EVOLUTION OF REGULATION IN END-TO-END RECONFIGURABILITY CONTEXT

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ABSTRACT

This paper presents the E²R [1] regulatory research and first outcomes and recommendations. Reconfigurability implies reconfigurable equipment (terminals, base stations, access points, gateways…) and support system functions. End-to-end reconfigurability will need a very flexible regulatory approach to develop its full potential. Some changes in the regulatory framework for telecommunication may be required. This has been recognized by major regulatory bodies (e.g. TCAM, FCC) that have started to identify possibilities, threats and required regulatory changes. E^2R aims to significantly contribute to this process. This will be done, by first of all addressing the current regulatory framework (material conformance, security, spectrum…) and the associated limitations and boundaries, and evaluating the impact of the E^2R reconfigurability scenarios on security, privacy, placing on the market, EMC, frequency sharing rules and finally responsibilities.

1. INTRODUCTION

The End-to-End Reconfigurability (E²R) research aims at bringing the full benefits of the valuable diversity within the radio eco-space, composed of a wide range of systems such as cellular, wireless local area and broadcast. The key objective of E^2R is to devise, develop and trial architectural design of reconfigurable devices and supporting system functions to offer an expanded set of operational choices to the different actors of the value chain in the context of heterogeneous mobile radio systems. Innovative research, development and proof of concept are sought over six years in an end-to-end aspect, stretching from user device all the way up to Internet protocol, and services, and in reconfigurability support, intrinsic functionalities such as management and control, download support, spectrum management, regulatory framework and business models.

In the past, the regulatory schemes were, albeit sometimes tedious, rather straight forwards, there were no major difficulties with the assignment of "who is responsible for what" and who is liable if unsolicited alterations to the equipment occur.

Following the 'old' regulatory regimes, user equipment was manufactured implementing all layers according to the given regulatory standards, and the coherence with these standards was verified through an independent type approval process in accredited test houses. In this case, the equipment configurations could not, or only during long lasting and tedious procedures, be changed after completion of the type approval. The proof of functionality and the responsibility that each tested product would comply with the given regulation was with the test house.

Yet, with introduction of the R&TTE directive [2], the situation drastically changed (i.e. similar with the still ongoing discussion on ruling of classes for permissive changes, conducted by the FCC). On the one hand, the scope of regulation has been drastically reduced to the sole objective of avoiding "harmful interference", i.e. practically reduced to the sole physical layer, and on the other, manufacturers are now permitted to not only produce but to self-certify the standard compliance of their equipment, and when required they can introduce patches and upgrades in a significantly short time. However, with the simplification of the process also the liability for any possible failure was shifted to the manufacturer. Yet still, it has to be noted that the regulatory approach for equipment (re)configuration is rather different within the world radio regions [3].

The increasing likelihood for widespread availability of SDR equipment and the facilitation of end-to-end reconfigurability will require a further step of changes to the regulatory environment. The flexibility such systems will provide will open the market for third party software vendors to provide not only application and service software but also system software to implement different waveforms and different radio standards. And it also opens the possibility for most actors involved (e.g. operator, manufacturer, user) to change the Software element in the HW/SW combination even *after* the equipment has been

shipped to the market and to install or upgrade the configurations during equipment operation. The question of how this can be governed, who will be responsible and how will regulators be able to take into account such flexibility are yet to be answered, and are currently under investigation in the E^2R project.

This paper outlines the current regulatory arrangements applicable in most parts of Europe, describing some of the tasks major institutions (including CEPT, ETSI and ITU) are tackling and the work items they follow in their discussions about reconfigurability. Further, the main areas where regulatory changes need to accommodate the use and circulation of reconfigurable equipment as well as the implementation of flexible spectrum management schemes are raised. And finally, the E^2R approach to build a regulatory framework for reconfigurable communication systems will be described.

2. REGULATORY GROUPS AND BODIES

The example of the rulings for the IMT-2000 standards family, which originally was intended to become one global standard, is sufficiently expressive to illustrate the difficulties in forming global standards for radio access schemes or even for radio equipment. Narrowing this down and looking at the regulation regimes within one of the radio areas only provides a sufficiently complex scenario in its current form. However, when considering Software Definable or Reconfigurable Radios, the whole process becomes rather tedious; within Europe, each of the countries has their own regulatory regime and their own national ruling, this is coordinated (n.b. particularly to avoid problems in border areas) by a super-national organization to coordinate spectrum usage throughout Europe (CEPT).

In terms of regulation, there are two main issues that affect SDR technology, the first being the use and circulation of terminals (mobile user equipment[1]) whose radio emissions may be altered by software and the second the implication reconfigurability may have on the spectrum side, in terms of spectrum savings through more flexible and efficient usage. The various regulators and regulatory bodies need to be made aware about these implications and have already started to tackle many of the associated challenges.

2.1 CEPT

CEPT [4], the "European Conference of Postal and Telecommunications Administrations", was established in 1959. Until the telecom liberalisation CEPT's activities incorporated co-operation on commercial, operational, regulatory and technical standardisation issues.

Standardisation was taken out in 1988 to create the European Telecommunications Standards Institute (ETSI), which then took over all the telecommunication standardisation efforts and activities.

A little later, with the European policy to separate postal and telecommunications operations from the policy-making and regulatory bodies, CEPT was transformed into a body comprising only policy-makers and regulators.

Today CEPT increased its total number of members to 45 administrations, covering (almost) the whole geographical area of Europe, as well as Turkey and the Asian part of Russia.

In Copenhagen, the two permanent offices, ERO (European Radiocommunicatiosn Office) and ETO (European Telecommunications Office) , are now merged. Under the CEPT umbrella, and besides the Postal Committee (CERP, Comité Européen des Régulateurs Postaux), the ECC (Electronic Communications Committee) covers all regulatory aspects of electronic communications, but de facto deals mostly with frequency matters.

Yet, although CEPT and ECC play an important co-ordination role, they are not based on a treaty and ECC decisions are not automatically binding for governments. This is why the individual member countries still have their own regulatory authorities (eg. ANFR or ART in France, RegTP in Germany, Ofcom in UK, …). These national regulatory authorities have the right to assign spectrum to users as they require. Nevertheless, ECC elaborates "ECC Decisions" which are first simply "proposed" to administrations, which then have the choice to commit themselves to implement them. When they do so, administrations are bound. ECC also produces reports or recommendations. For instance, to limit the possibility for interference in border areas, CEPT recommendations are widely accepted.

The role and purpose of CEPT were redefined at a plenary assembly on 5-6 September 1995 in Weimar, the aim of this restructuring process was that CEPT could offer its members the chance to:

- Establish a European forum for discussions on sovereign and regulatory issues in the field of post and telecommunications issues;
- Provide mutual assistance among members with regard to the settlement of sovereign/regulatory issues;

[1] *On the network side, radio equipment remains at a fixed location, and under the tight control of the network operator. Therefore, there are no serious regulatory issues to solve.*

- Exert influence on the goals and priorities in the field of European Post and Telecommunications through common positions;
- Shape the relevant areas in the field of European posts and telecommunications;
- Carry out all activities at a pan- European level;
- Strengthen and foster intensive co-operation with Eastern and Central European countries;
- Promote and facilitate relations between European regulators (e.g. through personal contacts);
- Influence, through common positions, developments within ITU and UPU in accordance with European goals;
- Respond to new circumstances in a non-bureaucratic and cost-effective way and carrying out its activities within an allocated time frame;
- Settle common problems at committee level, through close collaboration between its committees.

The European Union now plays an increasing role in association with ECC which acts as its technical adviser. A piece of EU legislation, the Spectrum Decision 2002/672, establishes a Radio Spectrum Committee (RSC) for adopting binding application measures, usually on spectrum use harmonisation, elaborated in cooperation with ECC.

At strategic level, the Radio Spectrum Policy Group (RSPG), composed of Member States and the European Parliament, advises the Commission.

2.2 ETSI

A spin-off of CEPT in 1988 (see Section 2.1), the European Telecommunications Standards Institute (ETSI) is an independent, non-profit organization, whose mission is to produce telecommunications standards for today and for the future. In particular, ETSI developed the GSM standards which had been started within CEPT..

ETSI is based in Sophia-Antipolis in the south of France, and brings together more than 680 members from 55 countries, the membership comprises of manufacturers, network operators and service providers, administrations, research bodies and users. The Standards institute provides a forum to which all small or major players can contribute and can help shaping standardization. With the advent of the third generation systems, most of the mobile standardisation efforts were brought into the 3GPP (3G Partnership Project, associating ETSI to Japanese, US, Chinese, and Korean standards bodies) which now collates all standards related to 3G in the corresponding countries.

ETSI is the only telecommunications standardisation organisation recognized by the EU (directive 98/34). It is therefore bound to support EU policies and receives standardization mandates from the EU, including for standards with a regulatory purpose, and some of which are funded.

The processes within ETSI are structured so that the members determine the institute's work program, they allocate resources and approve the deliverables. ETSI's activities are, because of this influence from its members, closely aligned with market needs and there is usually industry wide acceptance of its standards products (i.e. the standards are built on consensus rather than market share).

2.3 ITU

At global level, the ITU (International Telecommunication Union) is one of the specialized UN agencies, and among other things is both the international authority on spectrum allocation matters, and the telecommunication global standardisation body. The ITU operates by developing answers to specific technical questions and by formulating recommendations to its Member States. As detailed in [3], the ITU, (originally formed in 1865), is now based on cooperation between governments and the private sector. The ITU's membership brings together telecommunication policy-makers and regulators, network operators, equipment manufacturers, hardware and software developers, regional standards-making organizations and financial institutions. The ITU is composed of the Sectors: Radiocommunication (ITU-R), Telecommunication Standardization (ITU-T), and Telecommunication Development (ITU-D).

The activities of these sectors cover all aspects of telecommunication, from setting standards that facilitate seamless inter-working of equipment and systems, to defining operational procedures for wireless services and outlining plans to improve the telecommunication infrastructure. Each of the three Sectors works by holding conferences and meetings, where the members discuss about agreements, which then provide the basis for the operation of global telecommunication services:

- ITU-R draws the technical characteristics of terrestrial and space-based wireless services and systems, and develops operational procedures. The sector also undertakes important technical studies which serve as basis for the regulatory decisions made at radiocommunication conferences (WRC). Those decisions constitute the so-called Radio Regulations (RR) which have binding Treaty value.
- ITU-T experts prepare non binding technical specifications for telecommunication systems, networks and services, including network operation,

performance and maintenance. The work within this area also covers the pricing principles and accounting methods used to provide international service,

- ITU-D focuses on the preparation of recommendations, opinions, guidelines, handbooks, manuals and reports, which provide decision-makers in developing countries with "best business practices" relating to a host of issues ranging from development strategies and policies to network management.

The ITU hosts 24 Study Groups (24 SG: 8 in ITU-R, 14 in ITU-T, 2 in ITU-D), that are made up of experts from leading telecommunication organizations worldwide. These experts carry out the technical work and prepare the detailed studies that lead to authoritative ITU Recommendations. The 8 ITU-R Study Groups comprise of currently 10 Task Groups and 32 Working Parties.

ITU addresses already some of the specific questions related to Software Defined Radio (Question ITU-R 230/8) [6]. These questions consider that SDRs may facilitate spectrum efficiency in complex mobile radio configurations and that recommendations on SDR design would be complementary to other ITU-R Recommendations on mobile telecommunications. Among the questions that are to be answered on SDR are (Question 2) “What frequency band considerations are important to the application of SDR?”, (Question 3) “What special interference considerations may be required in SDR applications?” and (Question 6) “What technical considerations are necessary to insure conformance with ITU Recommendations and Radio Regulations?”. The ITU is seeking input to the discussions and aims to provide conclusive responses.

3. REGULATORY ISSUES FOR RECONFIGURABILITY

Among many other organizations (foremost the FCC), the TCAM-Group on SDR (TGS) initiated a questionnaire on the “Impact of SDR on the R&TTE Directive”. The aim of this consultation was to collect comments from interested parties on the various issues related to software defined radio ("SDR") and assess the possible need for amending the Directive.

TCAM already acknowledged that SDR technology can offer a number of advantages for users, manufacturers and regulators compared to currently available radio equipment:

- To the user, the technology can offer the possibility to have a wider range of features, the ability to adapt to multiple communication standards, whereas it can overcome limitations in frequency allocations within the EU (as well as globally).
- To manufacturers, the use of SDR technology, could offer increased economies of scale in production as well as increased global marketing opportunities (i.e. one terminal platform, reducing manufacturing costs and shifting the maintenance from HW to SW updates).
- Looking at the impact SDR technology could have for regulators, the technology would provide the possibility for more flexible spectrum management since spectrum assignment would not be constrained by technical limitations of the hardware used.

The main focus of this original RTTE questionnaire was to identify the regulatory implications of the developments in the SDR area, and to evaluate whether and how these developments may impact following areas:

1. Regulation regarding the right to place on the market, (bearing in mind the use and free movement of radio equipment).
2. Regulatory market surveillance of radio equipment.
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3. What are the standardisation related issues.

However, reconfigurability can also impact heavily on other regulatory areas, such as:

- legal interceptions
- protection of personal data or privacy
- IPRs
- spectrum trading
- regulatory spectrum management
- competition issues
- network security and integrity.

4. THE E^{2}R APPROACH TO DEFINE A NEW REGULATORY FRAMEWORK

The E^{2}R project aims to collate and further the approaches and the discussion outcomes of the different organizations world wide. Although this paper so far outlines mainly the approaches followed in Europe, the E^{2}R consortium aims to collect and analyse the trends of the global community. The approach followed consists of the development, distribution and analysis of a regulatory questionnaire and based on the outcomes of this on the definition of a regulatory framework that will cover both of the main areas related to SDR and reconfigurable technologies.

The purpose of the E^{2}R questionnaire on regulatory issues is to gather the points of view on how end-to-end

reconfigurability and its associated concepts will influence and impact regulation and to identify possible regulatory changes necessary and feasible to facilitate implementation of the various technical concepts proposed.

The scope of these concepts ranges from the basic SDR related problems (e.g. equipment certification), reconfiguration responsibility via spectrum management, through to spectrum trading and sharing concepts.

Aim of the questionnaire is to support an understanding of the regulatory obstructions reconfigurable technology will face and where either technical or political solutions will be required.

The questionnaire covers a number of areas and issues, the areas include spectrum management, terminal reconfigurability, network reconfigurability, and the question of responsibility. Following the responsibility chain concept [7], a number of issues are of particular interest for rule makers, and the relevant questions will be asked in the questionnaire:

- SDR technology will allow new actors to enter the market, also, the role of some of the incumbent actors will change even during operation of a reconfigurable terminal, the question of which actor takes the responsibility for third party software and who vouches that such software can be used to implement a radio protocol on the platform built by a specific manufacturer.
- Reconfiguration Software may be provided by the equipment manufacturer or operator, respectively, and the configurations would be used in a different administrative domain.
- The matter about whether or not to permit (reconfigured) terminals to access/use an operator's Radio Access Technology (RAT).
- Finally, the question about who can (and will) take the responsibility if a terminal is being reconfigured.

The latter two questions deal with the need to prevent the misuse of spectrum (e.g. in the Cognitive Radio approach, when a user does not releases the spectrum) as well as the spectrum control.

To tackle these problems, a clear understanding of the relationships between the actors in end-to-end reconfigurable environment needs to be established. The concept of the responsibility chain provides an overview of the different responsibilities and aims to show their relationships and also delivers a possibility for regulators to clearly define where and how now rulings may grasp and be applied.

This responsibility chain will be related to the value chain of mobile telecoms, with the aim to outline possible approaches for the assignment of responsibilities and penalties in reconfigurable radio systems. The responsibility chain defines a model where the accountability for reconfigurations can be assigned to the different actors within end-to-end reconfigurable systems. Connected to the concept of value chain in the definition of the business models for end-to-end reconfigurable systems, the responsibility chain will identify the dynamic interactions between actors encompassing information data, control data and money flow.

5. CONCLUDING REMARKS

Regulation of radio equipment is already a non-trivial task without having reconfigurable or software defined terminals, the complexity of the regulatory process however increases significantly with the introduction of reconfigurable terminals (and other equipments such as base stations, access points, gateways....). A common approach to develop a harmonized way to regulate SDR and reconfigurable technology has to be found and defined. This paper aimed to outline the difficulties and to draft a sketch on how E^2R aims to support this effort.

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