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Reconfigurable Radio Systems (RRS) ;
Use cases for dynamic equipment reconfiguration

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Foreword

This Technical Report (TR) 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 present document outlines the Use Cases which are related to the introduction of mechanisms to enable, for reconfigurable radio systems, the dynamic reconfiguration of equipment and its continuing conformity with the applicable legislation**.** These Use Cases involve the dynamic reconfiguration of reconfigurable radio equipment after its initial Declaration of Conformity and deployment. Such post-deployment reconfiguration will ensure the continued conformity in the new configuration to the applicable legislation. In some Use Cases, new mechanisms that enable reconfigurable devices to have their Declaration of Conformity dynamically verified may be introduced.

Note that the term "Declaration of Conformity" is typically used in conjunction with the European Radio Equipment Directive. In other regulation domains, other terminology may be employed. While the Use Cases presented in the present document are designed to support the novel radio reconfiguration features of the Radio Equipment Directive [i.3] that is applicable in Europe, the principles and the Use Cases outlined here are not limited to Europe and may also be appropriate for other regions.

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 reference document (including any amendments) applies.

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

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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] Report Recommendation ITU-R SM.2152: "Definitions of Software Defined Radio (SDR) and Cognitive Radio System (CRS"), 2009.

[i.2] Void.

[i.3] 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.

3 Definitions and abbreviations

3.1 Definitions

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

Cognitive Radio System (CRS): Radio system employing technology that allows the system: to obtain knowledge of its operational and geographical environment, established policies and its internal state; to dynamically and autonomously adjust its operational parameters and protocols according to its obtained knowledge in order to achieve predefined objectives; and to learn from the results obtained.

NOTE: This is the current definition as given in Report Recommendation ITU-R SM.2152 [i.1].

RadioApp (RA): software component to be installed and operated on reconfigurable Mobile Devices

NOTE: The operation of the software component impacts the conformity of the reconfigurable equipment to the applicable legislation.

Reconfigurable Equipment (RE): 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): generic term for radio systems encompassing Software Defined and/or Cognitive Radio Systems

Software Defined Radio (SDR): radio transmitter and/or receiver employing a technology that allows the RF operating parameters including, but not limited to, frequency range, modulation type, or output power to be set or altered by software, excluding changes to operating parameters which occur during the normal pre-installed and predetermined operation of a radio according to a system specification or standard

NOTE: This is the current definition as given in Report Recommendation ITU-R SM.2152 [i.1].

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

3.2 Abbreviations

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

CRS	Cognitive Radio System
DoC	Declaration of Conformity
EC	European Commission
GSM	Global System for Mobile Communications
HW	HardWare
NRA	National Regulatory Authority
OEM	Original Equipment Manufacturer
PAMR	Public Access Mobile Radio
PMR	Professional Mobile Radio
PPDR	Public Protection and Disaster Relief
RAT	Radio Access Technology
RE	Reconfigurable Equipment
RMP	Reconfiguration Market Platform
RRS	Reconfigurable Radio System
RVM	Radio Virtual Machine
SDR	Software Defined Radio
SM	Software Manufacturer
SP	Service Provider
StoC	Statement of conformity
SW	SoftWare
TCAM	Telecommunication Conformity Assessment and Market Surveillance Committee

4 Principles and Objectives for Reconfigurable Equipment

The present document focuses on the Use Cases and the related procedures applicable to equipment to be placed on the market that is able to be dynamically reconfigured. This includes, for instance, a piece of equipment for which the radio part can be reconfigured after deployment with new software remotely. Very often such a reconfiguration may occur "over-the-air" while the reconfigurable equipment is attached to a network. In the framework of the present document, it is assumed that equipment reconfiguration may include software provided by third party software suppliers. A corresponding legal framework is available in Europe under the Radio Equipment Directive (RED) [i.3]. Other regions may have their specific legal frameworks for placing such reconfigurable equipment on the market and/or putting it into service.

Herein, it is assumed that methods and processes traditionally used in the context of the assessment of conformity to applicable legislation may continue to be applied.

The extensions and standards for dynamically reconfigurable equipment may take into consideration the following principles and objectives:

i) One single entity, typically but not necessarily the Original Equipment Manufacturer, will ensure and declare that the resulting combination of (third party) software and hardware is in conformity to the applicable requirements.

ii) The entity responsible for the joint operation of hardware and software will provide all relevant technical documentation on request for market surveillance (including all background information used for the DoC).

iii) A mechanism may be developed to ensure that reconfigurable equipment will only allow compliant software to be installed and to ensure the externally verifiable integrity of the software. A mechanism may be used to indicate that a Declaration of Conformity has been issued for the combination of the software and hardware equipment in question.

iv) Third party software may be installed as long as the resulting combination of software and hardware is in conformity with the appropriate applicable legislation.

v) A history file should be kept inside the dynamically reconfigurable equipment for storing information on previous reconfigurations. This may enable the equipment to go back to a previous (stable) configuration in case of unexpected operation (e.g. creation of interference to other users or systems) and/or to identify which software modifications have been installed onto the equipment (so as to facilitate ex-post equipment monitoring).

vi) Typically, a Declaration of Conformity may be issued for software and hardware components which are available at the time of the Declaration ("Scenario 1"); additionally, depending on the applicable legislation, a Declaration of Conformity may be issued for hardware components in combination with available software components which can be extended for inclusion of software components to be developed in the future ("Scenario 2"). In the latter case, a future software component is typically made available together with a "Statement of Conformity", indicating that the combination of concerned hardware and software complies with the appropriate requirements. In Scenario 2, the Declaration of Conformity together with the appropriate Statement of Conformity is expected to be equivalent to Scenario 1.

  Scenario 2 is expected to reduce the administrative overhead for the responsible entity (typically the Original Equipment Manufacturer), while the legal result would be the same as in Scenario 1. It still needs to be verified whether:

  i) Scenario 2 is finally meeting its objectives; and

  ii) be acceptable from a legal perspective.

Figure 1 positions the application of Scenario 1 and Scenario 2 with respect to the verification needs of an equipment after Software Reconfiguration. Scenario 2 is an alternative to Scenario 1, especially in the case of a very limited access to radio parameters for (third party) software developers - the latter can be addressed by an Radio Virtual Machine (RVM) approach enabling the management of various levels of access to Radio Parameters by Software Components. Finally, together with the limited effort required for verification (i.e. only those test-cases need to be executed which are affected by the reconfiguration), a less complex assessment procedure might be possible.

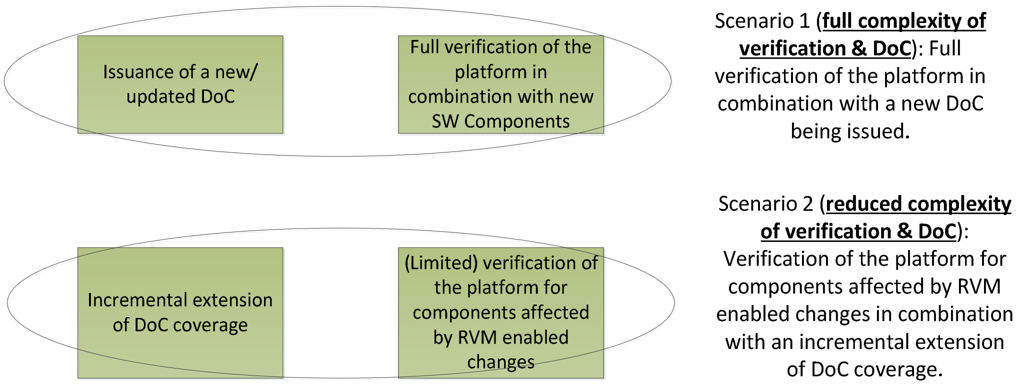

Figure 1: Scenario 1 and Scenario 2 Declaration of Conformity.

Figure 2 highlights that both Scenario 1 and Scenario 2 based Declaration of Conformity lead to an identical situation, i.e. the Declaration of Conformity is finally covering the concerned combination of hardware and software after the Reconfiguration process.

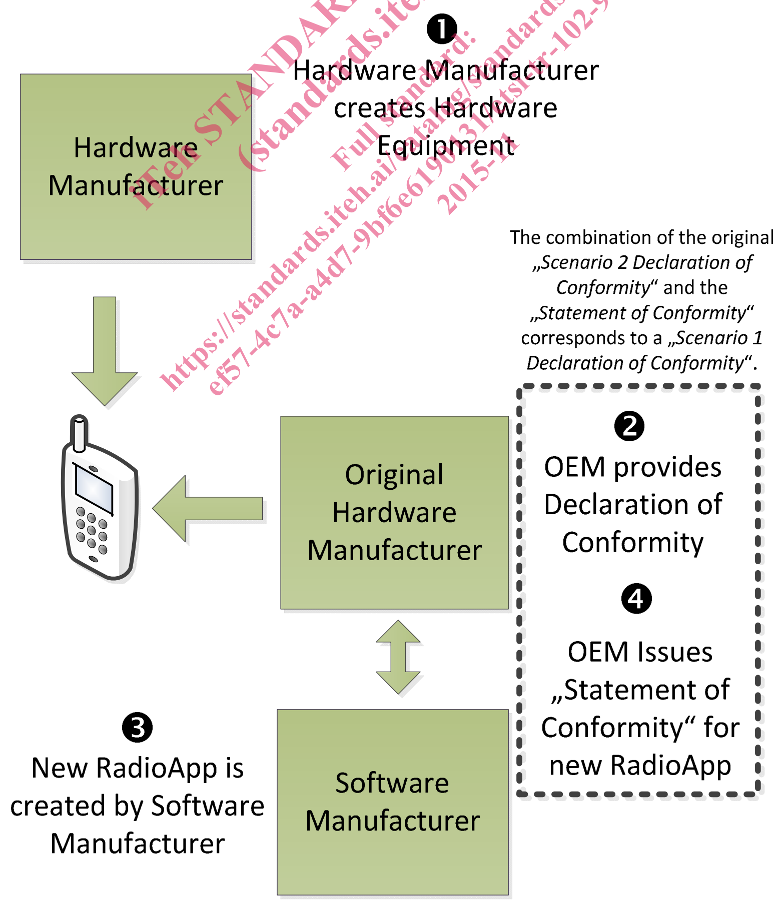

Figure 2: Identical situation for Scenario 1 and Scenario 2 Declaration of Conformity.

5 Stakeholders and Interrelations

5.0 Introduction

The ability to dynamically reconfigure equipment throughout its lifetime is important to enable the rapid and economical upgrading of equipment after initial deployment while at the same time assuring the continued conformity to all the applicable rules and the applicable legislation. It is through providing a climate of dynamic re-configurability that the economic benefits of Cognitive Radio Systems technology and rapid deployment of new innovative reconfigurable radio systems will be fostered. Such re-configurability will enable systems to be designed for the future and to take advantage of new technology and regulatory developments.

However, while it is important that the dynamic reconfiguration process does not hinder the development of new systems, the process should accommodate a wide variety of equipment, be sustainable over decades of regulatory control, be legally sound and be proof against both innocent misuse and malevolent perversion. In some cases, the new Declaration of Conformity may cover regulations that were not in effect at the time of original Declaration of Conformity or involve service aspects that are new capabilities. The reconfiguration may also be performed in a regulatory domain that is different from the initial Declaration of Conformity domain and the reconfiguration may affect features that may be regulated differently in different regulatory domains. It can be anticipated, for example, that in a first phase reconfiguration features are likely to be used only within a single regulatory domain. At a later time, the features could be extended to multiple regulatory domains as needed.

It should be understood that the Use Cases discussed in the present document are not about the conformity testing or "Declaration of Conformity" of equipment that has been upgraded with new software. All upgrades should first be verified by their developers using testing processes that are already established within the industry that conform to the applicable legislation. The reconfiguration Use Cases that are the subject of the present document address the process of assuring that new configurations for reconfigurable equipment are properly and appropriately loaded. The software and equipment design for the new configuration may be tested for conformity through the appropriate entities. Once the conformity testing of the new configuration is successful and a new Declaration of Conformity for the new configuration is issued, the reconfiguration process that is the subject of the Use Cases in the present document may be used to dynamically reconfigure the equipment.

Reconfigurations may involve many layers of software or hardware, and some reconfigurations may rely on presumed operation of previously established configurations. Also, due to the large volumes of deployments of consumer devices, the reconfiguration process should be scalable to accommodate (literally) billions of deployed devices and a similar number of possible new configurations.

This introductory clause outlines key stakeholders and key concepts for dynamically reconfiguring equipment while ensuring its continued conformity/compliance to/with applicable legislation and standards. One of the purposes of the present document is to enumerate some of the practical and technical Use Cases that should be accommodated by the dynamic reconfiguration process. For example, due to the equipment long life-cycles, the configuration process requires care and caution in its design to prevent failures or malevolent perversion. Furthermore, security requirements for the reconfigurable equipment should be considered to ensure trustworthy operation.

5.1 Stakeholders, Entities and Statements of Conformity

This clause lists and briefly describes the Stakeholders ([S]) and Entities ([E]) involved in the illustrated reconfiguration Use Cases as well as the "Statement of Conformity"([StoC]).

Note that the requirement for some or all of the below mentioned entities depends on the implementation of the reconfiguration framework. In particular a first implementation of the software reconfiguration framework is expected to limit itself to the most essential features only.

Not all of the listed stakeholders are involved at the same time.