

Reconfigurable Radio Systems (RRS); Potential regulatory aspects of Cognitive Radio and Software Defined Radio systems

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Foreword

This Technical Report (TR) has been produced by ETSI Technical Committee Reconfigurable Radio Systems (RRS).

Introduction

The present document addresses, in particular, the studies carried out by ETSI TC-RRS related to the study reports published by the working group WG1, WG2, WG3 and WG4. For example, the study results provided by ETSI TC-RRS working groups have been considered for items of potential relevance to regulation authorities.

The present document provides a recommendation to ETSI TC-RRS working groups. It is outlined which technical proposal of the working groups may require further regulatory actions in order to be deployed in the market.

As a European Standardization Organisation, ETSI receives mandate from the European Commission to develop Harmonised Standards that have a regulatory status as they can be referenced to by manufacturers to ensure that their products comply with the essential requirements of the R&TTE Directive [i.8]. It is then necessary to identify where the implementation of CR and SDR technologies may impact on the development of Harmonised Standards. The aspects discussed in the present document may motivate the creation of a related harmonized standard in the future.

In addition to that, some CR enablers (e.g. CPC) or functionality may impact on the conditions of use of one or several spectrum bands. These modifications need to be identified and submitted for study purpose to regulatory bodies; potentially CR enablers and functionalities need to be identified which are beyond the scope of the present document, which is limited to those addressed so far, in particular in ETSI RRS technical reports [i.1] to [i.6].

1 Scope

The present document gives recommendations related to the regulatory issues addressed in feasibility studies carried out by the Working Groups 1-4 of TC-RRS since January 2008. The Working Groups are responsible for following study areas:

- WG1: RRS System Aspects
- WG2: Reconfigurable Radio Equipment Architecture
- WG3: Functional Architecture and Cognitive Pilot Channel (in Cognitive Radio Network Management)
- WG4: RRS Public Safety

As a whole these studies have covered radio system technologies more generally known as Software Defined Radio and Cognitive Radio.

The present document also addresses the outcome of previous work such as that carried out by TCAM as a result of the Report drafted by its ad-hoc group on Software Defined Radios [i.7], in particular during TCAM meetings 17, 18 and 19.

2 References

References are either specific (identified by date of publication and/or edition number or version number) or non-specific.

- For a specific reference, subsequent revisions do not apply.
- Non-specific reference may be made only to a complete document or a part thereof and only in the following cases:
 - if it is accepted that it will be possible to use all future changes of the referenced document for the purposes of the referring document;
 - for informative references.

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.

2.1 Normative references

The following referenced documents are indispensable for the application of the present document. For dated references, only the edition cited applies. For non-specific references, the latest edition of the referenced document (including any amendments) applies.

Not applicable.

2.2 Informative references

The following referenced documents are not essential to the use of the present document but they assist the user with regard to a particular subject area. For non-specific references, the latest version of the referenced document (including any amendments) applies.

- [i.1] ETSI TR 102 680: "Reconfigurable Radio Systems (RRS); SDR Reference Architecture for Mobile Device".

- [i.2] ETSI TR 102 681: "Reconfigurable Radio Systems (RRS); Radio Base Station (RBS) Software Defined Radio (SDR) status, implementations and costs aspects, including future possibilities".
- [i.3] ETSI TR 102 682: "Reconfigurable Radio Systems (RRS); Functional Architecture (FA) for the Management and Control of Reconfigurable Radio Systems".
- [i.4] ETSI TR 102 683: "Reconfigurable Radio Systems (RRS); Cognitive Pilot Channel (CPC)".
- [i.5] ETSI TR 102 745: "Reconfigurable Radio Systems (RRS); User Requirements for Public Safety".
- [i.6] ETSI TR 102 733: "Reconfigurable Radio Systems (RRS); System Aspects for Public Safety".
- [i.7] TGS-Report-to-TCAM.doc: "Chairman's Report of the last TCAM Group on SDR (TGS) meeting", Brussels, 15. November 2004, DG ENTR/G/3, TCAM 17 (04) 28.
- [i.8] Directive 1999/5/EC of the European Parliament and of the Council of 9 March 1999 on radio equipment and telecommunications terminal equipment and the mutual recognition of their conformity (R&TTE Directive).

3 Definitions and abbreviations

3.1 Definitions

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

cognitive radio: radio, which has the following capabilities:

- to obtain the knowledge of radio operational environment and established policies and to monitor usage patterns and users' needs;
- to dynamically and autonomously adjust its operational parameters and protocols according to this knowledge in order to achieve predefined objectives, e.g. more efficient utilization of spectrum; and
- to learn from the results of its actions in order to further improve its performance.

NOTE 1: Radio operational environment encompasses radio and geographical environments, and internal states of the Cognitive Radio System.

NOTE 2: To obtain knowledge encompasses, for instance, by sensing the spectrum, by using knowledge data base, by user collaboration, or by broadcasting and receiving of control information.

NOTE 3: Cognitive Radio System comprises a set of entities able to communicate with each other (e.g. network and terminal entities and management entities).

software defined radio: radio in which the RF operating parameters including, but not limited to, frequency range, modulation type, or output power can be set or altered by software, and/or the technique by which this is achieved

NOTE 1: Excludes 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 2: SDR is an implementation technique applicable to many radio technologies and standards.

NOTE 3: SDR techniques are applicable to both transmitters and receivers.

3.2 Abbreviations

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

CPC	Cognitive Pilot Channel
CR	Cognitive Radio
ECC	Electronic Communications Committee
GSM	Global System for Mobile communication

RAT	Radio Access Technology
RF	Radio Frequency
RRS	Reconfigurable Radio System
RSPG	Radio Spectrum Policy Group
SDR	Software Defined Radio
TCAM	Telecommunications Conformity Assessment and Market Surveillance Committee

4 Regulatory issues related to SDR and CR feasibility studies

This clause summarizes potential regulatory issues of relevance in the study reports of all TC-RRS working groups. It also includes conclusions reached by previous work, such as that carried out by TCAM (see clauses 4.1 and 4.4).

4.1 Potential regulatory issues in TR 102 680

SDR Mobile Device Market Model

- **Responsibility Issues:** in the case that a device does not operate within the regulatory framework, the regulators typically request that the responsibility are within one single entity which needs to be easily identifiable.
- TCAM (Telecommunications Conformity Assessment and Market Surveillance Committee) studies proposed a definition for two market models - horizontal and vertical markets [i.7]:
 - **Vertical Markets:** all hardware and SDR software which is relevant for the declaration of conformity with the essential requirements for the intended use during the whole life cycle are controlled by one entity;
 - **Horizontal market:** independent companies placing hardware and SDR software (3rd party SW providers, etc.) separately on the market which, when used together, are subject to declaration of conformity with the essential requirements for the intended use of the equipment.

Responsibility issues can often be avoided or minimized by applying the Vertical Markets model. In case of the Horizontal market model, it is important to satisfy regulatory requirements.

Frequency agility

- The SDR radio applications will operate on multiple frequency bands (e.g. from 400 MHz to 10 GHz) and use multiple bandwidths (e.g. from 200 KHz to 500 MHz):
 - Depending on the usage of SDR technology, a regulatory impact may or may not be expected. For example, if SDR is applied for initial implementation purposes only and no further spectrum usage flexibility is introduced, then no regulatory impact is expected; however, in case that the spectrum usage flexibility is increased, there would be a regulatory impact.

Multiradio configuration capability

- As stated in [i.1], SDR equipment is expected to offer multiradio configuration capability: "Multiradio configuration capability: SDR equipment in mobile device is expected to install, load and activate a radio application while running a set of radio systems already."
 - It is not expected that the multiradio configuration capability in general will lead to regulatory issues at this stage.
- As stated in [i.1], SDR equipment is expected to offer multiradio operation capability: "Multiradio operation capability: SDR equipment in mobile device is expected to execute number of radio systems simultaneously":
 - It is expected that the multiradio operation capability may potentially lead to issues for ensuring the satisfaction of test and validation requirements imposed by regulators.

- **Example of an issue as it may typically arise if a device has multiradio operation capability:** As an example, it is assumed that computational resources within a Mobile Device are not sufficient for full simultaneous operation of multiple RATs; in order to address this problem, for example, a GSM transmitter may drop some speech frames in order to reduce the computation requirements that are then used for the simultaneous operation of other RATs. In such a scenario, various issues and questions may come up such as for example: is there currently a regulatory requirement that all speech frames need to be transmitted? This is a new problem not considered by radio standards so far. If such a device behaviour could occur, the corresponding regulatory implications need to be investigated.
- As stated in [i.1], SDR equipment is expected to offer "Compile-time and run-time functions of Radio Computer":
 - Compile functions are assumed to be done by the manufacturer off-line and not by each device. Consequently, no regulatory issues are expected.
 - Linkage/Insertion of new software into a device taking its current configuration into account (i.e. memory addresses for RAT code may depend on code already available on the device). Consequently, no regulatory issues are expected.
 - Depending on the execution environment, there may be potential issues for the specific case of "interpreted code" (similar to JAVA requiring a JAVA runtime environment or any other interpreter). In such a case it is unclear how the platform is reacting to execution errors and hence the compliance to the regulatory framework needs to be ensured.
 - In general, the execution environment ensures that the regulatory framework requirements are met.

Item of potential regulatory relevance: Functional architecture of SDR Equipment

- As stated in [i.1], SDR equipment is expected to introduce a novel Functional Architecture. An abstract architecture is not expected to have regulatory implications.

4.2 Potential regulatory issues in TR 102 683

Item of potential regulatory relevance: In-band CPC

- Following the definitions in [i.4], no regulatory issues are expected for the in-band CPC.

Item of potential regulatory relevance: Out-band CPC

- Following the definitions in [i.4] with respect to the out-band CPC, the regulatory implications depend on the various possible implementation possibilities and frequency bands. Among many examples, two are outlined:
 - Out-band CPC is operated on dedicated new frequency band. In this case it is expected that regulatory measures have to be taken in order to enable the use of the new frequency band.
 - Out-band CPC is operated on an already assigned frequency. In this case it is expected that regulatory measures have to be taken in order to ensure the use of the already assigned frequency band (i.e. frequency band already used by licensed services).
- For information, the following general problem is expected for the operation of an out-band CPC in the special case that the CPC is operated by a third-party provider: The CPC provider should distribute CPC information from various sources in a "fair" way. The operator providing information to the CPC operator should provide "reliable" information. It may be of future regulatory relevance to guarantee these "fairness" requirements and others related to third party CPC operators. Since these aspects are not considered to be handled by Spectrum Regulators, corresponding regulation mechanisms need to be considered by other regulation entities.
- For information, for the out-band CPC in general, regulators are expected to impose limitation on radio TX parameters such as max emission power levels, etc. However, the RAT or protocol to be used is not expected to be imposed by the regulator.

Mesh approach for provision of CPC information

- Following the definitions in [i.4] with respect to the mesh-approach for CPC information provision, no corresponding regulatory issues are expected.

Type of CPC information provision – broadcast or on-demand CPC

- Following the definitions in [i.4] with respect to broadcast or on-demand CPC provision, no corresponding regulatory issues are expected.

4.3 Indications on contents of potential regulatory relevance in TR 102 733

- If an out-of-band CPC is adopted in the system architecture definition, there are regulatory implications for the specification of a dedicated new frequency band. The new frequency band should be harmonized across national boundaries (see clause 5.4 of TR 102 733 [i.6]).
- There are regulatory implications if spectrum sharing is proposed in case of an emergency crisis. The process for acquiring and releasing spectrum bands and the roles for public safety organizations and other stakeholders (e.g. spectrum bands owners like commercial operators) may be defined at regulatory level (see clause 5.4 of TR 102 733 [i.6]).

4.4 Other Items of potential regulatory relevance

As already indicated in clause 4.1, TCAM had identified two different market models for SDR equipment and its SDR Software.

It was also noted, that while SDRs can be considered as a choice of implementation by the manufacturer, features such as the possibility of uploading Software modules or new Software versions may be offered as a service to the user, or not (i.e. kept undisclosed and secured). This may have direct implications.

The conclusion of TCAM was that "software components of Software Definable Radios" are "relevant components" in the sense of Article 2 of the R&TTE Directive (see point 18.16 in TCAM 18 and subsequent discussions).

It was also noted during the discussions that it was key that equipment is used in accordance with its "intended use" as defined by the manufacturer, and that security measures had to be taken in order to avoid unintended Software to be uploaded to SDR equipment.

Decision 18.4 of TCAM 18 considers: "Harmonised standards covering SDR devices, when appropriate, contain elements obliging to protect against illegal programming and hacks for equipment, that are at risk."

ETSI TC-RRS and TC-ERM also had an exchange of Liaison Statements addressing methods of measurements for SDR equipment, and the conclusion is that some usual methods of measurement are based on assumptions concerning the architecture of the radio modules (e.g. front end, Power Amplifiers, etc.), so that methods of measurement may need to be adapted or reconsidered when intended to cover SDR equipment adequately.

At the time of drafting the present report, work on Cognitive Radios is also being carried out in RSPG and ECC (initially in a correspondence group, subsequently in WG FM). This work may have to be analysed at a later stage and the conclusions included in another report of TC-RRS.

5 Conclusions

The present document outlines potential issues related to the ETSI RRS WG1-WG4 study reports [i.1] to [i.6], and to other work carried out in other ETSI Technical Committees (see the exchange of LSs with TC-ERM), and in TCAM. It is recommended to consider these issues for the future work of ETSI RRS.

In the sequel, the key findings of the present document are summarized:

- No regulatory issues are identified for vertical market case in general if an SDR/CR device is developed and verified for operating all possible RATs that may be used by the end-users; if novel standards can possibly be uploaded onto the SDR/CR device after market introduction and the device can thus be configured to operate RATs that have not been planned for during the original development and verification steps, potential regulatory issues need to be addressed; measures have to be deployed, for example in relation to security.