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Reconfigurable Radio Systems (RRS);
Definition of Radio Application Package

Reference
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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

This Technical Specification details the format of a Radio Application Package (RAP).

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.

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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 103 436 (V1.2.1): "Reconfigurable Radio Systems (RRS); Security requirements for reconfigurable radios".

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 EN 303 641 (V1.1.2): "Reconfigurable Radio Systems (RRS); Radio Equipment (RE) reconfiguration requirements".

[i.2] ETSI EN 303 648 (V1.1.2): "Reconfigurable Radio Systems (RRS); Radio Equipment (RE) reconfiguration architecture".

[i.3] ETSI EN 303 681-1 (V1.1.2): "Reconfigurable Radio Systems (RRS); Radio Equipment (RE) information models and protocols for generalized software reconfiguration architecture; Part 1: generalized Multiradio Interface (gMURI)".

[i.4] ETSI EN 303 681-2 (V1.1.2): "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.5] ETSI EN 303 681-3 (V1.1.2): "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.6] ETSI EN 303 681-4 (V1.1.2): "Reconfigurable Radio Systems (RRS); Radio Equipment (RE) information models and protocols for generalized software reconfiguration architecture; Part 4: generalized Radio Programming Interface (gRPI)".

[i.7] ETSI EN 302 969 (V1.3.1): "Reconfigurable Radio Systems (RRS); Radio Reconfiguration related Requirements for Mobile Devices".

[i.8] ETSI EN 303 095 (V1.3.1): "Reconfigurable Radio Systems (RRS); Radio reconfiguration related architecture for Mobile Devices (MD)".

[i.9] ETSI EN 303 146-1 (V1.3.1): "Reconfigurable Radio Systems (RRS); Mobile Device (MD) information models and protocols; Part 1: Multiradio Interface (MURI)".

[i.10] ETSI EN 303 146-2 (V1.2.1): "Reconfigurable Radio Systems (RRS); Mobile Device (MD) information models and protocols; Part 2: Reconfigurable Radio Frequency Interface (RRFI)".

[i.11] ETSI EN 303 146-3 (V1.3.1): "Reconfigurable Radio Systems (RRS); Mobile Device (MD) information models and protocols; Part 3: Unified Radio Application Interface (URAI)".

[i.12] ETSI EN 303 146-4 (V1.1.2): "Reconfigurable Radio Systems (RRS); Mobile Device (MD) information models and protocols; Part 4: Radio Programming Interface (RPI)".

3 Definition of terms, symbols and abbreviations

3.1 Terms

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

administrative RAP metadata: information to help manage a resource, like resource type, permissions, and when and how it was created

descriptive RAP metadata: descriptive information about a resource, such as a target reconfiguration platform, a compiler, etc. used for discovery and identification and including elements such as title, abstract, author and keywords

NOTE: A Radio Application Package (RAP) contains metadata itself.

legal RAP metadata: information about the creator, copyright holder, and public licensing, if provided

metadata: data about the data, which can be structural or descriptive

NOTE: In the present document Metadata related to Descriptive RAP metadata, Structural RAP metadata, Administrative RAP metadata, Legal RAP metadata or a combination of some or all.

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

NOTE 2: The Radio Platform is the hardware part of the radio computer.

radio reconfiguration: reconfiguration of parameters related to air interface

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

NOTE: A 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 equipment: part of a reconfigurable radio system

NOTE: The Reconfigurable Equipment is capable of being dynamically reconfigured to adapt to a wide range of communications conditions. Such reconfiguration may include the band of operation, the radio access technology, the associated networks and the services accessed. The reconfiguration may occur after initial sale deployment and operation.

Reconfigurable Radio System (RRS): radio systems encompassing Software Defined and/or Cognitive Radio Systems

structural RAP metadata: metadata about Radio Application Package structure, indicating how compound objects are put together, for example, where to find information fields related to Code, Security, etc. and describing the types, versions, relationships and other characteristics of digital materials

user: user of the Reconfigurable Radio System or the Reconfigurable Equipment

3.2 Symbols

Void.

3.3 Abbreviations

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

BE	Back End
HAL	Hardware Abstraction Layer
HW	HardWare
IR	Intermediate Representation
MDRC	Mobile Device Reconfiguration Class
OS	Operating System
RA	Radio Application
RAP	Radio Application Package
RC	Radio Controller
RE	Reconfigurable Equipment
RERC	Radio Equipment Reconfiguration Class
RF	Radio Frequency
ROS	Radio Operating System
RRS	Reconfigurable Radio System
RVM	Radio Virtual Machine
SFB	Standard Functional Block
UDFB	User Defined Functional Block
URA	Unified Radio Application

4 Usage of Radio Application Packages

4.1 Context

A Radio Application Package (RAP) is being used in order to provide new Radio Applications to a target radio equipment. As detailed in ETSI EN 303 648 [i.2] for radio equipment in general and in ETSI EN 303 095 [i.8] for the specific case of mobile devices, the RAP is used for distribution and installation of RA codes on the target reconfigurable REs. During the design time, the RA codes provider will generate a Radio Application Package (RAP) that includes metadata and RA codes. Note that the Radio Computer (RC) codes are part of the RA codes. In case that RC codes are executed in the non-real-time environment, they are compiled to be executed in a given Computational Resources before they are included in the RAP.

During the installation time, the RAP will be downloaded from a RadioApp Store and installed in the reconfigurable RE. The RA codes, including RC codes, and metadata included in the RAP are installed in the reconfigurable RE. Note that the RC codes are installed in the Computational Resources for operations that do not have to be executed in real time processing such as context information processing, while the Functional Block (SFBs & UDFBs) codes shall be installed in the radio computers to be processed in real-time.

The full chain is illustrated in Figure 1 for the case of general radio equipment as defined in ETSI EN 303 648 [i.2]:

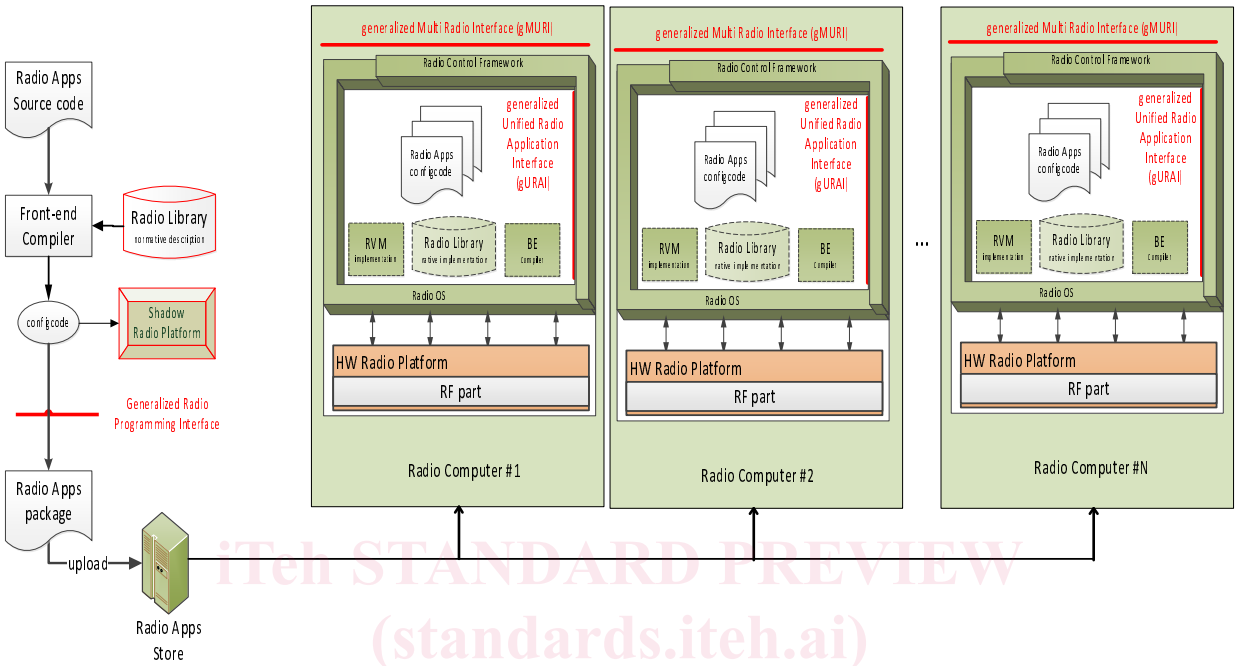

Figure 1: System architecture for radio computers where Radio Library and Back End (BE) compiler are included within the radio computers

The present document will define the structure of a RAP that shall be used for the software reconfiguration framework defined in [i.1] to [i.12].

4.2 Reconfiguration Classes

The information to be provided in a Radio Application Package (RAP) is dependent on the level of reprogrammability of the concerned platform. In the present document, it is thus referred to the Mobile Device Reconfiguration Classes (MDRC) as defined in ETSI EN 302 969 [i.7] for reconfigurable Mobile Devices and Radio Equipment Reconfiguration Classes (RERC) as defined in ETSI EN 303 641 [i.1] for any other reconfigurable equipment. A related summary is provided in Figures 2 and 3.

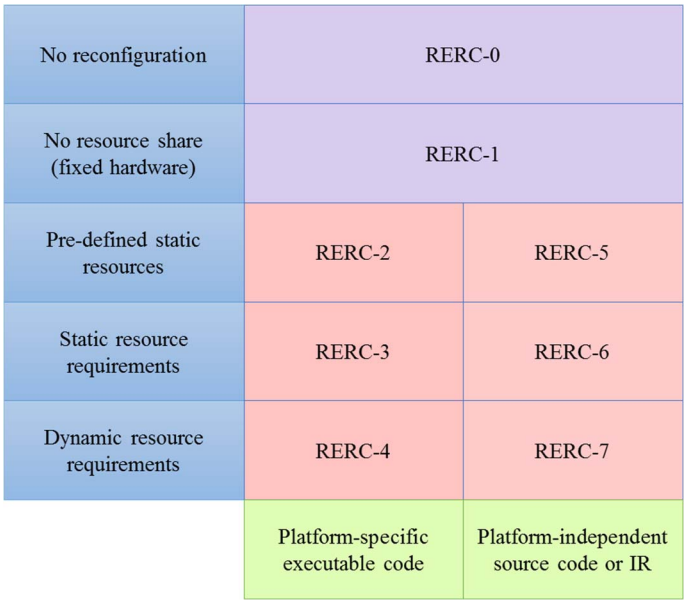

Figure 2: Definition of Radio Equipment Reconfiguration Classes (RERCs) according to reconfiguration capabilities [i.1]

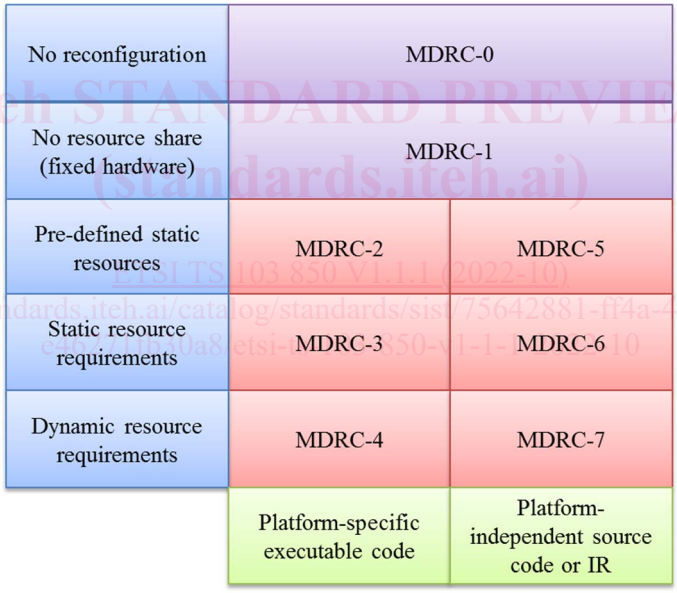

Figure 3: Definition of Mobile Device Reconfiguration Classes (MDRCs) according to reconfiguration capabilities [i.7]

5 Definition of Radio Application Packages

5.1 Content

In the present clause, the format of the RAP container is described on a high level. In order to keep the approach flexible, each of the information elements will be combined with a length indication (number of octets) such that manufacturers can adapt the size of any information element as required. The high-level RAP container format shall be defined as indicated in Figure 4.

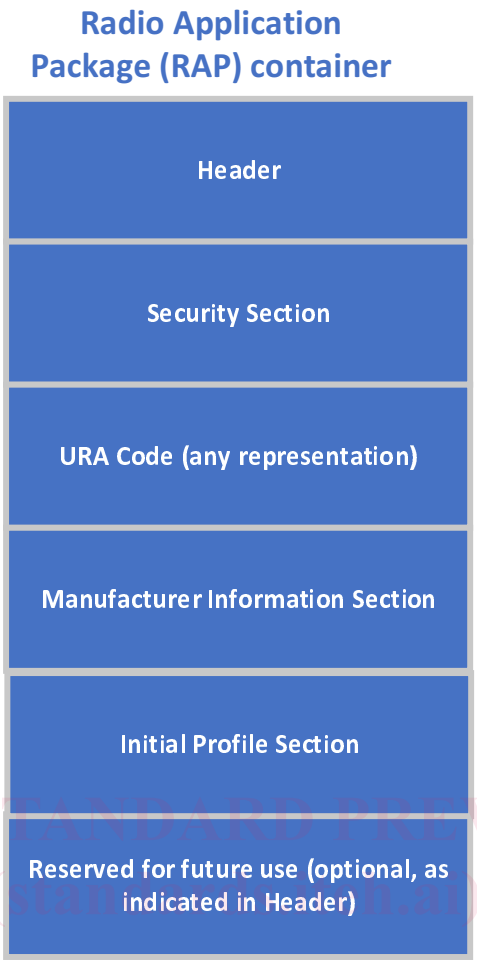

Figure 4: High level Radio Application Package container format

5.2 Tree Structure

5.2.1 Introduction

The RAP is a complex hierarchical bit field which is represented as a graph with specific properties. The RAP bit field is a sequence of bits. Therefore, the graph properties shall insure the only way for the RAP writing operation when the RAP is created as well as the RAP reading operation during which all RAP elements are decoded.

The RAP graph consists of nodes and edges between them. Each node of the RAP graph represents some bit field. Two nodes are connected by the edge if and only if one of them is a part of another one assuming that the one bit field is a part of another bit field. The RAP graph is a tree. It means that there is the only path between any pair of graph nodes. All the RAP graph elements are ordered in the following way:

- From the top to the bottom, the RAP graph is structured by layers. Nodes from the upper layer are connected with nodes from the adjusted lower layer. There are no edges between nodes from the same layer. If there is an edge between the upper layer node and the lower layer node it means that the bit field represented by the lower layer node is a part of the bit field represented by the upper layer node.
- From the left-hand to the right-hand, nodes from the same layer have fixed layer positions. It defines a position of the RAP element in the RAP bit field sequence: the left-hand elements are placed before the right-hand RAP element.

Below the RAP graph nodes are denoted by circles and edges by lines. Some of the RAP elements can be optional. In such case corresponding nodes can be omitted in the RAP graph structure and related edges are drawn as dotted lines. They also will be labelled by the letter "o" ("optional") or by a particular condition defining the related option. All other edges are drawn by the solid lines.

5.2.2 Top Level

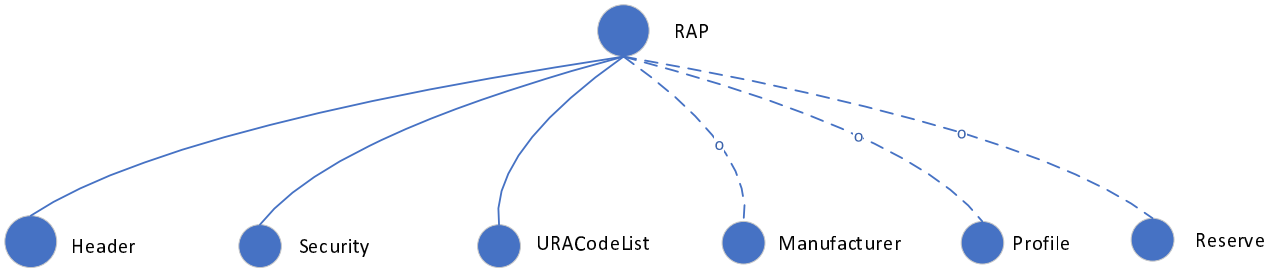

Figure 5: Top Level Tree Structure

The highest layer of the RAP graph consists of the only one the RAP node which represents the whole RAP bit field as it is pointed out in Figure 5 The lower layer consists of the following nodes representing particular RAP sections from Figure 4.

Table 1: Top Level Tree Structure Bit Fields

N	Node name	Node type	Bit field
1	Header	mandatory	The RAP header
2	Security	mandatory	The Security section
3	URACodeList	mandatory	URA codes (any representation). The URA code list consisting of code sections for a few Radio Applications
4	Manufacturer	optional	The Manufacturer Information section
5	Profile	optional	The Initial Profile section
6	Reserve	optional	Reserved for the future use

5.2.3 Tree - Header Section

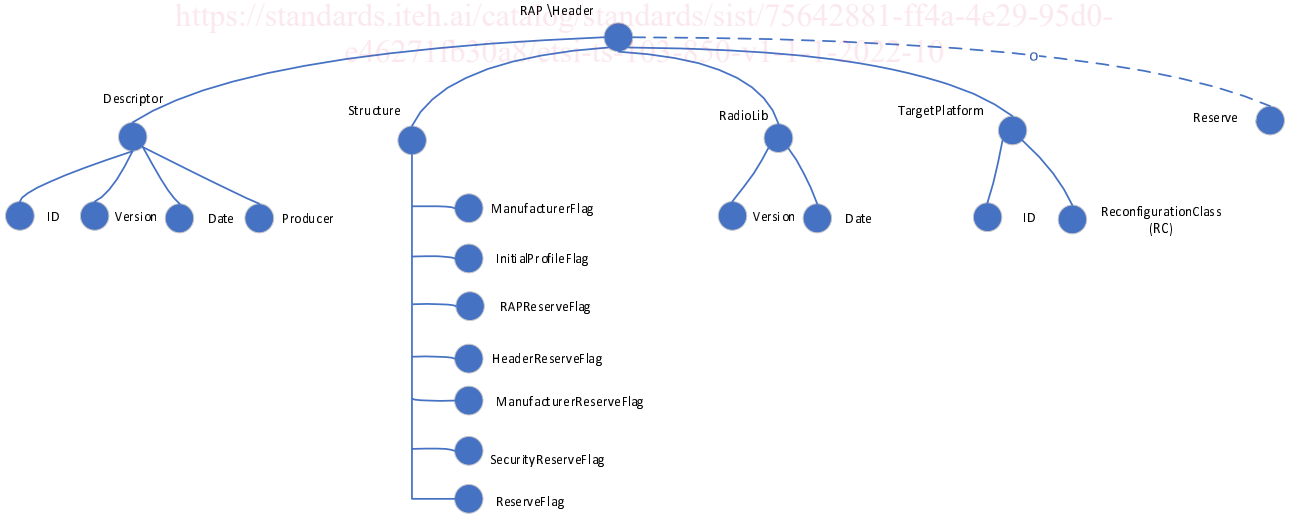

Figure 6: Tree - Header Section

The RAP Header subtree is depicted in Figure 6 Elements of the RAP Header are described in Table 2.