Draft ETSI EN 303 146-3 V1.1.7 (2016-05)

Reconfigurable Radio Systems (RRS);
Mobile Device (MD) information models and protocols;
Part 3: Unified Radio Application Interface (URAI)

Reference

DEN/RRS-0213

Keywords

interface, mobile, SDR

ETSI

650 Route des Lucioles
F-06921 Sophia Antipolis Cedex - FRANCE

Tel.: +33 4 92 94 42 00 Fax: +33 4 93 65 47 16

Siret N° 348 623 562 00017 - NAF 742 C
Association à but non lucratif enregistrée à la
Sous-Préfecture de Grasse (06) N° 7803/88

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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.

The present document is part 1 of a multi-part deliverable covering Mobile Device (MD) information models and protocols, as identified below:

Part 1: "Multiradio Interface (MURI)";

Part 2: "Reconfigurable Radio Frequency Interface (RRFI)";

Part 3: "Unified Radio Application Interface (URAI)";

Part 4: "Radio Programming Interface (RPI)".

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
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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).

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

1 Scope

The scope of the present document is to define an information model and protocol for unified radio application interface for mobile device reconfiguration. The work is based on the Use Cases defined in ETSI TR 102 944 [i.1], on the system requirements defined in ETSI EN 302 969 [1] and on the radio reconfiguration related architecture for mobile devices defined in ETSI EN 303 095 [i.2] and on the mobile device information models and protocols related Multiradio Interface defined ETSI EN 303 146-1 [i.3].

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 http://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 302 969 (V1.2.1) (11-2014): "Reconfigurable Radio Systems (RRS); Radio Reconfiguration related Requirements for Mobile Devices".

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 102 944: "Reconfigurable Radio Systems (RRS); Use Cases for Baseband Interfaces for Unified Radio Applications of Mobile Device".

[i.2] ETSI EN 303 095 (V1.2.1): "Reconfigurable Radio Systems (RRS); Radio Reconfiguration related Architecture for Mobile Devices".

[i.3] ETSI EN 303 146-1: "Reconfigurable Radio Systems (RRS); Mobile Device Information Models and Protocols; Part 1: Multiradio Interface (MURI)".

[i.4] ETSI EN 303 146-2: "Reconfigurable Radio Systems (RRS); Mobile Device Information Models and Protocols; Part 2: Reconfigurable Radio Frequency Interface (RRFI)".

[i.5] ETSI TR 102 839: "Reconfigurable Radio Systems (RRS); Multiradio Interface for Software Defined Radio (SDR) Mobile Device Architecture and Services".

[i.6] 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.7] Recommendation ITU-T X.680: "Information technology - Abstract Syntax Notation One (ASN.1): Specification of basic notation".

3 Definitions and abbreviations

3.1 Definitions

For the purposes of the present document, the following terms and definitions 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 mobile device. It can be reached by establishing a logical communication link (i.e. an association) between the reconfigurable mobile device 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 EN 303 095 [i.2].

communication services layer: 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

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 mobile device hardware working under ROS control and on which RAs are executed

NOTE: A Radio Computer typically includes programmable processors, hardware accelerators, peripherals, 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.

3.2 Abbreviations

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

ASN	Abstract Syntax Notation
ASN.1	Abstract Syntax Notation One
BLER	BLock Error Rate
CM	Configuration Manager

CSL	Communication Services Layer
FC	Flow Controller
ID	IDentification
MD	Mobile Device
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
RCM	Radio Connection Manager
RF	Radio Frequency
RM	Resource Manager
ROS	Radio Operating System
RPI	Radio Programming Interface
RRFI	Reconfigurable Radio Frequency Interface
SINR	Signal to Interference plus Noise Ratio
UML	Unified Modelling Language
URA	Unified Radio Applications
URAI	Unified Radio Application Interface

4 Introduction

A reconfigurable MD is capable of running multiple radios simultaneously and of changing the set of radios by loading new Radio Application Package (RAP). All Radio Applications (RAs) are called Unified Radio Applications (URAs) when they exhibit a common behaviour from the reconfigurable MD's point of view [i.2]. In order to run multiple URAs, the reconfigurable MD will include Communication Services Layer (CSL), Radio Control Framework (RCF), Radio Platform and 4 sets of interfaces for their interconnection.

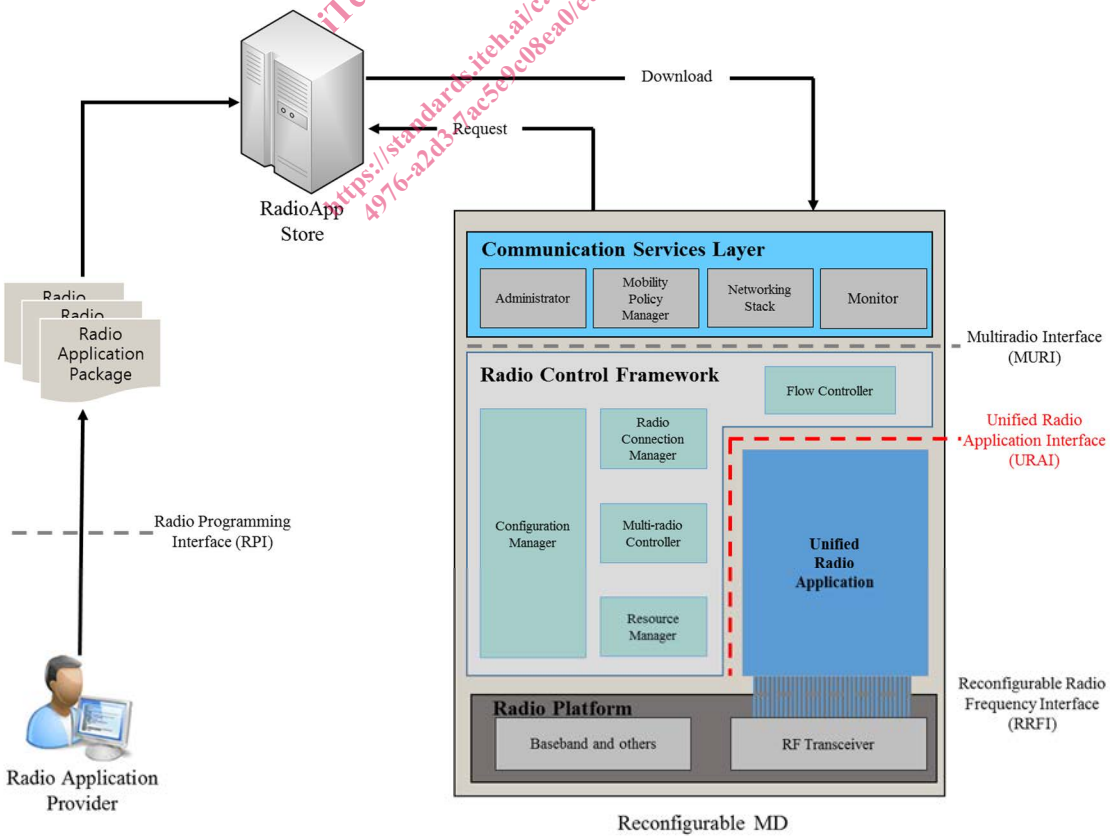

Figure 4.1: Four sets of interfaces for Reconfigurable MD

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

- MURI for interfacing CSL and RCF [i.3];
- RRFI for interfacing URA and RF Transceiver [i.4];
- URAI for interfacing URA and RCF which is the scope of the present document ;
- RPI for allowing an independent and uniform production of RAs [i.5].

The present document defines UARI.

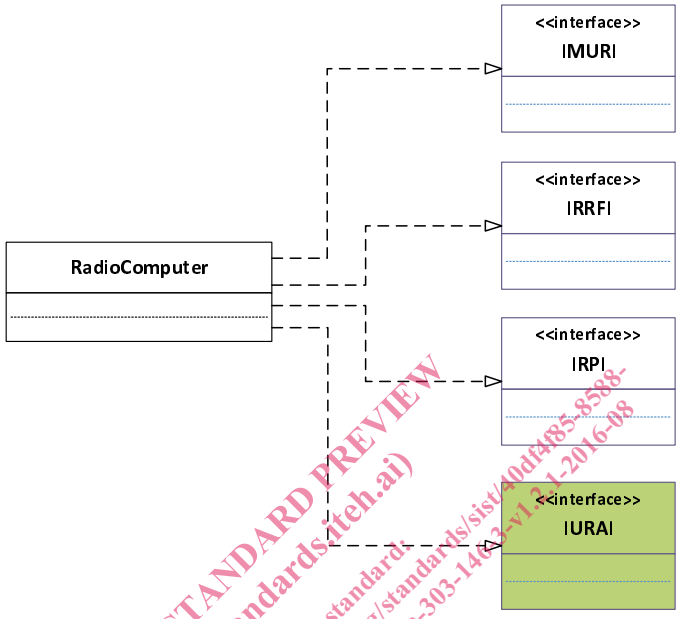

Figure 4.2: UML class diagram for Radio Computer interfaces

Figure 4.2 illustrates UML class diagram for Radio Computer interfaces. The reconfigurable MD may be seen as a Radio Computer where individual URAs are engineered as software entities [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 URAI, other modelling languages could be used as well.

5 System Identification

5.1 Radio Computer Structure

Figure 5.1 illustrates how RCF and URA interact with each other using URAI.

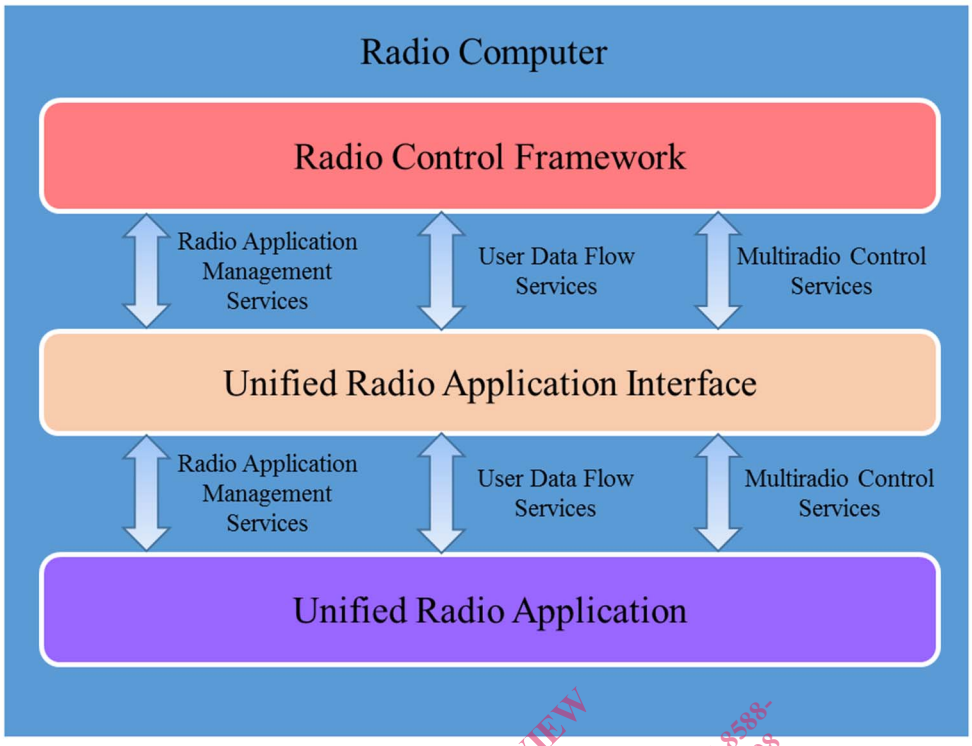

Figure 5.1: Interconnection between RCF and URA using URAI for Reconfigurable MD

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

- **Radio Application Management Services**

These services are used by Radio Connection Manager (RCM) which is included in the RCF, to control URA functions such as reporting of discovered Peer Equipments, creating/terminating association with Peer Equipment, starting/stopping communication with Peer Equipment, etc.

- **User Data Flow Services**

These services are used by Flow Controller (FC) which is included in the RCF, to transmit user data to URA, or used by URA to transmit received user data to FC. These services also include management of data flow, which is provided by FC.

- **Multiradio Control Services**

These services are used by Multiradio Controller (MRC) which is included in RCF, to manage spectral resource usage.

The RCF and URA are defined in ETSI EN 303 095 [i.2].

5.2 URAI System Requirement Mapping

The Radio Computer components above described shall support the URAI system requirements shown in table 5.1 and described in clause 6 of ETSI EN 302 969 [1].

Table 5.1: Mapping of Radio Computer Components to the system requirements described in ETSI EN 302 969 [1]

Entity/Component/Unit	System Requirements [1]	Comments
Flow Controller	R-FUNC-RAT-05	If a reconfigurable MD allows parallel connections to RATs (in alignment to R-FUNC-RAT-01), various independent data flows should be maintained simultaneously. The requirement is described in clause 6.1.5 of ETSI EN 302 969 [1].
	R-FUNC-RA-04	Radio Applications should support the function of transferring receive (Rx)/transmit (Tx) data to/from the networking stack. The requirement is described in clause 6.2.4 of ETSI EN 302 969 [1].
Multiradio Controller	R-FUNC-RAT-01	A reconfigurable MD should support parallel connections to more than one Radio Access Technology. The requirement is described in clause 6.1.1 of ETSI EN 302 969 [1].
	R-FUNC-RAT-02	If a reconfigurable MD allows parallel connections to RATs, (in alignment to R-FUNC-RAT-01), in-device coexistence functionalities shall be implemented. The requirement is described in clause 6.1.2 of ETSI EN 302 969 [1].
	R-FUNC-RAT-03	If a reconfigurable MD allows parallel connections to RATs (in alignment to R-FUNC-RAT-01), seamless handover of data streams from one RAT to another RAT should be implemented. The requirement is described in clause 6.1.3 of ETSI EN 302 969 [1].
	R-FUNC-RAT-06	If a reconfigurable MD allows parallel connections to RATs (in alignment to R-FUNC-RAT-01), Link Adaptation techniques across multiple RATs should be implemented. The requirement is described in clause 6.1.6 of ETSI EN 302 969 [1].
	R-FUNC-MDR-03	The radio configuration of a reconfigurable MD shall be realized with the activation of Radio Applications (RA) and, if necessary, changing parameters of the activated RAs. The requirement is described in clause 6.4.3 of ETSI EN 302 969 [1].
Radio Connection Manager	R-FUNC-RAT-04	If policies are applied to a reconfigurable MD, the link selection functionality in the reconfigurable MD shall meet the related conditions. The requirement is described in clause 6.1.4 of ETSI EN 302 969 [1].
	R-FUNC-RAT-05	If a reconfigurable MD allows parallel connections to RATs (in alignment to R-FUNC-RAT-01), various independent data flows should be maintained simultaneously. The requirement is described in clause 6.1.5 of ETSI EN 302 969 [1].
	R-FUNC-RAT-06	If a reconfigurable MD allows parallel connections to RATs (in alignment to R-FUNC-RAT-01), Link Adaptation techniques across multiple RATs should be implemented. The requirement is described in clause 6.1.6 of ETSI EN 302 969 [1].
	R-FUNC-RA-03	Reconfigurable MDs should support concurrent execution of Radio Applications. The requirement is described in clause 6.2.3 of ETSI EN 302 969 [1].
	R-FUNC-MDR-03	The radio configuration of a reconfigurable MD shall be realized with the activation of Radio Applications (RA) and, if necessary, changing parameters of the activated RAs. The requirement is described in clause 6.4.3 of ETSI EN 302 969 [1].

6 Notational Tools

6.1 Notational Tool for Information Model Classes

Table 6.1 shows a template for defining information model classes [i.6]. Each information model class is defined in clause 7.2 in accordance with the template shown in table 6.1.

NOTE: ASN.1 is used throughout the present document for abstract type definitions; however, alternative ways are possible and are not excluded.

Table 6.1: Template for defining Information Model Classes

Class<Class name>*[(abstract class)]*			
<Description of the class>			
DERIVED FROM	<List of super-classes>		
ATTRIBUTES			
<Attribute name> *[<optional>]*	*Value type:* <Attribute value type>	*Possible access:* <Attribute access qualifier>	*Default value:* <Default value>
<Description of the attribute>			
CONTAINED IN	<List of classes, whose instances may contain an instance of this class. If this class is an abstract class, that is, it is used for further refinement only and will never be instantiated, then this list is empty.>		
CONTAINS	<List of classes, whose instances may be contained in an instance of this class. Constraints used are: • [*] - zero or more instances, • [+] - one or more instances, • [<n>] - exactly n instances, • [<m> - <n>] - not less than m and not more than n instances.>		
SUPPORTED EVENTS	<List of event names that are detected by this class and lead potentially to a corresponding event report.>		

Further details on the template in table 6.1 are given 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.
- DERIVED FROM field identifies the super class of the class in case of sub-classing.
- ATTRIBUTES field describes the attributes that have been defined in the class. More specifically:
  - <Attribute name> identifies the name of an attribute, as it is included in the class definition.
  - <Attribute value type> holds the type of the attribute specified in Abstract Syntax Notation One (ASN.1). Details related to the ASN.1 module are specified in annex A.
  - <Attribute access qualifier> provides information about the level of accessibility of the attribute. This may include: 'Read', 'Write', 'Read-Write', 'Add-Remove' (for list-type attributes), 'Read-Add-Remove', and 'None' (for internal access only).
- CONTAINED IN field includes a list of classes whose instances may contain an instance of this class; containment is a strong aggregation relationship, that is, a contained instance is for its lifetime bound to its container object and it is contained only in this one container.
- CONTAINS field provides a list of classes whose instances may be contained in an instance of the class in question.
- SUPPORTED EVENTS field includes a list of event names that are detected by this class and lead potentially to a corresponding event report.