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Reconfigurable Radio Systems (RRS);
Radio Equipment (RE) reconfiguration requirements

Reference

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Keywords

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Foreword

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

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 scope of the present document is to define the high level system requirements for reconfigurable Radio Equipment enabling the provision of Radio Applications. The work is based on the Use Cases defined in ETSI TR 103 062 [i.1], ETSI TR 102 944 [i.2], ETSI TR 103 585 [i.3] and ETSI EN 302 969 [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.

Referenced documents which are not found to be publicly available in the expected location might be found at https://docbox.etsi.org/Reference.

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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".

[i.3] ETSI TR 103 585: "Reconfigurable Radio Systems (RRS); Radio Equipment Reconfiguration Use Cases".

[i.4] ETSI EN 302 969: "Reconfigurable Radio Systems (RRS); Radio Reconfiguration related Requirements for Mobile Devices".

3 Definition of terms, symbols and abbreviations

3.1 Terms

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

distributed computations: model in which components located on networked computers communicate and coordinate their actions by passing messages interacting with each other in order to achieve a common goal

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 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.

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

NOTE 1: Resources are provided by the reconfigurable Radio Equipment (RE), 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 RE.

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

3.2 Symbols

Void.

3.3 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
FB	Functional Block
FEC	Forward Error Correction
FFT	Fast Fourier Transform
HAL	Hardware Abstraction Layer
IoT	Internet of Things
IR	Intermediate Representation
LTE	Long Term Evolution
MAC	Media Access Control
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
RE	Radio Equipment
RERC	Radio Equipment Reconfiguration Class
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

4.0 General

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.

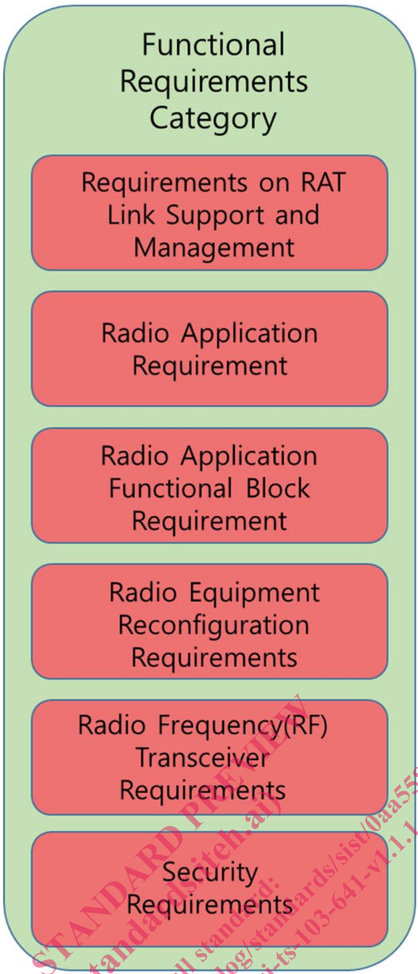

Figure 1: Overall requirements structure

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 the terms as described in the clause "Modal verbs terminology" above.

5 Working assumptions

5.1 Assumptions

5.1.1 Radio Equipment Reconfiguration Classes

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

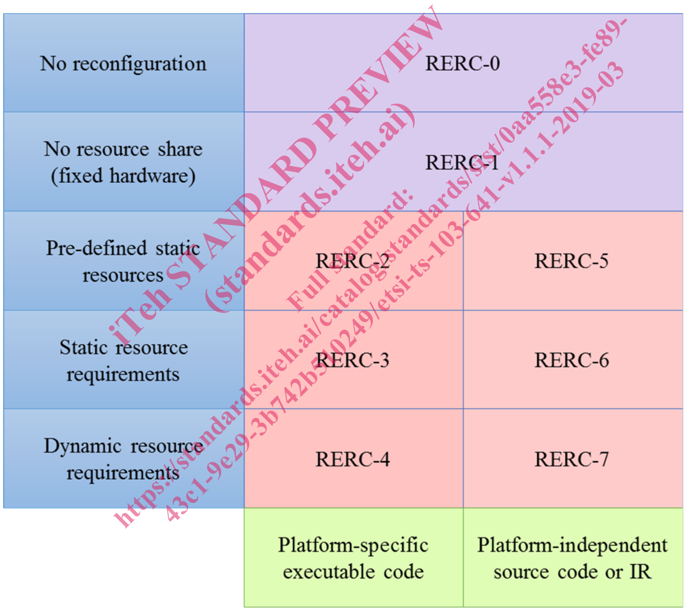

Figure 2: Definition of RERCs according to reconfiguration capabilities

A reconfigurable RE 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 RE classes are defined as follows (see also Figure 2):

1) RERC-0: No RE reconfiguration is possible.

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

2) RERC-1: Radio Applications use different fixed Resources.

In this scenario, at least some of the radios are implemented with non-software defined radio (SDR) technology, e.g. with dedicated Application Specific Integrated Circuits (ASICs), and are Resource-wise independent of each other. Simple CR functionality may be supported through radio parameter management to the extent which the radio implementations allow. RERC-1 implements multiple Radio Applications with fixed Resources allocation and no Resource sharing.