January 2015	Publication as ETSI TS 103 143
V1.1.2	July 2015	EN Approval Procedure AP 20151106: 2015-07-09 to 2015-11-06