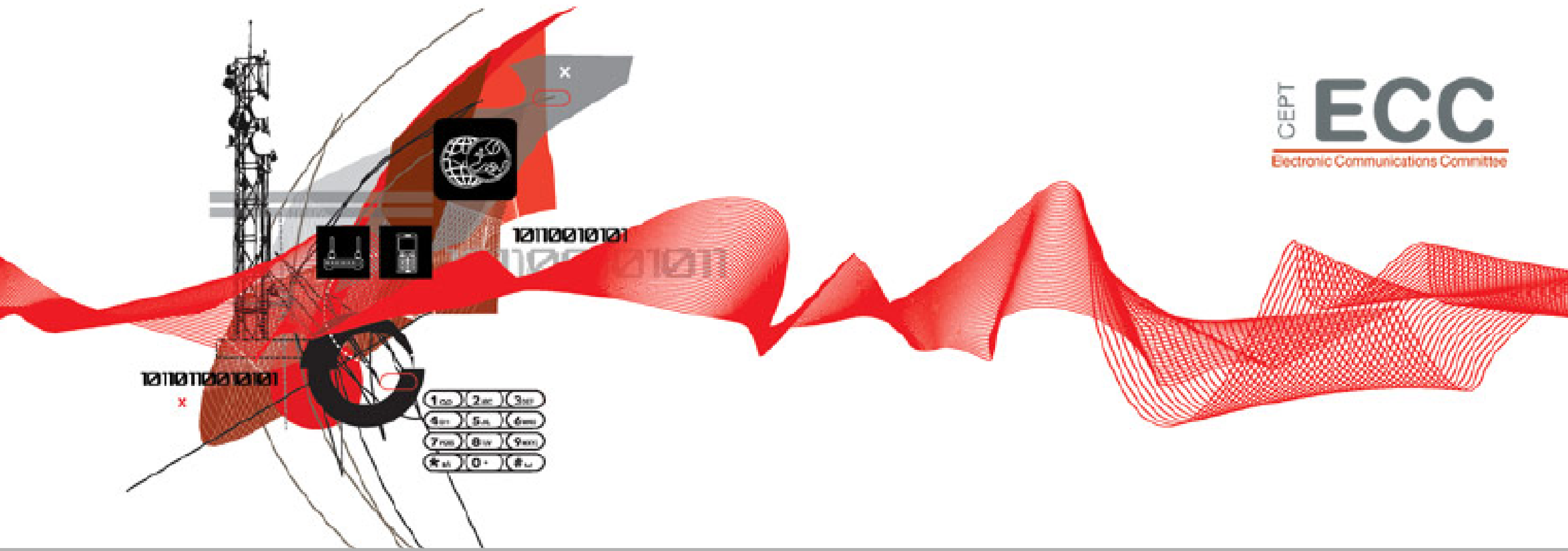


ECC NEWSLETTER **June 2011**

Cognitive Radio in the ECC

Where we are now and where we are going

Promise in the air

Cognitive Radio is one of the most talked-about developments in spectrum use for many years. Its early life has been mainly theoretical, bringing predictions that computer code and related advances will revolutionise the approach to spectrum management, bypassing the regulator and enabling the efficient use of large amounts of spectrum that existing users waste. Waste through inefficiencies of design, or the limitations of conventional technology, or the determination of incumbent users to protect what they regard as an exclusive right to their existing spectrum allocation.

But that analysis is a mix of much truth and some misunderstanding. We know how technology advances, and we should expect it to offer us more than just the improvements in physical efficiency of radio transceivers.

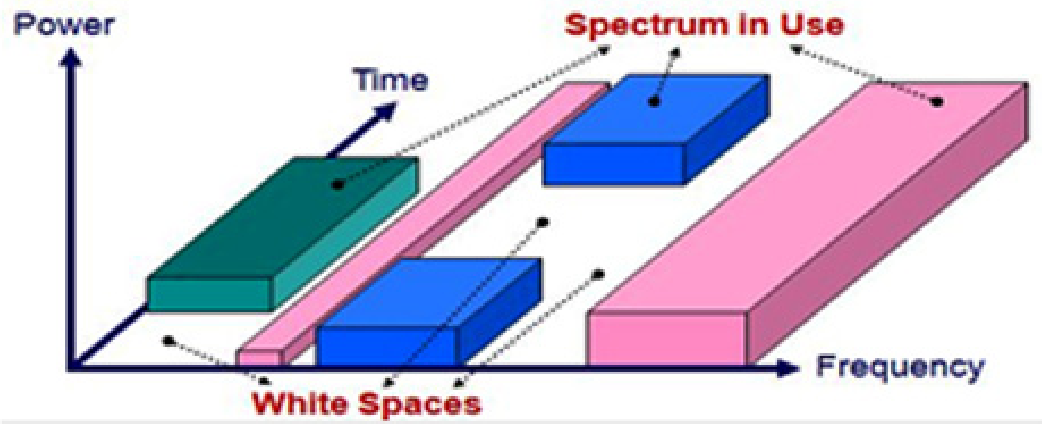
Most serious considerations of what Cognitive Radio could offer focus on it overlaying its use on an existing, more conventional environment. Cognitive is therefore seen as a 'secondary' use, coexisting with itself and with the primary service. This means it has to protect the primary service from interference, and cannot expect any regulated protection from it; so it has to arrange its own protection.

The ECC has been actively working since early 2009 to get past the rhetoric and establish some common understanding as a step towards practical regulatory initiatives.

White spaces: an early opportunity?

As in the USA and elsewhere, the ECC's early attention has focused on the use of 'white space devices' (WSD) in the UHF television bands (effectively now 470-790MHz). These frequencies have very useful propagation characteristics, and TV transmitters have large coverage areas and therefore even larger unused areas between them where signals are getting gradually weak enough for the frequency to be reused for more TV reception.

There may also be secondary uses such as Programme Making and Special Events (PMSE) which are there at some times but not others. Figure 1 attempts to illustrate the concept.



This creates opportunities: the lower power applications (PMSE) which use these frequencies already, such as theatre microphones and wireless TV cameras, are usually based on managed databases which identify where the white space opportunities are. This principle of 'geolocation' - with better and more detailed databases, is at the heart of ideas for use of white space spectrum by cognitive devices - cognitive as part of a wider system of management.

The more autonomous element of 'cognitive' behaviour in radio transceivers is 'sensing', i.e. being able to detect what other signals are present and to respond accordingly to reduce the chance of interference. This principle is already used in techniques such as 'listen before talk' (LBT), and the Dynamic Frequency Selection (DFS) used in 5 GHz Radio Local Area Networks (RLANs) to ensure coexistence with radars. This is even used with consumer equipment: one after-market in-car DAB digital radio receiver finds an unused FM radio frequency to use in order to feed its audio into the car's existing FM radio.

"Report 159" - set to become another well-known number?

The ECC set up a Project Team, PT SE43, to look at the compatibility issues between the relevant services using 'white spaces' in the UHF TV bands. After 19 months' work, SE43 delivered ECC Report 159 in January 2011. Its conclusions about the technical and operational requirements of WSDs are not so different from those of the FCC in the US (the FCC has already approved operators of databases for cognitive WSD devices). The report identified a picture of steady development which could open new opportunities, but that the technological breakthroughs needed for a more revolutionary paradigm shift remain for the longer term.

PT SE43 has considered the cognitive techniques of geo-location databases, autonomous sensing and the use of beacons to inform the devices. Most of SE43's efforts considered the appropriateness of geo-location databases and/or autonomous sensing to provide protection to the incumbent services. SE43:

- made the preliminary conclusion that autonomous sensing is very challenging at the current stage of technological development - probably too difficult - to be used in order adequately to protect to the existing services;
- provided guidance on the algorithms to be used in future geolocation database(s).
- drew up a list of areas requiring further studies, including to address scenarios enabled by future technology developments, when these become better

Other ECC activities

The ECC's Regulatory Affairs group, WG RA, has now started work to produce a report complementary to the ECC Report 159. This will focus on different regulatory models for the management of Cognitive Radio databases, in particular:

- certification or accreditation framework for database provider(s);
- a suitable authorisation regime (can be different depending on National administrations) under which the Cognitive Radio device should operate (i.e. general or individual authorisation).

This comes at a time when some industry players are advocating a more formally licensed environment of cognitive devices in order to achieve a quality of performance which would enable them to offer further mobile broadband capacity. The concept is called 'Authorised Shared Access'.

The ECC's Frequency Management group, WG FM, in February 2011 tasked a Correspondence Group to develop a regulatory framework for using cognitive technology for Programme Making and Special Events, based on Chapter 11 of ECC Report 159 .

More to come

The ECC's work is part of a set of developments which represent a large effort to achieve some practical realisations of Cognitive Radio. The IETF (the Internet Engineering Task Force) recently issued a Memo stating that Cognitive Radio and TV white space technology is now in the process of being approved by regulatory bodies around the world. The interface between the white space devices and databases is over the Internet and uses IP connectivity.

You can keep up with the ECC's work on cognitive radio on a special page on our www.cept.org/ecc. Follow the links under 'topics' on the front page. This is a central point to get an overview, and there are also short summaries and links on activity within ETSI, within the EU Research Framework Programme.

Many have questioned the business models which would lead to commercial development of white space devices. And the ECC's work has clearly identified that some aspects of Cognitive Radio can be made reality well before others. But there is little doubt that Cognitive Radio can play a large role, increasing over time, to improve overall spectrum efficiency, and that could have far-reaching economic and social benefits.

Mark Thomas, Director of the ECO, and Stella Lyubchenko
ECO Expert in Spectrum Engineering

The role of Spectrum Engineering: an essential element to using spectrum efficiently

Googling "Spectrum Engineering" gives you 42,500,000 hits in 0.18 seconds. Adding "use spectrum efficiently" to the search returns 54,300,000 hits. This exercise is not strictly scientific, but it clearly indicates how relevant the role of spectrum engineering is in a world where it is commonly accepted that the radio spectrum is a limited resource and so must be used optimally.

If you want to apply 'good' spectrum engineering practice you will eventually be deriving the optimum separation (either in space or frequency) between a 'victim' system and the interfering radio systems. This should allow both the victim and the interfering system to work by minimising operational restrictions but also preventing interference that degrades radio applications' performances. The challenge of using the spectrum efficiently is not as trivial as it sounds. It encompasses on one hand the increasing penetration of the existing radio applications or the introduction of new radio applications and on the other hand the protection of existing services from interference. This balance has to consider regulatory, technical and economic aspects at national and international level.

The more harmonised the frequency bands are between the 48 member states of the CEPT region, the more efficient the spectrum becomes for the benefit of the European market. For these countries to optimise the usage of the spectrum nationally or across borders, they need to have regulations based on clear technical guidelines[1]. The electronic committee of the CEPT, the ECC, has long understood the importance of spectrum engineering. The Spectrum Engineering Working Group (WGSE) is responsible for investigating spectrum engineering matters.

It is composed of radio spectrum engineers from the CEPT administrations and also from the European industry that sit at the same table and share their experiences and expertise. Their work is consensus driven and creates the solutions for harmonising the radio spectrum through the CEPT countries based on open and transparent technical studies.

These range from dealing with mobile systems operating below 3 GHz (though IMT is considered by a separate group), space services, short range devices, fixed services, to new applications like cognitive radio. Needless to say that spectrum efficiency cannot be achieved without open communication and cooperation with the relevant European standard bodies like ETSI. WG SE's work also includes the creation of many of the ECC's 'CEPT Reports', prepared under mandate from the European Commission, and used in spectrum regulation which is binding on the 27 EU member states.

Nowadays, a lot of the electronic devices you manipulate use radio transceivers. To give just a few examples, think of your car keys, baby alarms, toll system as you drive along the bridges, tunnels and many of the motorways connecting Europe together or even down to the “wireless” door bell at 9.99 Euros at the nearest 'Do It Yourself' store. All of these applications or systems have, at one point or another, been under the scrutiny of radio experts like in PT SE24 for short range devices (SRDs) to study their feasible applicability for public usage. In what is called 'unlicensed' spectrum[2] (where most of the SRDs operate) technical rules[3] (i.e. power level, spectrum access, mitigation requirement, channel spacing) are set to prevent or mitigate the interference so that the spectrum is used as efficiently as possible. Otherwise you end up with a spectrum that is simply un-usable.

Another example of WGSE's work, perhaps less obvious to the public, is the guidance produced by PT SE7 to improve the coexistence between GSM-Railway network[4] and the well known public GSM cellular network. The work identified some of the measures which may be necessary to solve interference cases that may occur on a local/national basis. This approach allows national competences to apply additional spectrum engineering techniques for local site coordination when appropriate. It is a real example where the ECC sets strategic guidance but where the national regulators are eventually responsible for licensing and enforcement, and operators have responsibility to implement.

Spectrum efficiency can nowadays only be achieved when the engineering assumptions are prepared with state of the art spectrum software tools. You have many ways of analysing compatibility or coexistence criteria. One methodology called Monte Carlo[5] is widely used for the simulation of random processes based on statistical variables. For spectrum studies, a radio device is described by a series of variables (i.e. antenna height, power etc.) and when statistics are generated with sufficient confidence, the performance of 'real' life devices under specific interference mechanisms can be predicted. WGSE chooses the pragmatic approach to freely distribute the software called SEAMCAT[6] (maintained by the ECO). This results in a European tool used world-wide (i.e. within but also outside the CEPT region) that allows you to perform independent compatibility studies where the cost development of such a spectrum tool is shared between European partners.

Finally, spectrum regulations are not carved in tablets of stone. There is a constant need for technical studies to assess how new technologies or enhanced existing technologies can use the spectrum, and so benefit the European citizen. In order to maintain continuous European spectrum harmonisation in these days of economic recession, the European industry and administrations need to ensure a continued supply of competent and imaginative spectrum engineers to respond to the challenge of making efficient use of the radio spectrum in the long term.

Jean-Philippe Kermoal,
ECO Expert in Spectrum Engineering

[1]These technical guidelines can be ECC Recommendations, ECC or CEPT Reports.

[2]In an “unlicensed” spectrum band, the users of the band can not claim protection from interference, therefore generic regulation and “self-discipline” is required.

[3]See ERC/REC 70-03.

[4]GSM-R is used by the railway network operators for maintaining their railway infrastructure e.g. control command and signalling (see ECC Report 162).

[5]The term “Monte Carlo” methodology was coined in the 1940s by physicists working on nuclear weapon projects in the Los Alamos National Laboratory (USA). This approach was used for solving statistical problems; the code name given to the work was Monte Carlo.

[6]Spectrum Engineering Advanced Monte Carlo Analysis Tool (http://www.cept.org/eco/ecc-tools-and-services/seamcat)

Spectrum for life

Medical implants - a reality for millions

Mention the term 'electronic implant', and some may recall the frightening episode of cult 90s science-fiction series “The X-Files”, where Agent Scully is abducted by aliens and only realises some time later, after her return to (what was portrayed as) the real world, that she had acquired an implanted electronic chip in her neck. Thankfully, our reality is that similar earthly devices, 'active medical implants', do immense good.

About 7 million Europeans are subject to some form of heart failure, with about 600,000 new cases diagnosed each year. About one half of these can benefit from having implantable cardiac devices fitted. These devices uniquely deliver round-the-clock therapy that is needed to preserve and enhance the quality of life for those affected.

Less dramatic, but even more serious for some people, is diabetes. The International Diabetic Foundation estimates that about 32 million Europeans have the condition. These people (and especially the 1.6 million with Type 1 diabetes) could greatly benefit from glucose monitoring and insulin delivery systems which can be implanted into the body and which mimic the human pancreas by essentially delivering insulin 'on demand'.

These are just two examples. There are estimated to be more than 10 million European patients with some form of active medical implant in their body that makes use of these wireless medical applications.

What are they?

The devices implanted to the body typically do something active such as assisting the heart or partly replacing the pancreas function in the above examples. They also need to monitor what is going on (diagnostic data). So they are supported by external devices ('peripherals') which support their operation by providing a means for altering the programming of the implanted device, or retrieving medically related diagnostic data from the implant, or transferring data to a mass storage system for review by the doctor. These are Medical Implant Communication Devices: 'MICS systems'.

To take the example of the heart patients, MICS technology in the 401 MHz to 406 MHz band is utilised in cardiac devices such as pacemakers that control the rhythm of heart contractions, defibrillators that recognise an abnormally high heart rate and deliver a high-energy pulse to restore a more natural rhythm, and combination devices that can do both. The 401 MHz to 406 MHz band is used for initial programming of the Ultra-Low-Power-Active-Medical-Implants (ULP-AMI), transferring diagnostic information from the ULP-AMI, and monitoring in the patient's home.

Applications of medical implants

In addition to the Cardiac Rhythm applications, there are other applications which can use the same technology. Some are already in place and some are under development, exploiting new sensor technology. Examples are given below, with an indication of the type of data traffic they generate.

1. Neurological stimulator implants to control otherwise uncontrollable reflex muscular reactions from diseases such as Parkinson's and other brain disorders. This can also play a role in treating incontinence and pain. Deep Brain Stimulation (DBS) is an example of this type of implant, with devices having periods of relatively high duty cycle operation.

2. Data collection systems. Portable devices for recording diagnostic data sent from an implant. Heart patients such as those who have experienced recent periods of arrhythmia could wear these devices.

3. Body-worn sensor(s) communicating to an implanted device for the treatment of neurological disorders. These systems may require continuous or near continuous telemetry operation.

4. Medical systems to diagnose and treat a wide variety of medical conditions (diabetes, gastrointestinal disorders, neurological conditions) that utilise implanted sensors and peripheral devices. This includes cameras that can be swallowed to take pictures of the inside of the intestines. These systems will have a range of operating scenarios with widely varying duty cycles.

Another application for ULP-AMI is membrane medical implants for registering blood pressure data. These operate in the frequency range from 30 MHz to 37.5 MHz, again to link the implanted device with the monitor.

What are we doing?

As with most uses of spectrum, frequency harmonisation is an important pre-requisite for wireless medical applications, primarily for interoperability. The frequencies for wireless medical implant communication systems in the CEPT area are identified in ERC Recommendation 70-03 Annex 12, and so are regularly reviewed by the Short Range Devices Maintenance Group (SRD-MG) of the ECC's Frequency Management Working Group (WG FM).

Currently, the SRD-MG is working on two subjects in the medical wireless application field:

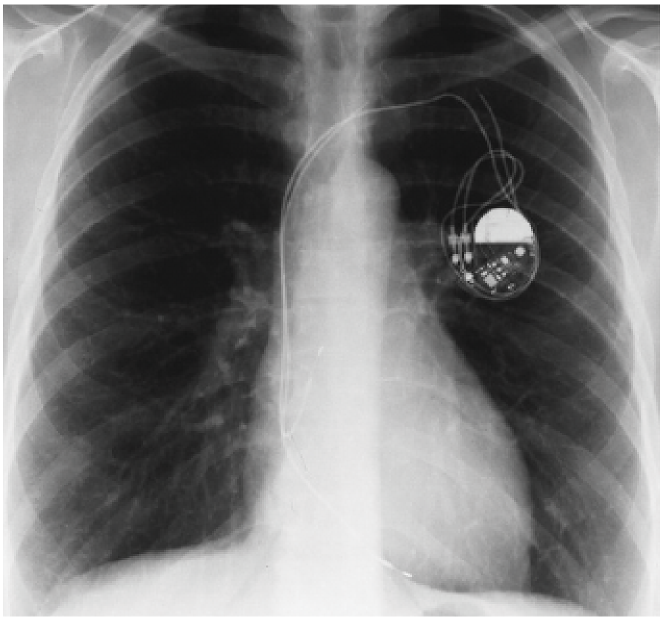
- to draft and propose to WGFM a revision of ECC Decision ECC/DEC/(01)17 with the aim to put ULP-AMI operating in the band 401-406 MHz directly under the mobile service. This is in line with the worldwide situation for medical implant communication devices in other ITU-R regions. This will only affect potential future proposals for other SRD applications for operation in this frequency band. It will not affect the existing radio services and applications in the band.

- a proposal to designate the whole or part of the band 2360-2400 MHz to MBANS (Medical Body Area Network Systems) to be used in hospitals, at home, or by ambulances. A regulation in the USA from the Federal Communications Commission (FCC) is also under development with a new proposed regulation for the same frequency range. MBANS consist of sensors on and around the body that communicate medical data wirelessly for applications such as professional wireless patient monitoring.

These life-saving devices play a pivotal role in improving the lives of millions of Europeans and emphasise the importance of providing space for future technological advancements in a complex spectrum environment.

Thomas Weber,
ECO Expert in Frequency Management

X-ray picture of an implanted heart pacemaker



Intestinal camera - taken as a 'pill'!

ECC helps to bring more flexibility in the use of radio spectrum

To increase spectrum efficiency and maximise the benefits of its use to society, spectrum management in Europe is changing significantly from the traditional command-and-control approach to introduce market-based mechanisms. Also, technology and service neutrality are in the focus of the new regulation. This is a response to several forces, especially the rapid nature of technological development, and the understanding that regulators are not always the best people to pick winners in a commercial marketplace. The new regulatory models being implemented in Europe are largely based on the harmonised regulatory principles and technical conditions of use which are being developed in the groups of the CEPT ECC.

Among the different strands of work being carried out in CEPT ECC on the issue of increasing spectrum flexibility, ECC Reports 132, 137 and 169 developed in recent years by the ECC Regulatory Affairs Working Group (WG RA) describe relevant regulatory models and best practices.

The easier the access to the radio spectrum, the more efficiently and innovatively it can be used, provided the minimum necessary technical conditions are respected to limit the negative impacts of interference. That is why establishing common regulatory principles in this area and harmonising the associated terminology would significantly facilitate the work of CEPT administrations on developing and implementing national regulatory frameworks in the area of licensing.

ECC Report 132 focuses on the light licensing and licence-exempt models of authorisation of spectrum use and brings together the relevant national practices. It also establishes some reference terminologies shown in Table 1 below.

Individual authorisation (Individual rights of use)		General authorisation (No individual rights of use	
Individual licence[1]	Light-licensing		Licence-exempt
Individual frequency planning / coordination Traditional procedure for issuing licences	Individual frequency planning / coordination Simplified procedure compared to traditional procedure for issuing licences With limitations in the number of users	No individual frequency planning / coordination Registration and/or notification No limitations in the number of users nor need for coordination	No individual frequency planning / coordination No registration nor notification

The findings of the Report are largely based on the survey conducted by WGRA in 2009 which aimed at gathering information on the most recent developments in the European national spectrum authorisation regulatory frameworks.

Typical examples of the licence-exempt applications referred to in the survey include most of the Short Range Devices (SRD) compliant with ERC/REC 70-03, Generic Ultra Wide Band (UWB) applications (defined in ECC Decisions (06)04 and (06)12), professional radios PMR446, Wi-Fi spots in the 5 GHz band, PR27 equipment (CB) and cordless telephony.

A more interesting part of ECC Report 132 deals with the so called 'light licensing' which appears to reside somewhere in between the licensing and licence-exempt models. The Report reveals that various types of 'light licensing' regimes implemented by the European countries are usually associated with some kinds of restrictions, either being maximum number of users in a given geographical area (the first-come-first-served principle) or restricted geographical area of operation (for example, 'general authorisation' throughout most of a national territory while some coordination zones may be subject to 'individual right of use'). At the same time, applications authorised under the 'light licensing' regime are normally permitted to use higher power than those under the licence-exempt regime. Many CEPT administrations consider 'light licensing' as a tool for national authorities to utilise IT systems and the Internet to simplify the licensing process for enterprises and other radio users.

Typical 'light licensing' applications mentioned by CEPT administrations in the WGRA survey included ground and wall probing radars (GPR/WPR imaging systems operating on non-interference, non-protected basis) and amateur and maritime VHF stations (indeed, although individual licences are issued in those cases, there is no need for individual frequency planning or coordination, and no prior limitation is placed on the number of users).

Another report developed by WGRA in 2010 (ECC Report 137) addresses from both regulatory and technical perspectives the issue of increasing flexibility, convergence and harmonisation in the current European regulatory framework.

The Report analyses 10 different models (including the Block Edge Mask (BEM) model already used in a number of ECC technical documents) which could be used to represent so-called 'technical licensing conditions'. It concludes that the most suitable model for representing the least restrictive technical conditions (LRTC) that provide optimum flexibility will depend on the licensing framework (i.e. General or Individual Authorisations). The models analysed in the Report were identified previously within the ECC as possible ways to provide the LRTC and they have been analysed within Spectrum Engineering Working Group (WG SE) (CEPT Report 019 on 'least restrictive technical conditions for WAPECS frequency bands') and WG RA (ECC Report 132 on 'light licensing, licence-exempt and commons').

By introducing more flexibility into the technical conditions associated with the national licence conditions, the Report suggests that some evolution in the way that corresponding Harmonised Standards are developed may need to be further considered within ETSI:

- ETSI may continue to produce Harmonised Standards which could cover either technology neutral generic applications or be for a specific technology or application.
- Harmonised Standards will have to show how the equipment under test would be able to meet the least restrictive technical conditions.

So there is now a toolkit of options for regulators. How flexible the spectrum 'rights of use' are depends on the regime chosen, together with final minimum technical conditions, and how these are reflected either in the individual licence conditions or exemption regulations.

The Report also points out that the recently developed guidelines by WG RA for Impact Assessment (see ECC Report 125) could be a useful tool to assess the relevant evidence in order to provide the justification for the degree of flexibility chosen.

The third and most recently approved report by WG RA ECC Report 169puts together various national practices related to trading of spectrum usage rights.

This report, similar to the one on light licensing, is also based on a recent WGRA survey and contains a lot of interesting data on transactions in different frequency bands. It generally describes the typical transaction procedure in a European country as containing the following four consecutive steps:

- notification of the intention to trade;
- publication of notified information;
- approval of transaction by the national authority, and
- publication of the final transaction.

An important observation drawn in the Report is that significantly different transaction patterns (number of licences and number of transactions) are observed in different frequency bands. This suggests that competition issues may arise in different bands and could be treated according to the specific needs of the relevant applications. A toolbox to address such issues includes the possibility to refuse a transaction on competition grounds as well as requirements in the licences for the effective exploitation of the rights of spectrum use. Detailed analysis of such tools however was outside the scope of this Report and may be a subject of further work.

ECC Report 169 also includes a section on the leasing of spectrum usage rights which deals exclusively with the leasing transaction procedure.

In conclusion, ECC Reports 132, 137 and 169 contain a number of very useful tools for increasing flexibility of spectrum use in Europe which can be applied by CEPT administrations in developing their national regulatory frameworks. This is an important step in enabling the most efficient use of spectrum, not just nationally, but across Europe.

Stelios Himonas, Chair of the ECC Regulatory Affairs Working Group,
and Alexander Gulyaev, ECO Expert in Spectrum Management

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[1]Sometimes also referred to as 'traditional licensing'

ECC Decisions to help environmental satellites

Environmental satellites are of major importance to the scientific community. They are 'passive' in that they do not transmit signals, but instead receive and gather vital measurement data. One type uses the 10.6 GHz band to monitor rain, snow, sea state, and soil moisture. Similar services use a higher frequency (the 31.3-31.5 GHz band) to gather information on temperature and other atmospheric parameters. Another range is 1400-1427 MHz to monitor sea surface salinity (also soil moisture).

This data helps scientists to gain a clearer picture of climate change and can be crucial in the prediction of certain natural disasters, as well as more routine forecasting and other aspects of earth exploration. These satellite services are typically non-commercial and need to be protected from interference to continue their valuable work in environmental monitoring.

The ECC's March 2011 meeting in Porto adopted the last of three Decisions which support this fight against climate change and predicting natural disaster (the others were adopted in November 2010 in Luxembourg). The Decisions aim to keep these passive satellite services free from interference.

Fixed and mobile services on the same frequency (at 10.6 GHz) and adjacent bands (at 31.3-31.5 GHz and 1400-1427 MHz) may cause interference to these sensing systems, and the new ECC Decision places tighter limits on this interference to enable the satellite services to function more effectively. The ECC believes that by translating the tighter limits on the mobile and fixed services into regulatory requirements within an ECC Decision, this will send a clear message that these important frequencies will be protected in the long term, and that Europe recognises the societal and economic values of these spectrum-based applications.

The Decision is consistent with the EU Radio Spectrum Policy Group's policy Opinion on a 'coordinated EU Spectrum approach for scientific use of radio spectrum', and it complements this with a clear technical framework which can apply across the wider 48-country CEPT area.