Input to ITU WP8F Report/Recommendation on Advanced Technology

Working Document SDRF-04-A-0001-V0.00

22 January 2004

Delet
\WP8I
TECH

Attachment 7.6

Source: Document 8F/TEMP/35

Working Document towards preliminary draft new [Report/Recommendation]: Software Defined Radio [IMT.SDR]

Editors note: Do we include qualifying text about IMT-2000.

1 Introduction

Radio functionality previously confined to fixed hardware implementations continues to migrate to software on special purpose hardware (DSP) and software running on general-purpose processors. This technological evolution to Software Defined Radios [will/can/may] have a profound effect on spectrum efficiency, utilization, and allocation in general, and IMT-2000 and systems beyond IMT-2000 in particular.

Software defined radios will not obviate the need for harmonized or 'quasi-harmonized' spectrum, nor reduce the need for sound spectrum policy but they may ease the frequency allocation process.

In the regulatory domain, impacts of SDR technology can be group into two major areas:

1. the impacts to spectrum management techniques; and
2. the impacts to equipment authorization and conformity

With regard to the latter, the impacts to certification arise from the fact that historical certification regimes have been developed based on an ex ante determination that the operating parameters of the device are in accordance with local regulations. Such regimes have no mechanisms to deal with a fundamental capability attributed to SDRs- that such devices can change their operating parameters ex post of its certification or declaration of conformity.

Global regulatory action may be required to permit software modifications and electronic labeling, for example, as explicated in FCC Report and Order 0124B.

A consistent global regulatory environment would facilitate:

1. Global circulation of handsets, and
2. The reduction in the number of handset variations that manufacturers must currently produce in order to meet diverse regulatory strictures in different regions.

Form

2 Scope

This [Recommendation/report] addresses primarily software-defined radio's application and implication to IMT-2000 systems and Systems Beyond IMT-2000.

This [Recommendation/Report] includes high level technical and market aspects of SDR such as state of technology and recent market deployments.

[It also includes guidance with respect to the unique aspects of SDR such as, conformity [issues (including circulation), spectrum management, and security.]

More study is needed to determine if conformity issues should be a subject for this document and the correct form of and subsequent suggestions

3 Definitions

Software Defined Radio:

> A radio in which the operating parameters including frequency range, modulation type or maximum output power (either radiated or conducted) can be altered by making a change in software without making any changes to hardware components that affect the radio frequency emissions. Software defined radio is merely a new technological implementation of classical radio functions; historically new functions occur in a gradual, evolutionary manner.

Delet
implen
multip
NOTE
that SI

Reconfigurable radio

Reconfigurable radios are radios whose hardware and software can be changed under software control. Reconfiguration control of such radios involves all elements of the commercial mobile wireless network.

Cognitive radio

A radio that can sense its environment and dynamically and intelligently alters its operating parameters as a function of its operating environment.

Policy-based radio

A radio that is governed by a predetermined set of policies.

4 Discussion

In a narrow perspective, software defined radio is simply an implementation technique in which signal processing hardware is replaced by programmable digital signal processors or field programmable gate arrays. In the broader perspective, Software defined radio is a collection of hardware and software technologies that enable reconfigurable system architectures for wireless networks and user terminals. It is an enabling technology that is applicable across a wide range of

Delet
\WP8I
TECH

areas within the wireless industry. Software defined radios are elements of a wireless network whose operational modes and parameters can be changed or augmented, post-manufacturing, via software.

And so increasing advantages of software defined radio application to commercial wireless communications systems such as IMT-2000 and Systems Beyond IMT-2000 can be achieved by gradually including all elements of the network. This is described in ITU-R Report [XXXXXX], Technology Trends, Chapter 3.2.1 and Annex 6.

Contributions are solicited to expand on this point.

As this capability refers to the download, update and configuration of radio applications, which enables operators, manufacturers, and users to modify the radio's behavior according to their needs, it is envisaged that IMT-2000 SDR enabled devices will always be policy-based and only permit operation within an authorized sphere of activity.

Telefonica text

Base station reconfiguration

Benefits for operators

Base station reconfiguration includes both the complete change of functionality, for instance the move from one IMT-2000 radio access technology to another, as well as the partial modification or update of a certain radio access technology, such as the introduction of an optional capability or a new version.

For operators this capability may enable more flexibility and scalability in network deployment and operation, and, although IMT-2000 equipment incorporating SDR technology may be more costly initially than non-reconfigurable equipment, it seems reasonable to expect that in the long term infrastructure investments will become cost effective. Examples of this can be the reuse of network equipment for a new radio technology, the physical separation between the RF transmitter/receiver and the processing units, which can be centralised in a single location, therefore reducing the amount of equipment needed and enabling dynamic allocation of resources, or the infrastructure sharing between operators. One desirable characteristic of reconfigurable network equipment, that could further increase the cost savings associated to SDR technology, is the existence of standardized interfaces that will allow the development of software by third parties.

Operator concerns and possible solutions

In this scenario the main concern for operators is to be sure that the installation of new software will not cause malfunctioning that could affect other network equipment or users, reducing the QoS or even discontinuing system operation. In order to avoid such problems, reconfiguration should be carried out by and under complete control of the operator, which reduces the previously mentioned risks for several reasons. The possibility of performing tests before the definitive installation, the confidence and privileged relationship between operator and software provider, and the technical knowledge of the personnel in charge of the reconfiguration.

Terminal reconfiguration

Benefits for operators

As this capability refers to the download, update and configuration of radio applications in the terminal, which enables operators, manufacturers, and users to modify the radio behaviour of the terminal according to their needs, it is envisaged that IMT-2000 SDR enabled devices will always be policy-based and only permit operation within an authorized sphere of activity.

Terminal reconfiguration favours world-wide roaming and interoperability, because, ideally, one single terminal could be reconfigured to employ any radio access technology. Likewise, it enables the separation of services offered to the user, and the technology used to provide them. And it also makes bug corrections easier and more economical, as the costs of recalling defective terminals are eliminated, and the revenue losses during the time that the terminal is not operative are reduced.

Benefits may apply to many different groups (users, manufacturers, etc.)

2.2.2 Operator concerns and possible solutions

Evolution and interoperability

The evolution of IMT-2000 to Systems beyond IMT-2000 can be facilitated by the introduction of SDR technology into base stations and terminals. Cellular system infrastructures, for instance, could consist of co-existing mixes of protocols where the balance could be changed as the mass of component units changes from one protocol to another over time. This capability can reduce the need for expensive, time consuming, and difficult transition activities during generational changes.

Software defined radios also have the potential to enhance interoperability between diverse systems by allowing radios to modify their operating characteristics by changing software. In this manner, a radio can adapt to the environment in which it has to operate and that can create new operational concepts.

The main concern to operators presented by this capability is how to guarantee the secure and reliable operation of the terminal during and after the reconfiguration process. It is necessary to guarantee that after the installation of a new radio application the terminal will not interfere with other equipment (network equipment or other terminals) and that it will not prevent the user from connecting to the network. Besides, it is necessary to avoid the installation of malicious applications that could have access to sensible information stored in the terminal, use services without informing the user or alter the terminal behaviour rendering it unusable. These problems are more important if we consider a scenario in which any application, irrespective of its origin, can be installed in the terminal (as is the case with a PC).

One solution that could mitigate these problems is to restrict the possible sources of software to be installed in the terminal. Acceptable sources could be, for instance, the terminal manufacturer, the network operator or the service provider, and the terminal could verify the identity of the source by means of digital signatures. Then, it has to be defined who (manufacturer, operator, service provider and/or regulator) is responsible for signing each application, and how many signatures are needed, as it may be advisable to use more than one signature for critical applications. Another solution could be the execution of a virtual reconfiguration, prior to the real one, either in the terminal or the network that allows observing how the terminal will behave after the reconfiguration, and abort it if this behaviour is not adequate.

It also has to be defined which system elements and agents are responsible for each of the steps in the reconfiguration process, such as initiation, monitoring, data transfer, installation or validation. In any case it is necessary that the planning of the downloads be carried out by the operator in order to avoid congestion problems and make an efficient use of network resources.

In the case of bug corrections, it seems reasonable to assume that, normally, they will be performed transparently to the user, as they do not affect his/her interaction with the terminal and available applications. This facilitates the use of specific security mechanisms that do not require the participation of the user, consequently reducing the risks of an inappropriate reconfiguration.

Standards

Delet
\WP8
TECH

SDR technology does not replace the need for standards. It is expected that in the near future most instantiations of SDRs will continue to have classic radio functions, and the devices will continue to operate in the specific bands and using the specific protocols for which they are designed and intended. That means responsibility for certification and compliance will continue to accrue to the original manufacturer or, if software changes are made, to the person or organization that makes the changes.

SDR has long been viewed as enabling innovative spectrum management techniques such as opportunistic sharing. In this regard the key characteristic of such radios are their ability to change their operating parameters based on their operation environment, and governed by a predetermined policy. A generally accepted term for such radios is "Cognitive".

Delet
-

Two definitions are needed because the above-mentioned key characteristics (the ability to change operating parameters via software, post mnufacture, and ability to change their operating parameters based on their operation environment) New text may not necessarily be mutually present in every device, and because conditions will apply to one and not the other. In the case of cognitive radios, they may, or may not be software defined. For instance radios employing DFS in wireless access systems for the purpose of protecting the radio determination service in the 5 GHz band in compliance with Rec. ITU-R M.1652, could be permanently fixed in their operation, and have no ability to alter their certified operating performance in the field.

Likewise an SDR may have no cognitive abilities at all, and rely purely on external reconfiguration commands and data.

There are strong incentives, however, for the combination of both capabilities. The ability to reconfigure is especially crucial in sharing scenarios because the evolving technological needs and capabilities of multiple services now have to be comprehended. And so it will be useful for the environment-sensing mechanisms of Cognitive radios to also be programmable in order to comprehend the introduction of new and additional wireless interfaces.

Definitions of Software Defined Radio and Related Technologies

Software defined radio:

The following regulatory definition should be used for software defined radio:

> *Software Defined Radio.* A radio that includes a transmitter in which the operating parameters of frequency range, modulation type or maximum output power (either radiated or conducted) can be altered by making a change in software without making any changes to hardware components that affect the radio frequency emissions.

Reconfigurable radio

Reconfigurable radios are radios whose hardware and software can be changed under software control. Reconfiguration control of such radios involves all elements of the commercial mobile wireless network.

Cognitive radio

[Contributions are invited.]

3 Related Recommendations

ITU-R F.1399	Vocabulary of terms for wireless access
ITU-R M.687	International Mobile Telecommunications-2000 (IMT-2000)

ITU-R M.1652	Dynamic frequency selection[1] in wireless access systems including radio local area networks for the purpose of protecting the radiodetermination service in the 5 GHz band
ITU-R M.1645	Framework and overall objectives of the future development of IMT-2000 and systems beyond IMT-2000
ITU-R M.1450	Characteristics of broadband radio local area networks
ITU-R M.1457	Detailed specification of the radio interfaces of International Mobile Telecommunications-2000 (IMT-2000)

4 Considerings

The ITU-R,

considering

a) that considerable research and development has been done on Software Defined Radio (SDR) design;

b) that SDRs may offer design and operational versatility and flexibility in mobile radio systems;

c) that SDRs may facilitate spectrum efficiencies in complex mobile radio configurations;

d) that SDRs offer intersystem interoperability in disaster and emergency situations;

e) that SDRs may facilitate the regional and global harmonization of wireless communications;

f) that SDRs may provide for improve manufacturing economies of scale;

g) that SDR design can provide users with more operational features;

h) that Recommendations on SDR design would be complementary to other ITU-R Recommendations on mobile telecommunications;

i) the information on software defined radio provided in Annex X;

j) the need for global coordination of software defined radio technology to facilitate global circulation of terminals; and

k) that software defined radio is a technology that could increase the amount of spectrum access-able for systems beyond IMT-2000 especially for frequencies below those identified for IMT-2000,

noting

a) Software defined radios will not obviate the need for harmonized or 'quasi-harmonized' spectrum, nor reduce the need for sound spectrum policy but they may ease the frequency allocation process;

b) the software defined radio has network implications as noted in Annex X;

c) that because of the increasing number of frequency bands and modes in commercial wireless systems, software implementation is becoming increasingly important thereby increasing the complexity of the wireless devices;

[1] Dynamic frequency selection (DFS) is a general term used in this Recommendation to describe mitigation techniques that allow, amongst others, detection and avoidance of co-channel interference with respect to radar systems.

Delet
\WP8I
TECH

a) that software download to SDR-capable devices is of increasing importance to manufacturers and operators for software “bug fixes”;

b) that software download to SDR-capable devices is also of increasing importance to manufacturers and operators for implementation of new capabilities and services into both base stations and terminals;

c) that heterogeneous roaming requires interconnecting with an increasing and evolving set of frequency bands and air interfaces;

d) that sharing mechanisms will be needed for accessing frequencies below those identified for IMT-2000 which are extensively used by terrestrial services with applications other than IMT-2000 and systems beyond IMT-2000;

d) that SDR-capable devices are starting to reach the commercial wireless marketplace;

e) that regulatory agencies are considering innovative spectrum management techniques using SDR capable radios;

f) that regulatory agencies throughout the world are beginning to address conformity issues related to software defined radio;

e) that regulatory agencies are expecting that technical solutions are now or soon will be available to address security issues related to software download to SDR-capable devices and that these technical solutions will be implemented in appropriate standards;

f) that current assessments indicate SDRs can generally be accommodated within existing regulatory frameworks

g) that detailed technical specifications for software download to wireless devices are being developed by other standards fora and that the ITU has cooperative agreements with many of these fora and is seeking to enhance these synergistic working relationships,

and further noting

a) that software defined radio is a technology that could help facilitate effective, efficient use of the spectrum; and

b) the difficulty in finding globally aligned spectrum for commercial wireless systems;

c) SDR technologies will progressively assist with the implementation and availability of IMT-2000 services;

d) that the ITU-R has identified the following spectrum related issues as part of the development of Recommendation [M. xxx], Vision Framework and Overall Objectives of the Future Development of IMT-2000 and Systems Beyond IMT-2000:

(1) What technology developments in the radio access network might reduce the need for additional spectrum for systems beyond IMT-2000?

(2) What technology advances might reduce the need for globally aligned spectrum, while still allowing global roaming?

(3) How should spectrum efficiency be defined and evaluated for systems beyond IMT-2000?

(4) To what extent can techniques for "sharing" or "pooling" of spectrum between operators or for sharing with other radio services affect the amount of spectrum needed?

e) that the software defined radio is a technology enabler that can be applied to addressing the issues in (d) above.

5 Recommends

Editor's note: It is anticipated that substantial substantive Recommendations will be developed during the drafting of this document. Specifically, recommendations are expected regarding:

- *Recommends on SDR related to deployment including;*
  - *evolution and interoperability;*
  - *implementation aspects;*
  - *standards.*
- *Recommends on SDR related to spectrum including;*
  - *effective and efficient spectrum use;*
  - *frequency allocation in the context of global harmonization;*
- *Recommends on SDR related to conformity including:*
  - *provide safeguards against unauthorized modifications to SDRs;*
  - *assist circulation of SDR technology enabled devices*

(for example – that the need for additional regulation of SDR –enabled radios be confined to the unique aspects found in such devices US Text

b) Spectrum

– *[It is expected that specific recommendations with regard to spectrum will be developed]*

c) Conformity

– that administrations adopt regulations authorizing the use of software defined radios and cognitive radios by:

- enabling such radios to be reconfigured in the field by modifying existing conformity regulations to allow for the re-certification or declaration of conformity of such terminals post deployment;
- providing experimental licenses to trial innovative technologies and systems;

– that, such terminals should fulfill the requirement of not causing harmful interference in any country where they circulate:

- by taking steps to prevent unauthorized software changes;
- by taking steps to provide for possible means of trace-ability of current operating parameters.

d) Standardization

– that, in order to establish the technical basis for global circulation of SDR enabled IMT-2000 terminals, globally common standards and methods should be sought for;

- providing a trusted environment to maintain the integrity of the terminals operation;
- securely reconfiguring the operating parameters of the terminal including manual and Over-The-Air methods;

– that, existing, globally accepted, security technology be used wherever possible to accelerate development and maximize global circulation;

– that, a globally common method/language should be sought to assure administrations that SDR terminals conform to local policies;

Delet
addres
circula
<#>R
potent
Softwa
Manag
<#>R
techno
spectr
<#>R
techno
Interop
manag
<#>R
Spectr
Contri
these
implic

Delet
\WP8
TECH

– that, the level and type of standardization should be adapted to meet technical and user requirements at that time; and
– that in order for standardization to be performed in a timely manner such standardization should take into account existing efforts underway by other standards fora.

US Text

Annex [A]2

Technical Characteristics

[It is expected that the content for this section will be developed, in addition to new contributions, through a reconciliation with the SDR material in Technology Trends document.

It is expected to contain inter alia, current development, future technology roadmaps, and standards activities

It is further expected that technological aspects of security, such as encryption technologies, will be included.]

Annex [B]3

Market Aspects

[It is expected that this content will include contributions on specific applications such as downloading upgrades and patches to the operating parameters, as well upgrades for new air interfaces resulting from continuous on-going standards work.]

The economic impact of software radios will occur in three areas:

(a) Bug fixes-- defined by the Software Defined Radio Forum as: The process of delivering reconfiguration data and/or new executable code to a SDR device to modify its operation or performance [SDRF2, pg3]. In this way, software errors, or 'bugs,' can be corrected with new software downloads, and electronic labeling, as specified, in FCC Report and Order 0123B is necessary to make this effective. One study has indicated that for 2001 alone, the cost for software fixes for cellular handsets significantly exceeded $100 million (USD), and this could be mitigated by the use of over-the-air software downloads.

(b) Upgrades -- rather than make large equipment changes to implement new features, modulation techniques, or protocols, software downloads can be used to implement generational changes in equipment thereby reducing capital expenses.

(c) Reduced handset inventory -- manufacturers can take advantage of having a core system that can adapt to local conditions rather than have a specific radio design and implementation in all regions. This will permit a reduction in the number of radio types needed, and the number of spare parts required in inventory.

Annex [C]4

Spectrum Implications

As noted and considered above, the technological evolution to Software Defined Radios will have a profound effect on spectrum efficiency, utilization, and allocation in general, and IMT-2000 and Systems Beyond in particular.

Historical allocation regimes have been developed based on ex ante determination of available spectrum, and fixed assignment of services to that allocation. The result has been rigidity and legacy problems whereby some services are in want of spectrum in general, or are in need of bands with different propagation characteristics than presently available.

Software Defined Radios, with their ability to modify their spectrum usage parameters, are a key element in rectifying this situation with a minimum of dislocation to existing services.

Telefonica text

2.3 Better radio resource management

The possibility of modifying the operation of base stations and terminals allows network operators to make a more efficient use of their network resources. For instance, in a situation with more than one radio access technology, network resources could be assigned dynamically to each technology according to the number of users in each network and their needs, in order to avoid congestion.

Another solution to avoid network congestion would be to ask users' terminals to switch to a less congested radio access technology. In this case it must be guaranteed that the operation and QoS of the services currently in use are not affected by the reconfiguration, which, given these conditions, could be performed transparently to the user.

It also must be considered that SDR technology will allow base stations and terminals to operate in a larger frequency range, and to modify its operating frequency (or frequencies) within this range as well as the multiple access technology, the power transmission or the modulation scheme. This may enable a modification in the current scenario and allow operators to achieve higher spectral efficiency.

US text

Access to Spectrum

"In many bands, spectrum access is a more significant problem than physical scarcity of spectrum, in large part due to legacy command-and-control regulation that limits the ability of potential spectrum users to obtain such access."[2]

Many frequencies lie unused for large portions of the day, or in some cases forever. The problem is that historical regimes and technologies only permitted bands to be assigned on a near permanent basis, and there where no allocation methods or technologies that allowed for the economic sharing of spectrum between users.

Specifically with regard to IMT-2000 this situation has been highlighted in Resolution 228 (Rev.WRC-03)- Studies on frequency-related matters for the future development of IMT-2000 and systems beyond IMT-2000 as defined by ITU-R, which considering at *l)* "that many countries have

[2] FCC SPTF report at 3

Delet
\WP8
TECH

not yet made available spectrum already identified in the Radio Regulations for IMT-2000, due to various reasons, including the use of this spectrum by existing services," resolved at 5 that such studies "should include sharing and compatibility studies with services already having allocations in potential spectrum for the future development of IMT-2000 and systems beyond IMT-2000 taking into account the needs of other services;"[3]

Spectrum / service impedance matching

As noted above another problem is the lack of access to bands most suited to a particular service. Again with specific regard to IMT-2000 Resolution 228 recognized at e) "the need, in many developing countries and countries with large areas of low-population density, for the cost-effective implementation of IMT-2000, the future development of IMT-2000 and systems beyond IMT-2000, and that the propagation characteristics of frequency bands below those identified in No. **5.317A** result in larger cells;" and further at j) "that frequencies below those identified for IMT-2000 in No. **5.317A** are extensively used by terrestrial services with applications other than IMT-2000 and systems beyond IMT-2000,"[4] resolved "to invite ITU-R to conduct regulatory and technical studies on the usage of frequencies below those identified for IMT-2000 in No. **5.317A** for the future development of IMT-2000 and systems beyond IMT-2000, notably assessing their advantages and disadvantages"

It is obvious that SDR will play a dominant role in both the studies, and eventual realization of the sharing mechanisms envisioned.

Spectrum Overlays

One such mechanism is that of "Overlays" where usage rights under new allocations are "overlaid" on top of the incumbent users. Access to the spectrum by new users, in such a scenario, is predicated on:

a) the absence, at a given moment, of incumbent use; and

b) the new users ability to detect such absences.

Such opportunistic schemes require regulators rather than identifying, ex anti, spectrum vacancies into which a particular service may be deployed; to define the *method* a smart device may use to identify the vacancies, and the policy constraints the smart device must comply with to use the identified spectrum.

The operating parameters such as frequency, modulation and power, of the device are not rigidly defined by regulation, but rather are define as a function of its operating environment. In other words rather than Power = x; the parameters can be expressed as If Frequency = *f,* AND Detection Threshold = *th,* then Power = *x*

An example of allocation using such technology is Resolution [COM5/16] (WRC-03) that permitted the allocation of radio local area networks in the 5.470–5.725 band by employing just such a mechanism to protect radiodetermination systems in Recommendation ITU-R M.1652.

Rulemaking proceedings are underway in Europe and the US to implement this resolution.

Although such radios, eventually employing DFS for the purpose of protecting the radiodetermination service in the 5 GHz band in compliance with Rec. ITU-R M.1652, can be fixed and have no ability to alter their operating performance in the field, the need to share spectrum among an increasing set of services and bands, and the dynamism of innovation of air interfaces in those bands, necessitates the need for programmability in those sharing mechanisms.

---

[3] Resolution 228, resolves 5

[4] Ibid resolves 3

Annex [D]5

Conformity Aspects

[It is expected that this content for this section will include activities that administration have taken including modifying existing conformity regulations to authorize the use of software defined radios and cognitive radios. Such as inter alia:

- *enabling such radios to be reconfigured in the field by establishing rules to allow for the re-certification or declaration of conformity of such terminals post deployment;*
- *providing experimental licenses to trial innovative technologies and systems;*
- *establishing policies and regulations to prevent harmful interference by taking steps to prevent unauthorized software changes; and by*
- *establishing a means of trace-ability of current operating parameters.*

It is further expected that policy aspects of security, such as metrics for security levels, authentication, and non-repudiation will be included.]

SDR Forum text

Regulatory Models for Software Defined Radios

[Editor's note: This is a placeholder – additional contributions are invited.]

1 Existing Regulatory Models

Existing regulatory models address the following regulatory concerns:

- Electromagnetic compatibility (EMC).
- User safety.
- Radio spectrum use.

The typical regulatory model used by many administrations is based on a radio platform whose radiation characteristics (power, spectral mask, and frequency) can be changed only through hardware changes which require physical modifications made on each individual piece of equipment.

2 Regulatory Impact of SDR Technology

A basic premise of SDR and reconfigurable radio technology is that the radio device can be changed through software changes and hardware reconfiguration changes which can be made under software control. These changes can conceptually be made through an over-the-air software download mechanism. Thus, the current typical regulatory environment which does not allow for any modifications to the radio equipment after it is certified is not consistent with the capabilities of SDR and reconfigurable radio which could allow changes of all types of software in the wireless device at any time.

For reconfigurable radio technology to be deployed and to reach its promise, a global regulatory framework has to include high-level considerations which include provisions for:

Delet
\WP8
TECH

- Conformance to type approval for defined software/hardware combination for SDR-capable devices.
- Protection against unintentional or malicious radiation of signals having power, frequency and modulation combinations that are not legally sanctioned.
- Identification and characterization of parameters that can be modified by downloaded software in SDR equipment.

Appropriate type approval and configuration management for SDR equipmentSDR technology will not provide a substitute for regulatory policy, but it will provide flexibility that will make coherent policy easier to extend globally. Harmonized or 'quasi-harmonized' or regionally harmonized bands can be accommodated by having flexible radio hardware and software. This will foster global circulation of radios, and at the same time will ease the allocation process.

That is, because the radios can be adapted to local conditions, it will be possible to have slightly different frequency band allocations for similar services in different regions-- and the radios should be able to adapt to that change. Thus, the operation of the radio can be defined by the service and the region of operation rather than by frequency band, and the operation will appear to be harmonized.

Security/malfunction protection will be necessary to assure that malicious or dangerous software having the potential to alter radio characteristics cannot be introduced into in an unauthorized fashion into systems or system-elements, such as base stations or terminals. This may includes the need for provisions to monitor hardware/software compatibility, encryption, authentication, and non-repudiation of the downloads themselves.

3 Regulatory Models Compatible with Software Defined Radio Concepts

In addition to the existing regulatory concerns (EMC, user safety, and radio spectrum use), there are anticipated regulatory concerns as the result of SDR and reconfigurable radio systems including:

- Large number of hardware/software combinations
- Security issues particularly those issues related to over-the-air software download
- Trusted sources for software download
- Shared spectrum use
- Protection of data and executable code
- Digital rights management

Administrations may wish to consider new regulatory models to meet these concerns while at the same time taking advantage of SDR and reconfigurable radio technology. Some possible new models are provided in the following subsections.

Regulatory models need to comprehend different markets structures such as "Vertical" (where hardware and software come from one entity), and "Horizontal" (where hardware and software may come from different sources).

3.1 Regulatory Agency Certification of Each Hardware/Software Combination

Current regulatory policies of some administrations require the certification of each hardware/software combination. This approach may become difficult for regulators, manufacturers, and operators/service providers to manage.

3.2 Self-Certification by Manufacturer

[Editor's note: Some administrations permit self-certification. Input contributions are invited.]

3.3 Automated Conformance Evaluation

[Editor's note: there are a number of papers that address these concepts. Input contributions are invited.]

Telefonica text

2.2.3 Global circulation of terminals

Finally, it should be noted that SDR technology allows co-existence of multiple standards facilitating world-wide roaming, which is one of the key features of IMT-2000 systems and systems beyond IMT-2000 that require the global circulation of terminals.

However, it must be considered that SDR technology may have some impact on the global circulation of terminals as it poses the question of how regulate the global circulation of terminals that may work in several different ways. To make it possible there must be common regulatory principles that define which requirements a visiting terminal has to comply with. Also, it will be needed to define reconfiguration mechanisms that allow a terminal arriving at a new network to identify and install the software of an authorised source to operate in it.

Therefore, in order to address the new scenarios introduced by SDR it may be necessary to review the technical basis for global circulation of IMT-2000 and systems beyond IMT-2000 that affect WP 8F.

Delet
\WP8F
TECH

Annex Z

References

[1] ITU-R Report [xxxxxx], Technology Trends

[2] Software Defined Radio Forum, "Overview and Definition of Software Download for RF Reconfiguration (DL-DFN)", SDRF Doc. 2002-A-0002, 6 August 2002, publicly available at: http://www.sdrforum.org/appr_docs.html

[3] Software Defined Radio Forum, "Requirements for Radio Software Download for RF Reconfiguration (DL-REQ)", SDRF Doc. 2002-A-0007, 13 November 2002, publicly available at: http://www.sdrforum.org/appr_docs.html

[4] Software Radio Architecture: Objected Oriented Approaches to Wireless Systems Engineering, J. Mitola, J. Wiley & Sons, Chichester, UK, 2000

[5] Software Defined Radio: Architectures, Systems and Functions, Ed. by M. Dillinger, K. Madani, N. Alonistioti, J. Wiley & Sons, Chichester, UK, 2003

[6] United States of America, Federal Communications Commission, First Report and Order "Authorization and Use of Software Defined Radios" ET Docket No. 00-47, FCC 01-264, Adopted 13 September 2001, http://ww.fcc.gov (search for 01-2640); pp. 11-13 and Appendix A, para. 2.925

[7] A Regulatory View on Security Requirements for Reconfigurable Radio, J. Faroughi-Esfahani, R. Falk, N. Drew, and P. Bender, 2002 Software Defined Radio Technical Conference, 11-12 November 2002, San Diego, paper SW3-03, available from the SDR Forum (www.sdrforum.org)

[8] [SDRF1] Requirements for Radio Software Download for RF Reconfiguration (DL-REQ) SDRF-02-A-0007-V0.0, SDR Forum, 6 August 2002.

[9] [SDRF2] Overview and Definition of Software Download for RF Reconfiguration (DL-DFN) Document SDRF-02-A-0002-V0.00, SDR Forum, 13 November 2002