

## Reconfigurable Radio Systems (RRS); System Aspects for Public Safety

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# Contents

Intellectual Property Rights .....	5
Foreword.....	5
Introduction .....	5
1 Scope .....	6
2 References .....	6
2.1 Normative references .....	6
2.2 Informative references.....	6
3 Definitions and abbreviations.....	9
3.1 Definitions .....	9
3.2 Abbreviations .....	10
4 Relevant input from other organizations .....	11
4.1 Organizations .....	12
4.1.1 Association of Public-Safety Communications Officials International (APCO) .....	12
4.1.2 European Commission DG INFSO.....	12
4.1.3 ECC .....	12
4.1.4 ETSI EMTEL.....	13
4.1.5 ETSI TETRA.....	13
4.1.6 Intelligent Transportation System.....	13
4.1.7 NATO .....	14
4.1.8 PSCE Public Safety Communication Europe (NARTUS).....	14
4.1.9 Project MESA.....	14
4.1.10 SAFECOM .....	14
4.1.11 SDR Forum.....	15
4.2 Projects.....	15
4.2.1 Project CHORIST .....	15
4.2.2 E2R .....	16
4.2.3 ESSOR.....	16
4.2.4 EULER .....	16
4.2.5 WIDENS.....	17
4.2.6 WINTSEC.....	17
4.2.7 WISECOM .....	17
5 Current communication systems in Public Safety.....	17
5.1 Analog PMR.....	18
5.2 APCO 25 .....	18
5.3 Commercial cellular networks GSM/GPRS/UMTS/3G.....	18
5.4 TETRA.....	19
5.5 TETRAPOL .....	19
5.6 Satellite Networks .....	19
5.7 WiFi/WiMAX .....	19
5.8 Marine Communications .....	19
5.9 Avionics communication.....	20
5.10 Mapping Table .....	20
6 Overall System Design.....	20
6.1 Introduction .....	20
6.2 Input from other TC RRS working groups .....	22
6.3 Functional architecture and interfaces.....	22
6.4 Spectrum Management.....	26
6.4.1 Current status of Spectrum Policy for Public Safety .....	26
6.4.2 Dynamic Spectrum Management.....	27
6.4.2.1 Introduction.....	27
6.4.2.2 DSM design in Public Safety domain .....	28
6.4.2.3 DSM two-layers approach in Public Safety domain .....	30

6.4.3	Architectures for Dynamic Spectrum Management.....	31
6.4.3.1	Centralized architecture, Out-of-band channel.....	32
6.4.3.2	Centralized architecture, In-band channel.....	34
6.4.3.3	De-centralized architecture .....	35
6.4.3.4	Evaluation of DSM architectures against requirements .....	38
6.4.4	Modelling and simulation of Cognitive Wireless networks in Public Safety .....	38
6.5	Security .....	39
6.6	Interoperability .....	44
6.7	Policy Framework .....	46
7	Terminal Architecture .....	47
7.1	Introduction .....	47
7.2	ETSI TC RRS SDR Architecture for Mobile Devices .....	47
7.3	Software architecture.....	48
7.3.1	Software Communications Architecture (SCA).....	50
7.3.2	The European Software Radio Architecture (ESRA) .....	51
7.4	Conclusions .....	52
8	Investigation on Deployment/Integration/Evolution/Migration from current infrastructures and equipment.....	52
8.1	Cost considerations (lifecycle/terminal price/software portability/deployment).....	52
8.1.1	Introduction.....	52
8.1.2	Terminal price.....	53
8.1.3	Deployment.....	53
8.1.4	SW Portability and related business model.....	53
8.1.5	Lifecycle .....	55
8.2	Impact to organizational structures and procedures.....	55
8.3	Considerations for evaluation and testing.....	56
8.3.1	Certification .....	56
8.3.2	Measurements and testing of wireless interferences.....	56
History	.....	57

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## Foreword

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

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## Introduction

The present document provides a feasibility study of the Systems Aspects for the application of reconfigurable radio systems to the Public Safety domain.

While the Public Safety domain has specific sets of requirements and challenges in comparison to the consumer domain, reconfigurable radio systems can provide improved operational capabilities to public safety organizations.

The purpose of the present document is to provide an overview of the main system design areas to investigate, to present potential design solutions and related trade-offs.

As a feasibility study the present document provides basis for decision making at ETSI Board level on standardization of some or all topics of the systems aspects in Public Safety domain.

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# 1 Scope

The present document gives guidelines for the application of reconfigurable radio technologies in the Public Safety domain and how they can solve or mitigate some of the challenges faced by Public safety communications today:

- Public safety organizations use many separate and often incompatible systems with quite different capabilities.
- New Public Safety applications or the evolution of existing ones require an increase need for broadband connectivity.
- Public Safety organizations usually operate in uncertain and changing operational scenarios.

In this context, the present document establishes the general principles for the application of dynamic spectrum management and cognitive radio in public safety domain. Security aspects will also addressed in the present document.

The document will also present relevant past and current activity in this context from other projects and standardizations bodies.

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# 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:
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  - for informative references.

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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.

## 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.

- |       |   |
|-------|---|
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## 3 Definitions and abbreviations

### 3.1 Definitions

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

**Cognitive Radio (CR):** 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.

**Cognitive Radio System (CRS):** radio system, 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).

NOTE 4: Radio system is typically designed to use certain radio frequency band(s) and it includes agreed schemes for multiple access, modulation, channel and data coding as well as control protocols for all radio layers needed to maintain user data links between adjacent radio devices.

**non-RRS network node:** wireless communication terminal or base station, which does not have cognitive radio capabilities or is not based on software defined radio concepts

NOTE: As an example, non-RRS network node is a conventional wireless communications systems based on TETRA Release 1 [i.22].

**public safety organization:** organization which is responsible for the prevention and protection from events that could endanger the safety of the general public

NOTE: Such events could be natural or man-made. Example of Public Safety organizations are police, fire-fighters and others.

**radio technology:** technology for wireless transmission and/or reception of electromagnetic radiation for information transfer

**RRS network node:** wireless communication terminal or base station, which has cognitive radio capabilities or which is based on software defined radio concepts

## 3.2 Abbreviations

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

AP	Access Point
APCO	Association of Public-Safety Communications Officials International
API	Application Program Interface
BER	Bit Error Rate
CALM	Communications, Air-interface, Long and Medium range
CCM	Cognitive Control Manager
CDMA	Code Division Multiple Access
CEPT	European Conference of Postal and Telecommunications Administrations
CPC	Cognitive Pilot Channel
CQPSK	Compatible differential offset Quadrature Phase Shift Keying

NOTE: QPSK-C to be changed to CQPSK in the document.

CR	Cognitive Radio
CRS	Cognitive Radio System
CS	Circuit Switched
DMO	Direct Mode of Operation
DoS	Denial of Service
DSM	Dynamic Spectrum Management
DSP	Digital Signal Processor
E2R	End-to-End Reconfigurability
EAN	Extended Area Network
ECC	Electronic Communications Committee
EDA	European Defence Agency
ESRA	European Software Radio Architecture
ESRAB	European Security Research Advisory Board
ESRIF	European Security Research and Innovation Forum
EVM	Error Vector Magnitude
FDMA	Frequency Division Multiple Access
FM	Frequency Management
FPGA	Field Programmable Gate Array
GPP	General Purpose Processor
GSM	Global System for Mobile communications
HF	High Frequency
HSD	High Speed Data
HSDPA	High Speed Downlink Packet Access
HSPA	High Speed Packet Access
HSUPA	High Speed Uplink Packet Access
HW	Hard Ware
IAN	Incident Area Network
ICT	Information and Communication Technology
IDIS	Intra-Device Interface Standard
IDL	Interface Definition Language
ITS	Intelligent Transportation System
JAN	Jurisdiction Area Network
LS	Liaison Statement
MF	Medium Frequency
MSP	Multilevel Security Path
MSS	Mobile Satellite Services
MTSS	Mobile Terminal Semi-Stationary
NATO	North Atlantic Treaty Organization
NIAG	NATO Industrial Advisory Group
NNEC	NATO Network Enabled Capability

NOTE: This is a NATO term and it does not appear in ETSI.

OMG	Object Management Group
PAMR	Public Access Mobile Radio

PER Packet Error Rate

NOTE: This term is not in TEDDI but it is common knowledge.

PMR Professional Mobile Radio  
 PPDR Public Protection and Disaster Relief  
 PSCD Public Safety Communication Device  
 QoS Quality of Service  
 RAT Radio Access Technologies  
 RF Radio Frequency  
 RFI Request From Information  
 RRS Reconfigurable Radio Systems  
 RSPG Radio Spectrum Policy Group

NOTE: This term is not in TEDDI but the acronym is already defined in the document.

RTOS Real Time Operating System  
 SCA Software Communications Architecture  
 SCM Self Cognitive Module  
 SCV Spectrum Conformance Validator  
 SDA Software Download Authentication  
 SDD Software Download Distributor  
 SDR Software Defined Radio  
 SDRF Software Defined Radio Forum  
 SoR Statement of Requirements  
 SW Soft Ware  
 SW Soft Ware  
 TDMA Time Division Multiple Access  
 TETRA TERrestrial Trunked Radio  
 TIA Telecommunications Industry Association  
 UAV Unmanned Arial Vehicle  
 UHF Ultra High Frequency  
 UMTS Universal Mobile Telecommunications System  
 VHF Very High Frequency  
 WCDMA Wide band Code Division Multiple Access  
 WF WaveForm

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## 4 Relevant input from other organizations

This clause provides the list of input documents and information sources, which are relevant to the present document. The list includes deliverables and other documentation produced by organizations or projects.

Clauses 4.1 and 4.2 list the more relevant references and the relevant information to the present document.

NOTE: As described in the scope of the present document is to define the System Design aspects for the application of RRS to the Public Safety domain. The scope is not to define a new radio system for Public Safety. This means that some of the listed references will not be a direct input to the present document, even if they may still provide useful information.

EXAMPLE: An input document may describe Public Safety communication standards, which an RRS platform should support through waveforms.

## 4.1 Organizations

### 4.1.1 Association of Public-Safety Communications Officials International (APCO)

"The Association of Public-Safety Communications Officials International (APCO) is a member driven association of communications professionals that provides leadership; influences public safety communications decisions of government and industry; promotes professional development; and, fosters the development and use of technology for the benefit of the public" (from APCO web site, <http://www.apcointl.org/>. Last Accessed 4 September 2008).

APCO has been responsible for the definition of Project 25 suite of standards, which are mostly used by federal, state/province and local public safety agencies in North America to enable them to communicate with other agencies and mutual aid response teams in emergencies. The evolution for Broadband communication was APCO Project 34, the North American predecessor of Project MESA, q.v.

The following inputs are relevant for requirements definition:

- Technical reports produced by P25 User needs committee.

### 4.1.2 European Commission DG INFSO

In EC DG INFSO, the following entities are responsible for Radio Spectrum:

- Radio Spectrum Policy Group:
  - The RSPG set up in 2002 gathers high-level governmental experts from member States and helps the Commission developing general radio spectrum policy at Community level.
- Radio Spectrum Committee:
  - The RSC, created under the Radio Spectrum Decision in accordance with comitology rules, assists the Commission for the adoption of technical implementing measures in support of Community policies.

The following documents are relevant for system and technology aspects:

- PSC-Europe/RD/016. Status of Radio Spectrum Harmonization for the Emergency Services in the European Union.

### 4.1.3 ECC

The Electronic Communications Committee (ECC) is part of the CEPT (European Conference of Postal and Telecommunications Administrations).

ECC is responsible for (from [i.14]):

- 1) considering and developing policies on electronic communications and activities in a European context, taking account of European and international legislation and regulations;
- 2) develop European common positions and proposals, as appropriate, for use in the framework of international and regional bodies;
- 3) forward plan and harmonize within Europe the efficient use of the radio spectrum, satellite orbits and numbering resources, so as to satisfy the requirements of users and industry;
- 4) take decisions on the management of the work of the ECC.

The following documents are relevant for system and technology aspects, especially in relation to spectrum usage by the public safety domain:

- ECC REPORT 102 [i.15].

#### 4.1.4 ETSI EMTEL

The activities of TC EMTEL will follow the broad areas of:

- preparation of ETSI deliverables used to describe requirements for Users, Network Architectures, Network Resilience, Contingency planning, Priority Communications, Priority Access Technologies (e.g. Twisted Pair, Cable/ HFC, Satellite, Radio Frequencies/ fixed and mobile, new solutions) and Network management;
- studies of the issues related to National Security and Public Protection and Disaster Relief (PPDR).

The following documents are relevant for system and technology aspects:

- TR 102 476 [i.26];
- TR 102 445 [i.27]. The scope will also encompass the resiliency of mobile radio and/or other forms of emergency communications to/from the emergency responding units. The effort will address the resiliency of emergency communications, the availability of adequate capacity during periods of network component/facility failure or periods of high capacity demands due to disasters, terrorism or similar events, and expedited restoration during major service interruptions.

#### 4.1.5 ETSI TETRA

TERrestrial Trunked Radio (TETRA) is a digital trunked mobile radio standard developed to meet the needs of traditional Professional Mobile Radio (PMR) user organizations such as:

- Public Safety.
- Transportation.
- Utilities.
- Government.
- Military.
- PAMR.
- Commercial & Industry.
- Oil and Gas.

The following documents are relevant for system and technology aspects:

- Liaison Statement (LS) from ETSI TETRA TC to ETSI RRS TC regarding Digital Dividend Spectrum Cognitive Radio (CR). TETRA31 (08) 22.

#### 4.1.6 Intelligent Transportation System

The Intelligent Transportation System (ITS) refers to the set of information and communication technologies used to improve the transport infrastructure and vehicles to improve safety, efficiency and reduce vehicle wear and fuel consumption.

ITS is related to the public safety domain because many of the proposed ITS systems may involve surveillance of the roadways. ITS can also support the resolution of emergency crisis by improving the effort of mass evacuation or by increasing the operational speed and efficiency of the first responders.

ITS can take advantage of RRS technology to provide mobile equipment, which is re-configurable when moving among relevant regulatory jurisdictions. Furthermore ITS equipment should minimize spectrum interference with other standardized regional radio units and RRS technology could be used to this purpose.

In relation to the telecommunication domain, the CALM (Communications, Air-interface, Long and Medium range) is an important element to consider. CALM has been started by ISO TC 204/Working Group 16 to define a set of wireless communication protocols and air interfaces for a variety of communication scenarios spanning multiple modes of communications and multiple methods of transmissions in Intelligent Transportation System (ITS).