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Reconfigurable Radio Systems (RRS); Radio Equipment (RE) information models and protocols for generalized software reconfiguration architecture; Part 2: generalized Reconfigurable Radio Frequency Interface (gRRFI)

Reference

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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 2 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

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1 Scope

The present document defines an information model and protocol for generalized reconfigurable radio frequency interface for reconfigurable REs. 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 will be based on ETSI EN 303 146-2 [i.7] and provide a generalized interface definition for the generalized Reconfigurable Radio Frequency Interface.

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 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.

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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 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] DigRFSM Working Group: "MIPI® Alliance Specification for DigRFSM v4".

[i.5] Recommendation ITU-T X.680: "Information technology - Abstract Syntax Notation One (ASN.1): Specification of basic notation".

[i.6] 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.7] ETSI EN 303 146-2: "Reconfigurable Radio Systems (RRS); Mobile Device (MD) information models and protocols; Part 2: Reconfigurable Radio Frequency Interface (RRFI)".

[i.8] ETSI TS 103 681-1: "Reconfigurable Radio Systems (RRS); Radio Equipment (RE) information models and protocols for generalized software reconfiguration architecture; Part 1: generalized Multiradio Interface (gMURI)".

[i.9] 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.10] 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: connection from 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 (RC): 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), Multiradio Controller (MRC) and Resource Manager (RM) which 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.6].

Radio Frequency (RF) transceiver: part of radio platform converting, for transmission, baseband signals into radio signals, and, for reception, radio signals into baseband signals

Radio Operating System (ROS): any appropriate OS empowered by RCF

NOTE: ROS provides RCF capabilities as well as traditional management capabilities related to management of radio platform such as resource management, file system support, unified access to hardware resources, etc.

radio platform: part of radio equipment hardware which relates to radio processing capability, including programmable components, hardware accelerators, RF transceiver, and antenna(s)

NOTE: A Radio Platform is a piece of hardware capable of generating RF signals or receiving RF signals. By nature, it is heterogeneous hardware including different processing elements such as fixed accelerators, e.g. Application-Specific Integrated Circuit (ASIC), or reconfigurable accelerators, e.g. FPGAs, etc.

Radio Virtual Machine (RVM): abstract machine which supports reactive and concurrent executions

NOTE: An RVM may be implemented as a controlled execution environment which allows the selection of a trade-off between flexibility of base band code development and required (re-)certification efforts.

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.

3.2 Symbols

Void.

3.3 Abbreviations

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

ACK	ACKnowledgement
ACKM	ACKnowledgement with Modification
AP	Application Processor
ASIC	Application-Specific Integrated Circuit
ASN.1	Abstract Syntax Notation One
BBIC	Base-Band Integrated Circuit
BLER	Block Error Rate
CSL	Communication Services Layer
EU	European Union

gMURI	generalized Multiradio Interface
gRPI	generalized Radio Programming Interface
gRRFI	generalized Reconfigurable Radio Frequency Interface
gURAI	generalized Unified Radio Applications Interface
MIMO	Multiple Input Multiple Output
MPM	Mobility Policy Manager
NACK	Negative ACKnowledgement
OOB	Out Of Band
OS	Operating System
RA	Radio Application
RAN	Radio Access Network
RAP	Radio Application Package
RAT	Radio Access Technology
RC	Radio Computer
RCF	Radio Control Framework
RCID	Radio Computer Identification
RE	Radio Equipment
RERC	Radio Equipment Reconfiguration Class
RF	Radio Frequency
RFIC	Radio Frequency Integrated Circuit
ROS	Radio Operating System
RRFI	Reconfigurable Radio Frequency Interface
RVM	Radio Virtual Machine
RX	Reception
SINR	Signal to Interference plus Noise Ratio
TR	Technical Report
UML	Unified Modelling 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.

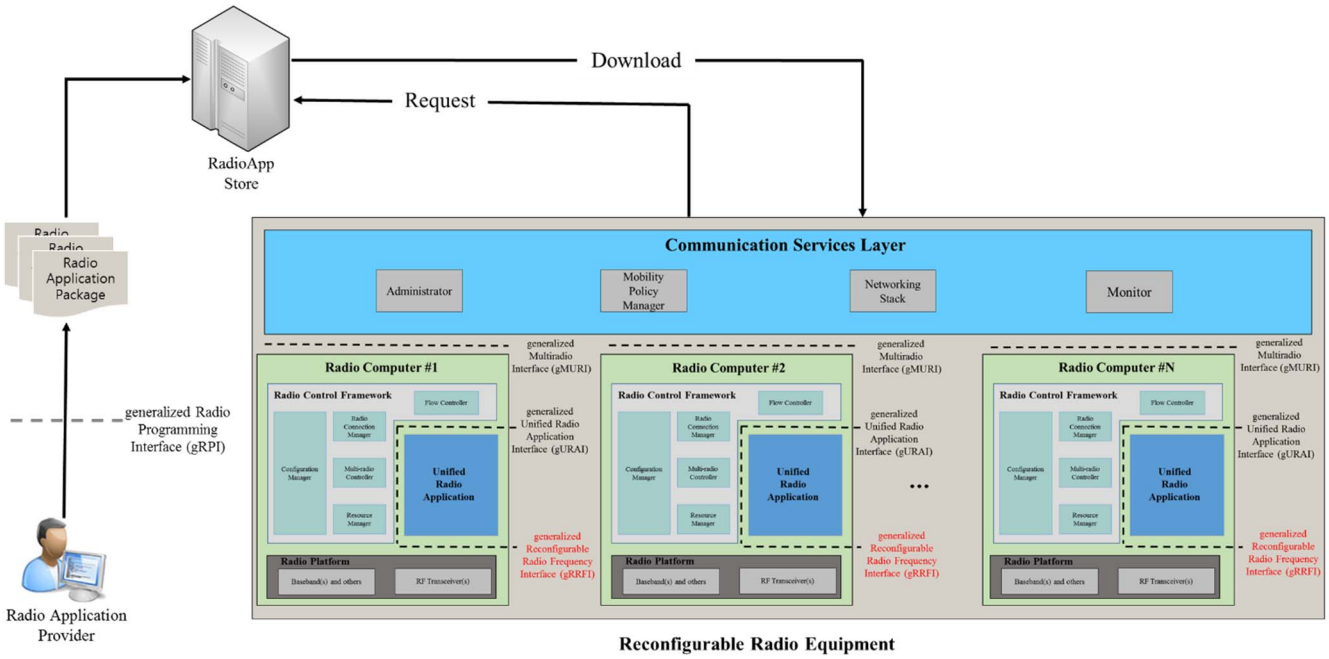

Figure 4.1: Four sets of interfaces for reconfigurable RE

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

- gMURI for interfacing CSL and RCF (in ETSI TS 103 681-1 [i.8]).
- gRRFI for interfacing URA and RF Transceiver, which is the scope of the present document.
- gURAI for interfacing URA and RCF (in ETSI TS 103 681-3 [i.9]).
- gRPI for allowing an independent and uniform production of RAs (in ETSI TS 103 681-4 [i.10]).

The present document defines gRRFI.

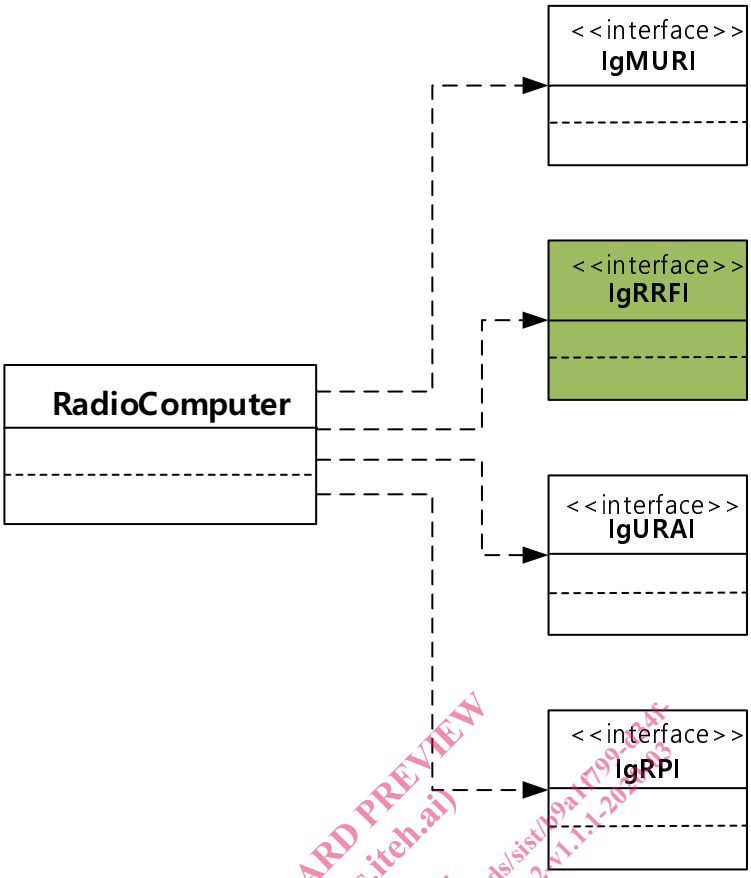

Figure 4.2: UML class diagram for RC interfaces

Figure 4.2 illustrates UML class diagram for RC interfaces. The reconfigurable RE may be seen as RCs 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 RC; and
- clause 8 describes the interface definition.

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

5 System Identification

5.1 Radio Computer Structure

Figure 5.1 illustrates how URA and RF Transceiver interacts with each other using gRRFI.

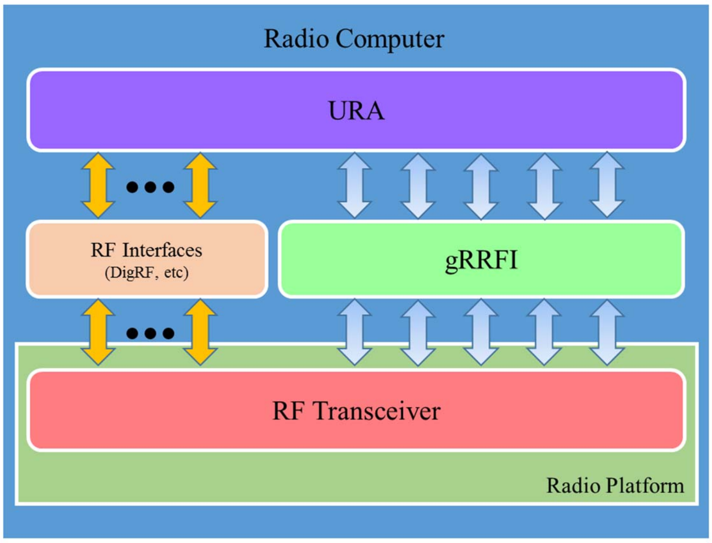

Figure 5.1: Interconnection between URA and RF Transceiver using gRRFI for reconfigurable RE

As shown in figure 5.1, gRRFI can support up to 5 kinds of services depending on the applicable RERC [1].

A Reconfigurable RE shall support all the services as required by the corresponding RERC as shown in table 5.1 and fully detailed in clause 8 of the present document. In case that a reconfigurable RE supports multiple RERCs, the concerned reconfigurable RE shall support all the services as defined in table 5.1.

Table 5.1: Required services of gRRFI according to each RERC

Radio Equipment Reconfiguration Class	Spectrum Control services	Power Control services	Antenna Management services	Tx/Rx Chain Control services	RVM Protection services
RERC-0	No	No	No	No	No
RERC-1	Yes	Yes	No	No	Yes
RERC-2, RERC-5	Yes	Yes	Yes	Yes (see note)	Yes
RERC-3, RERC-6	Yes	Yes	Yes	Yes	Yes
RERC-4, RERC-7	Yes	Yes	Yes	Yes	Yes
NOTE: Among the various Tx/Rx Chain Control services, only the service related with Tx/Rx timing is required in this case.					

A corresponding summary of the services is given below:

- **Spectrum Control services**
  - These services are used to set up spectrum-related parameters such as carrier frequency, bandwidth, sampling frequency, etc. that will be determined according to the URAs they are related to.
- **Power Control services**
  - These services are used to set up RF power-related parameters such as maximum transmit (Tx) power level, Tx power level per antenna, receive (Rx) gain, etc. Specific power schemes which have to be controlled according to the communication circumstance around the reconfigurable RE are also included in the Power Control services.
- **Antenna Management services**
  - These services are used to determine the antenna configuration. Antenna radiation pattern, antenna gain, antenna direction, sector configuration, polarization, frequency range, etc. are some factors to be considered in the Antenna Management services.

NOTE: Antenna Management services depend on the configurability of the antenna.