Avoiding Harmful Interference – The Current Paradigm

Yvonne Veenstra and Helmut Leonhard[6]

1 Introduction

Since the early beginnings of radio-communications interference plays an important role in spectrum governance. Already in the Final Acts of the "International Radio Telegraph Convention of Berlin: 1906" we find the following: "The service of operating wireless telegraph stations should be organized, as far as possible, in a manner not to interfere with the service of other stations" [7]. One hundred years later, planning and co-ordination of radio-communications services still is based on the same principle, albeit in a somewhat different wording: "In using frequency bands for radio services, Member States shall bear in mind that radio frequencies and any associated orbits… ..are limited natural resources and that they must be used rationally, efficiently and economically…. …so that countries … …may have equitable access to those orbits and frequencies…" and "All stations, whatever their purpose, must be established and operated in such a manner as not to cause harmful interference to the radio services or communications of other Members or of recognized operating agencies…" (No's 0.3 and 0.4 Preamble Radio Regulations, 2004, ITU)[8].

Based on these principles the international 'radio-community' has developed world-wide frequency allocation charts. Member states translate these allocation charts into their own National Frequency Plans.

Based on the above mentioned principles the international Radio Regulations have been developed. A framework, consisting of rules, recommendations and procedures for the regulation of radio-communications, mostly based on technical and physical assumptions translated into technical standards and license parameters for both transmitters and receivers. What ultimately has led to some sort of device-centric approach, i.e. harmful interference is being avoided by using certified apparatus under well defined license conditions.

New technological opportunities such as Software Defined Radios and Cognitive Radios provide degrees of freedom not foreseen in the current spectrum management paradigm.[9] In this contribution we will review the potential impact of these new technologies on the current regulatory regime and the related arrangements for enforcement of the regime, and identify aspects that need to be addressed and resolved before the introduction of these new technologies can be permitted.

---

[6] Mr. Yvonne Veenstra and Dr. Helmut Leonhard, Agentschap Telecom, PO Box 450, NL-9700 AL Groningen, the Netherlands; correspondence: helmut.leonhard@at-ez.nl.

[7] 1906, ITU, Geneva http://www.itu.int/ITU-R/information/promotion/100-years/documents/1906-Berlin-E.pdf

[8] 2004, ITU, Geneva http://www.itu.int/publ/R-REG-RR-2004/en

[9] For a description and definition of SDR and CR see the contribution by Przemyslaw Pawelczak "Technical challenges of cognitive radio-related systems".

2 Avoiding Interference

With radio communications one must realize that, depending on the frequency used, radio waves can travel quite a distance and, in due course, are able to disturb other communications services. On the other hand, the radio spectrum is a scarce natural resource. So the available frequency space has to be carefully reused.

2.1 Role of the ITU

The ITU, the International Telecommunications Union, provides us with technical standards, recommendations, and procedures to solve the abovementioned problem. Together with sophisticated propagation models these recommendations and procedures are translated into predictions of coverage areas and footprints. With the tacit understanding that the quality of the so planned radio communications service has a certain predefined probability both in time and location at the boundary of the service area. The coverage area then consists of all places where the wanted signal exceeds all the unwanted contributions from interfering stations by a certain predefined protection margin.

Thus, avoiding interference seems to be a question of proper planning and coordination, and using the right equipment. In practice, this is only true for what we would call overall interference, which formally considers all the standards, recommendations, procedures, propagation models, etc. However, the real interference problem, which we would call the local interference problem, is not solved. Local interference depends on local circumstances, such as the use of electrical apparatus, the quality of the equipment, the use of other radio communication equipment in the same area, building shielding, multi-path, and other propagation effects.

Generally, the overall planning from Administrations is rather conservative. By doing so, most of the uncertainties in propagation, morphology, apparatus, etc. are smoothed out and the probability of local interference is minimized. The use of Cognitive Radio and Software Defined Radio obviates the need for this type of conservative planning, moreover, in some cases Cognitive Radio or Software Defined Radio could even solve the local interference problem.

3 Potential regulatory implications with future radio solutions

In the following we will discuss potential regulatory implications with the use of future radio equipment. In this context it is obvious that software defined radio is the greater challenge than cognitive radio; i.e. Software Defined Radio has the ability to change all its vital parameters just by downloading and installing new software or a new software release. With cognitive radio it is more or less choosing the right radio channel for communication rather than changing essential radio operating parameters. Therefore we will discuss the implications of Software Defined Radio in more detail.

3.1 Interference considerations

The ability of an Software Defined Radio to dynamically modify its operating parameters surely can help managing interference; however the potential for causing interference to other authorized radio services cannot be overlooked. Remotely programmable Software Defined Radios must have some “cognitive part” built in, so as to avoid harmful interference to other authorized services. This is a serous problem which is discussed worldwide.

The adequacy of the security requirements for SDR software is a key factor in ensuring equipment operates within its allowable parameters to avoid the emission of harmful interference. Recurring media reports of security flaws in software packages and operating systems highlight a concern that the software based security mechanisms employed in SDR could also be vulnerable. The main security issues related to SDR that have been identified include: who has the authority to control the reconfiguration of the communications equipment; protection of the reconfiguration signaling; privacy of the reconfiguration information; the correctness and availability of the information on which the reconfiguration is based; and secure download of the software required for reconfiguration and issues related to the radio emission and associated conformance requirements of radio equipment.[10]

3.2 Spectrum management

Current spectrum management techniques still provide for designating specific frequency bands for each radio service. Software Defined Radio would have the ability to completely change its behaviour: it could switch between different technologies and/or radio services. At least in Europe, under the future framework for electronic communications, service and technology neutrality are the cornerstones for innovative frequency management and use of the spectrum. The European WAPECS (Wireless Access Policy for Electronic Communications Services)[11] approach provides for proper boundary conditions for future reconfigurable radios at least for a limited set of frequency bands.

It is obvious that Software Defined Radio and Cognitive Radio will boost dynamic spectrum management and will improve spectrum efficiency. A growing number of regulatory agencies around the world believe that there is a need for a new approach to spectrum management, spectrum allocation and spectrum utilization. The new spectrum paradigm is driven, in part, by the increasingly keen competition for spectrum – a problem common to many parts of the world and to all segments of the communications industry: government, commercial wireless, public safety, etc.

The magnitude of the spectrum management task of not only comprehending all of the dynamic or temporal and spatial or geographical sharing requirements, but also anticipating changes to all of these sharing arrangements in order to code them into the devices *ex ante*, makes a strong case for devices to have the ability to have their operating parameters modifiable via software in the field. Equally important is the need to be able to change the policies that dictate the radio's behaviour. [12]

Changing policies is not straightforward. Changing the policies of spectrum management takes us decades. Policy changes become possible when an new worldview or "policy epistemology" frames the terms of debate[13]. Software Defined Radio does not fit in the present legal framework which is mainly based on "putting on

---

[10] Software defined radio in the land mobile, amateur and amateur satellite services, Report M.2117, ITU, Geneva, 2007.

[11] RADIO SPECTRUM POLICY GROUP OPINION ON Wireless Access Policy for Electronic Communications Services (WAPECS), Brussels, 2005, http://rspg.ec.europa.eu/doc/documents/opinions/rspg05_102_op_wapecs.pdf

[12] Report M.2117, ITU, Geneva, 2007

[13] Michael J. Zarkin, Microeconomic Ideas, policy Epistemologies, and the Politics of Spectrum Licensing, 1922 -1997, Polity, 38, No. 2, April 2006

the market", "putting into service", "free movement of goods" and corresponding institutional arrangements as "certification", "labeling", "licensing", "monitoring", and "market surveillance". The development of Software Defined Radio brings us at the principles of the legal framework.

Discussions on changes in the spectrum management framework are still going on in all regions. The remaining major issue is how to fit Software Defined Radio into the conservative legal framework.

3.3 Situation in Europe

In Europe, placing on the market and putting into service of radio apparatus is covered by the Radio and Telecommunications Terminal Directive (R&TTE)[14]. As to this directive, Member States shall ensure that apparatus is placed on the market only if it complies with the appropriate essential requirements identified in the same directive and the other relevant provisions of this Directive, when it is properly installed and maintained and used for its intended purpose.

The following essential requirements are applicable to all apparatus [covered by the R&TTE Directive]:

(1) the protection of the health and the safety of the user and any other person, including the objectives with respect to safety requirements contained in Directive 73/23/EEC [i.e. the Low Voltage Directive], but with no voltage limit applying;

(2) the protection requirements with respect to electromagnetic compatibility contained in Directive 89/336/EEC [the EMC Directive].

(3) in addition, radio equipment shall be so constructed that it effectively uses the spectrum allocated to terrestrial/space radio communication and orbital resources so as to avoid harmful interference.

Compliance with the relevant essential requirements is the corner stone for placing on the market and putting into service. The Directive provides for different procedures for the manufacturers to declare the conformity of apparatus. These procedures imply the involvement of a *notified body* during conformity assessment. Furthermore the Directive instructs the manufacturer how to make up the so called *declaration of conformity* and to affix the proper markings [i.e. the *CE mark*]. Once radio apparatus has been placed onto the [European] market, the provisions of the directive are valid for the whole European territory.

The implications for Software Defined Radio are obvious. The equipment manufacturer provides for a so called "declaration of conformity". Once the apparatus is on the market and is in use the end user is responsible for the apparatus. Changing essential equipment parameters has, or can have, an unpredictable influence on the validity of the declaration of conformity. Not only by the end user, but, with the world of viruses, spam, hacking etc. in mind even by less reliable third parties.

[14] 1999, Brussels L91/10, Official Journal EC, 7.4.1999, http://ec.europa.eu/enterprise/rtte/dir99-5.htm

4 Conclusions

From the above it can be concluded that the whole family of Cognitive Radios as technically sound concept still represents a challenge for the regulator. There are two main concerns:

- the declaration of conformity as some species of *ex ante* regulation must stay valid despite any eventually *ex post* changing of the operating parameters of the equipment,
- different approaches within different Member States due to different [local] situations might lead to problems with free circulation of Cognitive Radio.

Properly designed and programmed Cognitive Radio should overcome these difficulties and should meet the essential requirements under all circumstances. On the other hand Software Defined Radio has shown us the edge of our regulatory framework. Worldwide discussions on this theme are still ongoing. Software Defined Radio can be the facilitator to develop new institutional arrangements in spectrum governance. But, as said before, policy changes only become feasible when a new world view frames the terms of debate. The present financial crisis possibly will give raise to an new world view, even in spectrum governance.

References

ITU. (1906). Geneva. Retrieved from: http://www.itu.int/ITU-R/information/promotion/100-years/documents/1906-Berlin-E.pdf

ITU. (2004). Geneva. Retrieved from: http://www.itu.int/publ/R-REG-RR-2004/en

EC. (1999). Brussels L91/10, Official Journal EC, 7.4. Retrieved from: http://ec.europa.eu/enterprise/rtte/dir99-5.htm

