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**Reconfigurable Radio Systems (RRS);
Radio Reconfiguration related Requirements
for Mobile Devices**

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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**", "**may not**", "**need**", "**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 scope of the present document is to define the high level system requirements for reconfigurable Mobile Devices enabling the provision of Radio Applications. The work will be based on the Use Cases defined in TR 103 062 [i.1] and TR 102 944 [i.2].

2 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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2.1 Normative references

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

Not applicable.

2.2 Informative references

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 103 062: "Reconfigurable Radio Systems (RRS); Use Cases and Scenarios for Software Defined Radio (SDR) Reference Architecture for Mobile Device".
- [i.2] ETSI TR 102 944: "Reconfigurable Radio Systems (RRS); Use Cases for Baseband Interfaces for Unified Radio Applications of Mobile Device".

3 Definitions and abbreviations

3.1 Definitions

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

Functional Block (FB): function needed for real-time implementation of Radio Application(s)

NOTE 1: A functional block includes not only the modem functions in Layer1 (L1), Layer2 (L2), and Layer 3 (L3) but also all the control functions that should be processed in real-time for implementing given Radio Application(s).

NOTE 2: Functional blocks are categorized into *standard functional blocks* and *user defined functional blocks*. In more details:

- 1) *Standard functional blocks* can be shared by many Radio Applications. For example, Forward Error Correction (FEC), Fast Fourier Transform (FFT)/Inverse Fast Fourier Transform (IFFT), (de)interleaver, Turbo coding, Viterbi coding, Multiple Input Multiple Output (MIMO), Beamforming, etc are the typical category of standard functional block.

- 2) *User defined functional blocks* include those functional blocks that are dependent upon a specific Radio Application. They are used to support special function(s) required in a specific Radio Application or to support a special algorithm used for performance improvement. In addition, a user defined functional block can be used as a baseband controller functional block which controls the functional blocks operating in baseband processor in real-time and to control some context information processed in real-time.

NOTE 3: Each functional block has its unique name, Input, Output and properties.

network coding: technique in which transmitted data is encoded and decoded to improve network performance

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: Radio applications 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;
- Intermediate Representations (IRs) including Radio Library calls of Radio Library native implementation and radio HAL calls;
- Executable codes for a particular radio platform.

radio library: library of Standard Functional Blocks (SFB) that is provided by a platform vendor in a form of platform-specific executable code

NOTE 1: SFBs implement reference codes of functions which are typical for radio signal processing. They are not atomic and their source codes are typed and visible for Radio Application developers.

NOTE 2: An SFB is implemented through a Radio Hardware Abstraction Layer (HAL) when the SFB is implemented on dedicated HW accelerators. Radio HAL is part of ROS.

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

NOTE: A Radio Virtual Machine 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 mobile device: Mobile Device with radio communication capabilities providing support for radio reconfiguration.

NOTE: Reconfigurable Mobile Devices include but are not limited to: Smartphones, Feature Phones, Tablets, Laptops.

resources: Hardware Resources that a Radio Application needs in active state

NOTE 1: Resources are provided by the reconfigurable Mobile Device (MD), to be used by the Radio Applications when they are active. Radio Applications provide their Resource needs (e.g. using operational states) so that the multiradio computer may judge whether these Resources are available, in order to ensure non-conflicting operation with other Radio Applications. Resources may or may not be shared in the reconfigurable MD.

NOTE 2: Resources may include processors, accelerators, memory, Radio Frequency circuitry, etc.

3.2 Abbreviations

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

ASIC	Application Specific Integrated Circuit
BER	Bit Error Rate
CAT	Category
CR	Cognitive Radio
DoA	Direction of Arrival
FB	Functional Block
FEC	Forward Error Correction
FFT	Fast Fourier Transform
HAL	Hardware Abstraction Layer
IR	Intermediate Representation
LTE	Long Term Evolution
MAC	Media Access Control
MD	Mobile Device
MDRC	Mobile Device Reconfiguration Class
MIMO	Multi-Input Multi-Output
MU-MIMO	Multi User- Multi-Input Multi-Output
PER	Packet Error Rate
PMI	Precoding Matrix Indicator
RA	Radio Application
RAT	Radio Access Technology
RF	Radio Frequency
RI	Rank Indicator
ROS	Radio Operating System
RRS	Reconfigurable Radio Systems
RSSI	Received Signal Strength Indication
RVM	Radio Virtual Machine
Rx	Receive
SDR	Software Defined Radio
SFB	Standard Functional Block
SINR	Signal to Interference-plus-Noise Ratio
SU-MIMO	Single User- Multi-Input Multi-Output
Tx	Transmit
UDFB	User Defined Functional Block
WiFi	Wireless Fidelity

4 Requirement Organization and Methodology

This clause is containing the description of how the requirements are organized and the related format.

4.1 Requirement Organization

As shown in Figure 1, all requirements described in the present document belong to one single category (the functional requirements category). Requirements are, in turn, organized into groups.

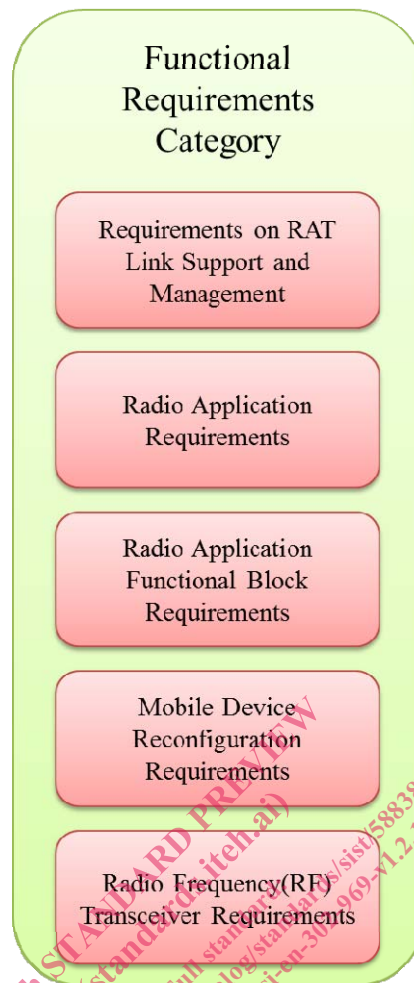


Figure 1: Overall requirements structure

4.2 Requirement Format

A letter code system is defined which makes a unique identification of each requirement R-<CAT>-<GROUP>-<XX>. Each requirement is constructed as follows:

- R-: Standard requirement prefix
- <CAT>

Code	Category
FUNC	Functional aspects

- <GROUP>: Requirement group identifier. A letter code will be used for this identifier. The three first letters will give the identifier of the group.
- <XX>: Requirement identifier within requirement group; range 01 => 99.

EXAMPLE: R-FUNC-QOS-01.

4.3 Requirement Formulation

A requirement is formulated in such a way that it is uniquely defined. It is built as follows:

Title: <Title Description>

- Description: the description of a requirement will be formulated using one of the following terms:
 - "shall" is used to express mandatory requirements (i.e. provisions that have to be followed)
 - "should" is used to express recommendations (provisions that an implementation is expected to follow unless there is a strong reason for not doing so)
 - "May" is used to express permissible actions (provisions that an implementation is able to follow or not follow)

5 Working assumptions

5.1 Assumptions

5.1.1 Mobile Device Reconfiguration Classes

As it is expected that the reconfiguration capabilities of a Mobile Device will evolve over time, Mobile Device Reconfiguration Classes (MDRC) are introduced. As shown in Figure 2, 7 different classes of reconfigurable MD are introduced (MDRC-0 corresponds to a non-reconfigurable device).

No reconfiguration	MDRC-0	
No resource share (fixed hardware)	MDRC-1	
Pre-defined static resources	MDRC-2	MDRC-5
Static resource requirements	MDRC-3	MDRC-6
Dynamic resource requirements	MDRC-4	MDRC-7
	Platform-specific executable code	Platform-independent source code or IR

Figure 2: Definition of MDRCs according to reconfiguration capabilities

A reconfigurable MD belongs to a defined class according to the reconfiguration capabilities, which are determined by the type of Resource requirements and the form of the Radio Application Package. Reconfigurable MD classes are defined as follows (see also Figure 2):

- 1) MDRC-0: No MD reconfiguration is possible

MDRC-0 represents legacy radio implementations and do not allow for MD reconfiguration (except for bug fixing and release-updates through firmware updates) or exploitation of Cognitive Radio (CR) features. MDRC-0 represents legacy radio implementations and does not allow for MD reconfiguration.