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TECHNICAL SPECIFICATION

**Reconfigurable Radio Systems (RRS);
Radio Equipment (RE) information models and protocols
for generalized software reconfiguration architecture;
Part 1: generalized Multiradio Interface (gMURI)**

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Foreword

This Technical Specification (TS) has been produced by ETSI Technical Committee Reconfigurable Radio Systems (RRS).

The present document is part 1 of a multi-part deliverable covering the Radio Equipment (RE) information models and protocols, as identified below:

Part 1: **"generalized Multiradio Interface (gMURI)";**

Part 2: "generalized Reconfigurable Radio Frequency Interface (gRRFI)";

Part 3: "generalized Unified Radio Application Interface (gURAI)";

Part 4: "generalized Radio Programming Interface (gRPI)".

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).

"**must**" and "**must not**" are **NOT** allowed in ETSI deliverables except when used in direct citation.

1   Scope

The present document defines an information model and protocol for multiradio interface for reconfigurable RE. The work is based on the Use Cases defined in ETSI TR 103 585 [i.1], on the system requirements defined in ETSI TS 103 641 [1] and on the radio reconfiguration related architecture for reconfigurable RE defined in ETSI TS 103 648 [i.2].

The present document is based on ETSI EN 303 146-1 [i.6] and provide a generalized interface definition for the generalized Software Reconfiguration Architecture.

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.

[1]   ETSI TS 103 641: "Reconfigurable Radio Systems (RRS); Radio Equipment (RE) reconfiguration requirements".

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.

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

[i.1]   ETSI TR 103 585: "Reconfigurable Radio Systems (RRS); Radio Equipment (RE) reconfiguration use cases".

[i.2]   ETSI TS 103 648: "Reconfigurable Radio Systems (RRS); Radio Equipment (RE) reconfiguration architecture".

[i.3]   IEEE 1900.4™-2009: "IEEE Standard for Architectural Building Blocks Enabling Network-Device Distributed Decision Making for Optimized Radio Resource Usage in Heterogeneous Wireless Access Networks".

[i.4]   Recommendation ITU-T X.680: "Information technology - Abstract Syntax Notation One (ASN.1): Specification of basic notation".

[i.5]   Directive 2014/53/EU of the European Parliament and of the Council of 16 April 2014 on the harmonisation of the laws of the Member States relating to the making available on the market of Radio Equipment and repealing Directive 1999/5/EC.

[i.6]   ETSI EN 303 146-1: "Reconfigurable Radio Systems (RRS); Mobile Device (MD) information models and protocols; Part 1: Multiradio Interface (MURI)".

[i.7]   ETSI TS 103 681-2: "Reconfigurable Radio Systems (RRS); Radio Equipment (RE) information models and protocols for generalized software reconfiguration architecture; Part 2: generalized Reconfigurable Radio Frequency Interface (gRRFI)".

[i.8]   ETSI TS 103 681-3: "Reconfigurable Radio Systems (RRS); Radio Equipment (RE) information models and protocols for generalized software reconfiguration architecture; Part 3: generalized Unified Radio Application Interface (gURAI)".

[i.9]   ETSI TS 103 681-4: "Reconfigurable Radio Systems (RRS); adio Equipment (RE) information models and protocols for generalized software reconfiguration architecture; Part 4: generalized Radio Programming Interface (gRPI)".

3   Definition of terms, symbols and abbreviations

3.1   Terms

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

association: logical communication link to a Radio Access Network or a peer equipment

NOTE 1:   Typically, some control signalling is necessary to maintain the association. No user data transfer may occur with only an association present, but a data flow may be established into an association for this purpose.

NOTE 2:   Peer equipment is any communication counterpart of a reconfigurable Radio Equipment. It can be reached by establishing a logical communication link (i.e. an association) between the reconfigurable Radio Equipment and peer equipment.

channel: designated part of the information transfer capability having specified characteristics, provided at the user network interface

NOTE: It is the over-the-air wireless propagation channel which is used to convey an information signal from transmitter to receiver. This definition is specified in ETSI TS 103 648 [i.2].

Communication Services Layer (CSL): layer related to communication services supporting generic applications

NOTE: A communication services layer supports generic applications like Internet access. In the present document, it consists of Administrator, Mobility Policy Manager (MPM), Networking stack and Monitor.

link: connecting one location to another through a given Radio Access Technology for the purpose of transmitting and receiving digital information

NOTE: Each link is conveyed over a given Channel.

Radio Application (RA): software which enforces the generation of the transmit RF signals or the decoding of the receive RF signals

NOTE 1:   The Software is executed on a particular radio platform or an RVM as part of the radio platform.

NOTE 2:   RAs might have different forms of representation. They are represented as:

- ▪ source codes including Radio Library calls of Radio Library native implementation and Radio HAL calls;

- ▪ IRs including Radio Library calls of Radio Library native implementation and radio HAL calls;

- ▪ executable codes for a particular radio platform.

radio computer: part of Radio Equipment working under ROS control and on which RAs are executed

NOTE: A radio computer typically includes programmable processors, hardware accelerators, peripherals, software, etc. RF part is considered to be part of peripherals.

Radio Control Framework (RCF): control framework which, as a part of the OS, extends OS capabilities in terms of radio resource management

NOTE: RCF is a control framework which consists of Configuration Manager (CM), Radio Connection Manager (RCM), Flow Controller (FC) and Multiradio Controller (MRC). The Resource Manager (RM) is typically part of OS.

Radio Equipment (RE): *"an electrical or electronic product, which intentionally emits and/or receives radio waves for the purpose of radio communication and/or radiodetermination, or an electrical or electronic product which must be completed with an accessory, such as antenna, so as to intentionally emit and/or receive radio waves for the purpose of radio communication and/or radiodetermination".*

NOTE: The definition above is as defined in the Radio Equipment Directive, Article 2(1)(1) [i.5].

reconfigurable Radio Equipment: Radio Equipment with radio communication capabilities providing support for radio reconfiguration

NOTE: Reconfigurable Radio Equipment includes Smartphones, Feature phones, Tablets, Laptops, Connected Vehicle communication platform, Network platform, IoT device, etc.

routing entity: entity which directs network packets from their source toward their destination through intermediate network nodes by specific packet forwarding mechanisms

NOTE 1: In the present document, source and destination relate either to CSL or radio computers.

NOTE 2: Note that the directing of packets may include decision making and physical routing.

Unified Radio Application (URA): Radio Application which complies with the reconfigurable RE framework defined in the present document

3.2 Symbols

Void.

3.3 Abbreviations

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

ASN.1	Abstract Syntax Notation One
BLER	BLock Error Rate
CM	Configuration Manager
CSL	Communication Services Layer
FC	Flow Controller
gMURI	generalized Multiradio Interface
gRPI	generalized Radio Programming Interface
gRRFI	generalized Reconfigurable Radio Frequency Interface
gURAI	generalized Unified Radio Applications Interface
ID	IDentification
IR	Intermediate Representation
ITU-T	International Telecommunication Uniton Telecommunication Standardization Sector
MPM	Mobility Policy Manager
MRC	MultiRadio Controller
MURI	Multiradio Interface
OS	Operating System
RA	Radio Application
RAN	Radio Access Network
RAP	Radio Application Package
RAT	Radio Access Technology
RCF	Radio Control Framework
RCID	Radio Computer Identification
RCM	Radio Connection Manager
RE	Radio Equipment

RERC	Radio Equipment Reconfiguration Class
RF	Radio Frequency
RM	Resource Manager
ROS	Radio Operating System
SINR	Signal to Interference plus Noise Ratio
SW	SoftWare
TCP/IP	Transmission Control Protocol/Internet Protocol
UML	Unified Modeling Language
URA	Unified Radio Applications

4 Introduction

A reconfigurable RE is capable of running multiple radios simultaneously, changing the set of radios by loading new Radio Application Packages (RAP) and setting their parameters. All Radio Applications (RAs) are called Unified Radio Applications (URAs) when they exhibit a common behaviour from the reconfigurable RE's point of view in ETSI TS 103 648 [i.2]. In order to run multiple URAs, the reconfigurable RE will include Communication Services Layer (CSL), Radio Control Frameworks (RCFs), Radio Platforms and 4 sets of interfaces for their interconnection.
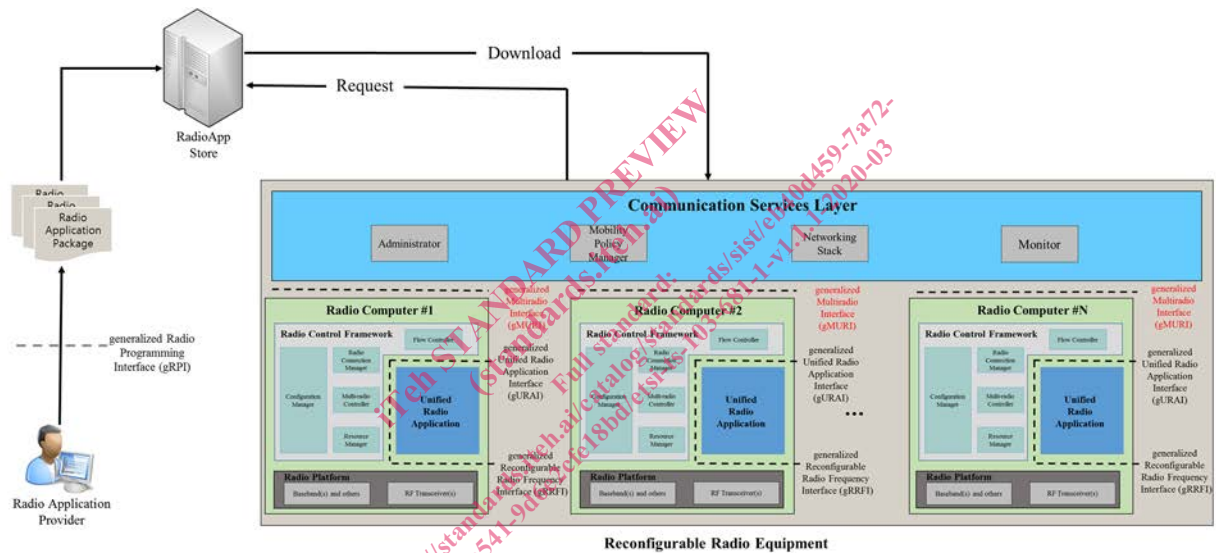

Figure 4.1: Four sets of interfaces for Reconfigurable RE

Figure 4.1 illustrates the Reconfigurable RE architecture with the 4 sets of interfaces, i.e.:

- gMURI for interfacing CSL and RCF which is the scope of the present document.

- gRRFI for interfacing URA and RF Transceiver (in ETSI EN 303 681-2 [i.7]).

- gURAI for interfacing URA and RCF (in ETSI EN 303 681-3 [i.8]).

- gRPI for allowing an independent and uniform production of RAs (in ETSI EN 303 681-4 [i.9]).
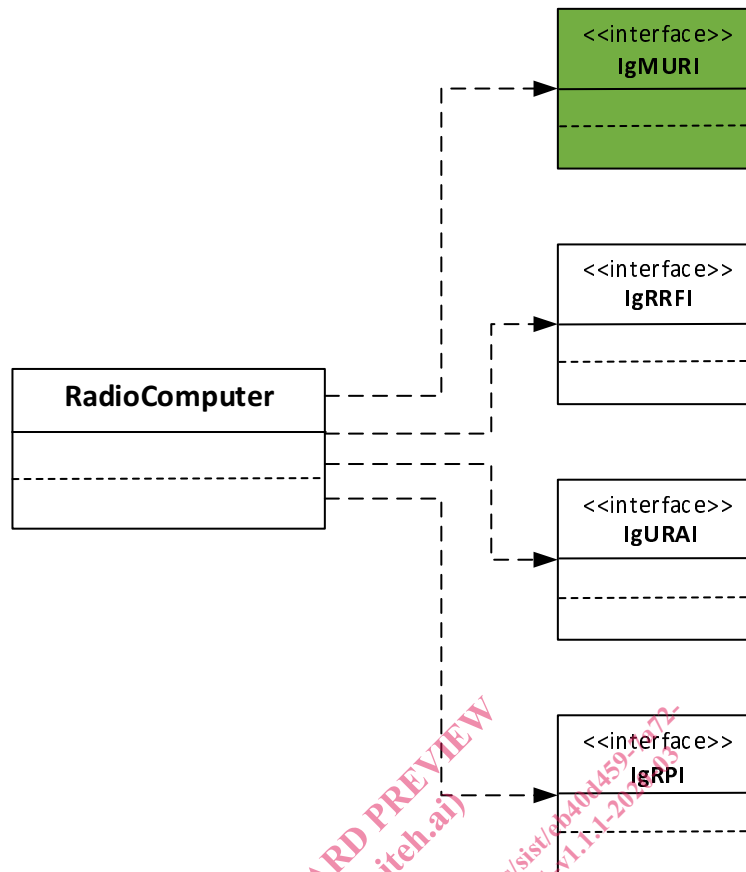
The present document defines gMURI.

Figure 4.2: UML class diagram for Radio Computer interfaces

Figure 4.2 illustrates UML class diagram for Radio Computer interfaces. The reconfigurable RE may be seen as a set of multiple Radio Computers where individual URAs are engineered as software entities in ETSI TS 103 648 [i.2].

The present document is organized as follows:

- clause 5 describes the system identification;

- clause 6 describes the notational tool for defining both information model classes and interface classes;

- clause 7 describes the information model for radio computer; and

- clause 8 describes the interface definition.

While UML is used for defining the information model and protocol related to gMURI, other modeling languages could be used as well.

5   System Identification

5.1   Radio Computer Structure

Figure 5.1 illustrates how CSL and RCFs interact with each other using gMURI.
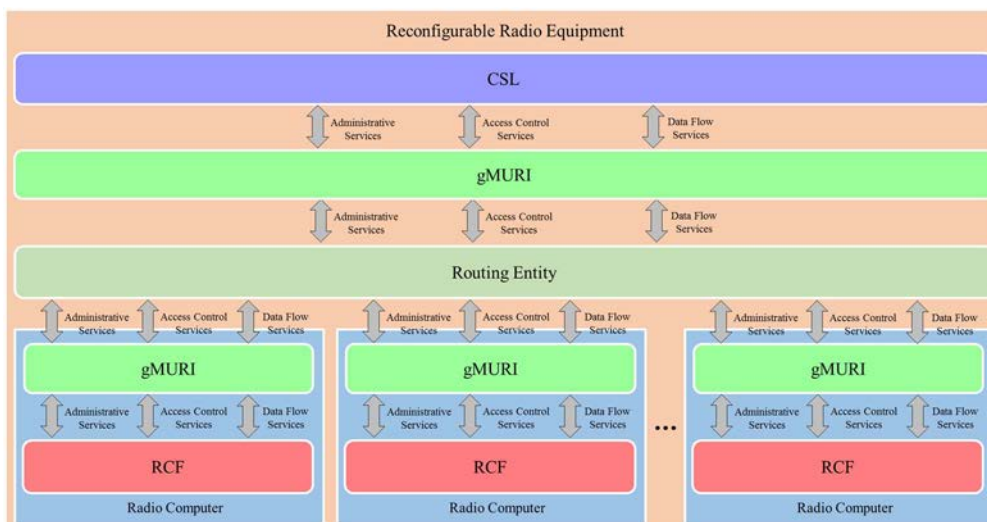
Figure 5.1: Interconnection between CSL and RCF using gMURI for Reconfigurable RE

As shown in figure 5.1, gMURI supports 3 kinds of services:

- **Administrative Services**

  - These services are used by some device configuration application i.e. Administrator which is included in the CSL, to (un)install a new URA into the Reconfigurable RE and create/delete an instance of the URA. Installation and loading may take place both at device start-up time to set up the network connection as well as during run-time, whenever reconfiguration of available URAs is needed. gMURI does not make any assumption on how and when the Radio Equipment will detect the need of the reconfiguration.

- **Access Control Services**

  - These services are used by the MPM to maintain the user policies and preferences related to the usage of different RATs and to make a selection between them. Modelling of such preferences and selection algorithms is not in the scope of the present document; however, the gMURI specification covers the information exchange of RAT selection decisions between CSL and RCF. The preferences themselves may originate either locally from applications or end user settings as well as in a distributed manner from network operator or from a cognitive radio management framework.

- **Data Flow Services**

  - These services are used by the networking stack of the Reconfigurable RE, such as the TCP/IP stack. Therefore data flow services represent the set of (logical) link layer services, which are provided in a uniform manner regardless of which URAs are active.

The Communication Services Layer (CSL) and Radio Control Framework (RCF) are defined in ETSI TS 103 648 [i.2].

5.2 gMURI System Requirement Mapping

The Radio Computer components above described shall support the gMURI system requirements shown in table 5.1 and described in clauses 6.1 and 6.2 of ETSI TS 103 641 [1].

**Table 5.1: Mapping of Radio Computer Components to
the system requirements described in ETSI TS 103 641 [1]**

Entity/Component/Unit	System Requirements [1]	Comments
Administrator	R-FUNC-RAT-01	The requirement is described in clause 6.1.1 of [1].
	R-FUNC-RA-01	The requirement is described in clause 6.2.1 of [1].
	R-FUNC-RER-01	The requirement is described in clause 6.4.1 of [1].
	R-FUNC-RER-02	The requirement is described in clause 6.4.2 of [1].
	R-FUNC-RER-03	The requirement is described in clause 6.4.3 of [1].
	R-FUNC-RER-16	The requirement is described in clause 6.4.16 of [1].

Entity/Component/Unit	System Requirements [1]	Comments
Mobility Policy Manager	R-FUNC-RAT-01	The requirement is described in clause 6.1.1 of [1].
	R-FUNC-RAT-04	The requirement is described in clause 6.1.4 of [1].
	R-FUNC-RA-03	The requirement is described in clause 6.2.3 of [1].
	R-FUNC-RER-16	The requirement is described in clause 6.4.16 of [1].
Networking Stack	R-FUNC-RAT-05	The requirement is described in clause 6.1.5 of [1].
	R-FUNC-RA-04	The requirement is described in clause 6.2.4 of [1].
Configuration Manager	R-FUNC-RAT-01	The requirement is described in clause 6.1.1 of [1].
	R-FUNC-RAT-02	The requirement is described in clause 6.1.2 of [1].
	R-FUNC-RA-01	The requirement is described in clause 6.2.1 of [1].
	R-FUNC-RER-01	The requirement is described in clause 6.4.1 of [1].
	R-FUNC-RER-02	The requirement is described in clause 6.4.2 of [1].
	R-FUNC-RER-03	The requirement is described in clause 6.4.3 of [1].
Radio Connection Manager	R-FUNC-RAT-01	The requirement is described in clause 6.1.1 of [1].
	R-FUNC-RAT-02	The requirement is described in clause 6.1.2 of [1].
	R-FUNC-RAT-03	The requirement is described in clause 6.1.3 of [1].
	R-FUNC-RAT-04	The requirement is described in clause 6.1.4 of [1].
	R-FUNC-RAT-06	The requirement is described in clause 6.1.6 of [1].
	R-FUNC-RA-03	The requirement is described in clause 6.2.3 of [1].
Flow Controller	R-FUNC-RAT-01	The requirement is described in clause 6.1.1 of [1].
	R-FUNC-RAT-03	The requirement is described in clause 6.1.3 of [1].
	R-FUNC-RAT-05	The requirement is described in clause 6.1.5 of [1].
	R-FUNC-RAT-06	The requirement is described in clause 6.1.6 of [1].
	R-FUNC-RA-04	The requirement is described in clause 6.2.4 of [1].

6 Notational Tools

6.1 Notational Tool for Information Model Classes

In the present document, information model classes are used as defined in annex B.1 of IEEE 1900.4™-2009 [i.3].

6.2 Notational Tool for Interface Classes

Table 6.1 shows a template for defining interface classes for gMURI. Each interface class for gMURI will be defined in clause 8.5 in accordance with the template shown in table 6.1.

Table 6.1: Template for defining Interface Classes

Class<Class name>[(abstract class)]		
<Description of the class>		
OPERATIONS		
<Operation name>	Return type: <Operation return type>	Value type: <Operation value type>
<Description of the operation>		

The template fields in table 6.1 are described below:

- <Class name> is the name of the Class as it appears in the corresponding model. Additional information is also included in case the class in question has been specified as an abstract one.

- OPERATIONS field describes the operations that have been defined in the class. More specifically:

  - <Operation name> identifies the name of an operation, as it is included in the class definition.

  - <Return type> identifies the type of return value at the corresponding operation. Details related to the ASN.1 module are specified in annex B of the present document.

  - <Value type> identifies the access levels for member functions: public, private, protected.