CEPT Report 24

Report C from CEPT to the European Commission
in response to the Mandate on:

“Technical considerations regarding
harmonisation options for the Digital Dividend”

“A preliminary assessment of the feasibility of fitting new/future applications/services into non-harmonised spectrum of the digital dividend (namely the so-called "white spaces" between allotments)”

Final Report on 27 June 2008 by the:

Electronic Communications Committee (ECC)
within the European Conference of Postal and Telecommunications Administrations (CEPT)

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0 EXECUTIVE SUMMARY

Justification

Under CEPT Report 24 (Report C in response to the 1st Mandate on Digital Dividend) the CEPT was requested to inspect preliminary the practicability of implementation of new/future applications within the white space spectrum in the band 470 - 862 MHz.

Findings

CEPT identified white space as a part of the spectrum, which is available for a radiocommunication application (service, system) at a given time in a given geographical area on a non-interfering / non-protected basis with regard to primary services and other services with a higher priority on a national basis.

The spectrum capacity offered by white spaces in the UHF band to other services will depend upon the use of the band by primary services.

Based on the decisions of the RRC06 and WRC-07 related to the UHF band, white space spectrum availability is being gradually reduced.

The controlled access of PMSE services to white space spectrum is expected to continue in the foreseeable future, taking into account the development of digital broadcasting in the frequency band 470 - 862 MHz.

The feasibility of cognitive sharing schemes has not yet been conclusively demonstrated. It is too early in the development cycle to judge the final capabilities of cognitive radio technology for white space devices.

The current CEPT view is that any new white space applications should be used on a non protected non interfering basis.

Further studies are required into the framework needed to enable the use of CR devices within white space spectrum.

Further studies

Based on the request from the mandate "*aiming at maximizing the value of the digital dividend from the overall societal and economic viewpoint*" further work is justified within the CEPT.

Since the CR technology is at a very early stage the CEPT recommends looking further into the requirements within the European environment for CR devices to be deployed in white space spectrum in order to facilitate the further development of CR technology.

The CEPT may also need to investigate the possible use of duplex and guard bands in the harmonized sub-band by other systems/services. Decisions will depend on the results of such investigations and on the final band plan proposed for implementation by an administration.

Glossary of terms

ARNS	Aeronautical Radionavigation Service
ATSC	Advanced Television Systems Committee
CEPT	European Conference of Postal and Telecommunications Administrations
CR	Cognitive Radio
DVB-T	Digital Video Broadcasting – Terrestrial
EC	European Commission
ECC	Electronic Communications Committee
ETSI	European Telecommunications Standards Institute
FCC	Federal Communications Commission
FS	Fixed Service
GE06	The Geneva 2006 Agreement and Plan
HSDPA	High-Speed Downlink Packet Access
IEM	In-Ear Monitors
IMT	International Mobile Telecommunications
LAN	Local Area Network
PMSE	Program Making and Special Events
PWMS	Professional Wireless Microphone Systems
RRC-06	Regional Radiocommunication Conference, Geneva 2006
SAB/SAP	Services Ancillary to Broadcasting and Programme making
SRD	Short range device
UHF	Ultra High Frequency, within the context of Report C refers to 470 – 862 MHz as covered by the GE06 Agreement
UMTS	Universal Mobile Telecommunications System
UWB	Ultra Wide Band
WLAN	Wireless Local Area Network
Wi-Fi	Wireless technology brand devoted to wireless LAN products based on the IEEE 802.11 standards
WSD	White Space Devices

1 INTRODUCTION

The wording of "White Spots" or "White Spaces" or "Interleaved Spectrum" has been used to introduce a concept of frequency spectrum which is potentially available at a given time for further utilisation within frequency spectrum originally planned for broadcasting in GE06 [1]. The available documentation mainly uses the term "White Spaces" and this will be used for the rest of the document to generically describe all the different cases. This will include all marginally available spectrum.

These white spaces have limited geographical extension and time duration, and any utilisation must take into account the protection of nearby Primary Services, and other systems (services, applications) allocated on a priority basis, which will put constraints on the operation of applications utilising white space spectrum. This white space operation can only be on a non interference and a non protection basis.

White space services would have to be capable of moving to alternative white space channels to avoid interfering with new stations in operation, or any other services given a higher priority on a national basis. Depending on national and cross border requirements white space services entering the band must be aware that additional stations, usually broadcasting, may be added.

So "White space" is a label indicating a part of the spectrum, which is available for a radiocommunication application (service, system) at a given time in a given geographical area on a non-interfering / non-protected basis with regard to other services with a higher priority on a national basis.

In its mandate to the CEPT on digital dividend the EC aims at the most flexible spectrum usage while allowing the widest possible range of uses and technologies. Therefore, in Report A, Report B and its supplement the CEPT has analysed the anticipated consequences of partial shared use in the band 470 - 862 MHz for digital broadcasting services and multimedia broadcasting and fixed/mobile services.

The RSPG in its Opinion #7 "EU spectrum policy implications of the digital dividend" notes that Member States in implementing digital dividend may wish to consider the impact on existing other services, including secondary services [2]. Indeed, implementation of digital dividend for broadcasting and non-broadcasting applications may have implications concerning the current existence of other services occupying interleaved, or 'white space', spectrum within the band 470 - 862 MHz. These include radio navigation, fixed or mobile services for military applications, Radio Astronomy and Services Ancillary to Broadcasting and Programme Making (SAB/SAP, also known in the industry as Program Making and Special Events services, or PMSE). Many of these services may be affected or constrained by development of the UHF band.

Moreover, there is potential for new applications in the white space spectrum that take advantage of the favourable physical propagation characteristics of the UHF spectrum, for example, easily going through the walls to enable whole home networking applications or neighbourhood mesh networks.

This Report is a preliminary review of the practicability of implementation of new/future applications within the white space spectrum in the band 470 - 862 MHz. The report has been prepared in response to the mandate issued by the EC [3].

2 WHITE SPACE SPECTRUM IN THE BAND 470 - 862 MHz

With the white space spectrum concept there will be localised gaps in the usage of the radio frequency spectrum in between the assigned television channels.

Specifically, the number of television channels that could be received in a defined region is an important characteristic of the GE06 Plan, and it is directly connected to the notion of a "layer". Planning of the band 470 - 862 MHz for digital television made it possible to ensure the reception of up to 7 - 8 channels in a given region across the territories of most European countries. To prevent interference, the channels used in one region are different from those used in neighbouring regions. In some countries some television channels are not available for broadcasting services and used for other services, e.g. radar (Channel 36), radio astronomy (Channel 38), SRD's (Channel 69), Aeronautical

Radionavigation Service (ARNS) (in some countries of Region 1 including CEPT countries) the 645 - 862 MHz frequency band is allocated to ARNS on the primary basis in accordance with No. 5.512 RR [4]) or Fixed Service (FS) (in Region 1 the 790 - 862 MHz frequency band is allocated to FS on the primary basis). Nominally, e.g. assuming television broadcast only, the unoccupied interleaved spectrum in the band 470 - 862 MHz in some areas would amount up to 40x8 MHz television channels and is potentially available for other uses. However, the use of these television channels for white space applications will be limited because of the need to protect the broadcasting and other services in the neighbouring areas.

In general, the re-planning and move to digital broadcasting under the GE06 Plan has already resulted in far less white space being available than previously under the Analogue ST61 [5] environment. There were 3 or 4 analogue services in each area, and this has now been increased following GE06, to around 7 or 8 digital multiplex broadcast services in the same location in the future. This is already leading to issues with local white space spectrum availability for PMSE, especially for the staging of major events.

Therefore, the white space in case of the GE06 Plan refers to the 8-MHz segments of spectrum between GE06 Plan frequencies received in a given area and in a given time.

However, the white space spectrum can still be used by additional television stations/networks on a local area basis with their deployment constrained by the need to protect the domestic reception of the networks and operating on the same channels in the same or adjacent region. It should be also noted here that the potential harmonisation of a sub-band for fixed/mobile applications (see CEPT Report B [6] and its supplement [7] for details) may diminish the amount of white space spectrum in the band 470 - 862 MHz that is available for any interleaved services. This may result from the needed displacement of television channels from the band 790 - 862 MHz, to be fitted into the presently existing white spaces in the band 470 - 790 MHz. It is generally envisaged that, in order to allow for the development of broadcasting services the use of white spaces by other services should only be made on a non-interfering / non-protected basis.

The spectrum capacity offered by white spaces in the UHF band to other services will depend upon the use of the band by primary services.

In particular, the available capacity is likely to be more limited in Europe than in the United States, due to the more dense usage of spectrum for broadcasting and other services.

In some CEPT countries a harmonized implementation of IMT in the band 790 - 862 MHz may trigger extensive re-arrangement activities with bilateral and multilateral coordination in the band 470 - 790 MHz in an attempt to re-channel affected GE06-broadcasting allotments/assignments that have frequencies in the sub-band 790 - 862 MHz. Such bilateral and multilateral coordination may take several years. Accordingly there is a high uncertainty regarding the extent of spectrum available for new applications/services in the band 470 - 790 MHz in the years to come. Possibly the same uncertainty exists for new applications/services in the guard bands and duplex gaps of the sub-band 790 - 862 MHz. In addition, an uncertainty may be due to the protection of analogue broadcasting services in some countries until 2012 (in EU) and 2015 in Region 1.

White space spectrum may also be present in the frequency band 790 - 862 MHz allocated to the mobile service, for example in the case where a given channel is not used everywhere, say during the initial implementation, or in areas where service may not be foreseen for whatever reason. This spectrum could be exploited by new applications. It is also important to consider flexible and efficient spectrum management for the guard and duplex bands of the sub-band harmonised for fixed/mobile services. However, in order to investigate the possibilities of using these parts of the spectrum further studies are required.

3 USERS OF THE WHITE SPACE SPECTRUM

3.1 Existing applications: Programme Making and Special Events services

Sharing white space spectrum is not a new idea. Programme Making and Special Events (PMSE) services already operate within the UHF spectrum on an interleaved basis.

PMSE-related equipments used in the UHF broadcast spectrum include Professional Wireless Microphones Systems (PWMS) and associated systems, e.g. In-Ear Monitors (IEM) Systems, Professional Talk-Back Systems, etc. Typical users include broadcasters, stage shows, news reporting teams, television and film production units, ‘reality’ television shows, medical institutions, business users, etc.

Traditionally, PMSE applications have used the interleaved spectrum between the analogue television transmissions in Bands IV and V. These systems are used extensively, and increasingly, in non-broadcast, as well as broadcast applications. Perhaps two of the more noticeable areas are stage shows, where stage monitor speakers have been replaced by in-ear monitors. All major artists currently employ multiple channels of wireless microphones and wireless instrument systems. ‘Reality’ television shows are also heavily dependent on wireless systems. Contestants typically have a wireless microphone each, more wireless microphones will be deployed to capture sound effects and multiple teams of television commentators will have their own wireless microphone and talk-back systems. It has now reached the stage where the situation is reversed and these productions have been designed around this wireless technology. Consequently they are so heavily dependant on wireless systems that they could not exist without them.

Entire multimedia production chains are now entirely dependant on PMSE applications, to the extent that disruptions can have expensive repercussions (e.g. if the wireless microphone for the main artist in a live music show is disrupted, that entire song will be unusable for multimedia productions based on it).

Usage is normally on a ‘tuning range’ basis, allowing different administrations to authorise these systems where and when they are needed. This maintains maximum flexibility and avoids ‘sterilizing’ spectrum. The only down-side to this is that events that tour across Europe have to set up different channels as they move across different countries. These can range from touring stage shows to sporting events, such as the Tour de France.

The remaining possibilities for PMSE will be less after the introduction of DVB-T, especially in areas with a great demand (program production studio’s and during special events).

The amount of spectrum available for PMSE in the UHF band depends both on the use of the band by digital television, as well as on the potential harmonisation of a sub-band for fixed/mobile applications (see CEPT Report B and its supplement for details).

PMSE may be authorized under general or individual licences, depending on national licensing regime and on the category of PMSE. However, even in the case of general licence, the devices are to the large extent used by professional users, which enable to ensure the coexistence with broadcasting service. This permits to grant a high quality of usage of the UHF band, and usually to avoid interferences to primary services.

Harmonised technical conditions of use are defined in ECC Recommendation ERC/REC 70-03 [8].

3.2 Potential candidate applications

There is potential for the shared use of the white space spectrum by other applications. Two classes of short and longer range devices can be considered for the interleaved deployment in the UHF band:

- Personal/portable devices, such as Wi-Fi cards in laptop computers, smart phones, PDA's, personal media players, which operate with, for example, a maximum power output of 100 mW.
- Fixed/access devices that are generally operated from a fixed location and may be used to provide a commercial service, such as wireless broadband Internet access. These devices could operate with, for example, a transmitter output power of up to 1 W.

Similar categories of devices operate today in 2.4 GHz and in 5 GHz bands.

It should be noted that the example transmitter powers are comparable to or higher than those assumed for mobile applications in the sub-band (21 dBm for UMTS). Therefore, protection of primary users in the UHF band will require guard bands and exclusion areas comparable to those already studied for the harmonised sub-band.

Industry has expressed interest in using the UHF band due to the specific propagation conditions, allowing greater range than at 2.4 GHz or 5 GHz, though operating in channels with lower bandwidth. Each 8 MHz channel would support data rates that are comparable with those of current wide-area services such as 5 MHz HSDPA, but lower than 802.11 devices operating on 20 MHz channels at 2.4 GHz and 5 GHz. However, white space devices could aggregate any available channels to gain increased capacity.

Some example applications are listed below:

- In home multimedia distribution
- WLAN networking and long range bridging
- Self organizing, mesh connected community and campus networks
- Gaming
- Home automation and control
- Non critical monitoring applications

Those applications may already be offered in other frequency bands than the UHF spectrum but the industry wishes to exploit specific benefits of the UHF spectrum. In particular, the superior propagation characteristics of UHF enable wider range connectivity and thus assist applications that require real-time delivery of data (home multimedia distribution, gaming, etc). From another hand, for the same reason, e.g. the superior propagation of UHF, interference generated by new white space devices towards primary or other prioritised services is also greater and will impose certain constraints on the operation of these devices.

The success of the envisaged applications may rely on their ability to offer alternative services or to provide additional capacity to other existing solutions, such as devices already delivering short range high capacity in the 2.4 GHz and 5 GHz bands, or the cellular networks.

4 POSSIBLE OPERATION OF EQUIPMENT WITHIN THE WHITE SPACE SPECTRUM

Deployment scenarios should preserve existing and future deployment of primary services aside white spaces and PMSE applications, which are already present in the UHF band, and may introduce new applications.

These scenarios can include licensed and/or licence exempt applications.

4.1 Programme Making and Special Events services

A study has concluded that PMSE services could continue to be operated on an interleaved basis within the white space spectrum, providing that they are subject to restrictions on the operating power of the transmitters and the need for coordination of specific assignments to ensure that they do not interfere with the reception of the digital broadcasting services in areas adjacent to their location.

To date the white space spectrum has been very intensively used by PMSE in certain areas and at certain times. The controlled employment has allowed it to use available white space in a very effective manner and in a way that minimises compatibility problems with the primary service (i.e. broadcasting).

In most cases, co-channel operation of DVB-T and radio microphones within a DVB–T coverage area will cause unacceptable interference to radio microphones and vice-versa. However, indoor operation of radio microphones, for instance in theatres, may be feasible even if these operate on the same channel as a digital broadcasting service depending on building shielding loss and the location of the nearest DVB-T receiver, and depending on the type of network and whether it aims to cover indoor or not. These cases may be evaluated on a site by site basis.

Operation of radio microphones in the adjacent channel to that used by a DVB-T service will be possible in a lot of cases providing a guard band of the first 500 kHz of this channel is used. In practice, use of the 2nd adjacent channel (n+2) by radio microphones will be feasible in most cases. This applies to both indoor and outdoor operation of radio microphones.

The measurements of these protection ratios were limited to professional DVB-T receivers. However, the immunity of domestic receivers, particularly for adjacent channel rejection, is not fully known and therefore additional measurements are needed.

PMSE may be authorized under general or individual licences, depending on national licensing regime and on the category of PMSE. However, even in the case of general licence, the devices are to the large extent used by professional users, which enable to ensure the coexistence with broadcasting service. This permits to grant a high quality of usage of the UHF band, and usually to avoid interferences to primary services.

4.2 Cognitive techniques for new white space applications

It is supposed that new applications within the UHF band will have to use cognitive techniques, which have been developed within the Cognitive Radio (CR) concept. The fundamental uniqueness of CR technology is its ability to adapt to a wireless spectrum or network environment automatically to accomplish some task. In general, CR is a radio communication system based on Adaptive Radio and other technologies that would be capable of altering and adapting its radio parameters based on communication and the exchange of information with related detectable radio systems in the same frequency band. Two different approaches can be followed: collaborative and non-collaborative CR. In the collaborative CR approach, radios of different technologies exchange mutual information regarding the frequency and time of usage of the spectrum. This approach requires a common protocol to negotiate these parameters. In the non-collaborative approach, a CR sense the radio environment and determines by itself the radio parameters without communication with possible other users of the spectrum.

The new applications, a priori under a licence exempt operation that could be introduced in the UHF band should communicate with other devices on a non-interfering/not-protected basis. The following cognitive techniques might be employed:

- Spectrum sensing (listen-before-talk, detect-and-avoid). With this method, if a device hears another transmission on the frequency it is using or on the adjacent frequencies, it automatically switches to another channel. The detection threshold has to account for sufficient margin to prevent interference taking into account potential interference distances and propagation variations.

- Geo-location. Devices that know their location by using a radionavigation system can avoid broadcast channels in their vicinity by reference to a database.

- Local beacon. A local beacon transmitter operating in an unoccupied television channel could broadcast information to licence-exempt devices operating nearby.

Drawing on techniques described above, multiple devices can exchange information to improve their collective awareness of spectrum occupation. However, even in a situation where the receiver to be protected (i.e. TV or PMSE receiver) is located close to the CR equipment and is in a line-of-sight from the wanted transmitter (i.e. with a wanted signal above the sensitivity), there may be an obstacle between the CR equipment and the wanted transmitter which would significantly decrease the signal level to be detected. This is called the hidden node problem. As a consequence, the detection threshold has to account for a large margin to take into account this effect.

The techniques listed above vary in cost, complexity and effectiveness. The simplest and most reliable of these appears to be spectrum sensing, which taking advantage of the latest technology appears to offer the greatest scope for reaping consumer benefits and with lower costs, higher efficiency of spectrum use and greater reliability than other approaches.

Geo-location depends on TV coverage databases and establishing connectivity, which adds complexity and potential for unreliability. For example, requiring CR devices to consult a central database would require them to have connectivity independent of any white space access and would inevitably be limited in precision and accuracy. At any given time this could lead to either underexploited spectrum or a risk of interference with established spectrum users.

Beacons are typically high power devices, with the potential to cause interference as well as helping to avoid it. They are likely to inhibit CR devices over an unnecessarily wide area, denying the benefits to consumers that live or work in their vicinity. Given the high transmission powers, by definition, it seems unlikely that beacons could operate safely on a licence exempt basis.

The IEEE 802.22 working group on Wireless regional area networks has had a substantial focus on techniques that enable coexistence with other signals within white spaces in UHF, including TV stations and radio microphone links [9]. Within the USA environment its proposed sensing algorithm uses a two step approach:

- A fast sensing period, typically under 1 ms per channel, in which an initial signal strength measurement is made
- A fine sensing period, which applies when the fast sensing indicates that the signal strength in a particular channel is above a predefined threshold. The channel is then sensed in greater detail, over a longer time window to recognise signature characteristics of the coexisting applications (e.g. 25 ms in the case of an ATSC signal)

Methods of detecting DVB-T signals requiring a different technique than for ATSC have been also proposed to the IEEE group [10].

4.2.1 Evaluation tests

However, whether these technologies, that will automatically know how not to interfere with already occupied frequencies, exist in a product form is still an open question. Prototype systems embodying such approaches in the UHF band have been developed in the US. The Federal Communications Commission's Laboratory has conducted a measurement study of the spectrum sensing and transmitting functions of prototype licence-exempt low power radio transmitting devices that would operate on frequencies in the broadcast television bands that are unused in each local area [11]. The study determined that the sample prototype white space devices submitted to the FCC for initial evaluation do not consistently sense or detect TV broadcast or wireless microphone signals. The FCC has now agreed to retest replacement sample devices.

It should be also noted, however, that all FCC tests have been and will be performed for 8-VSB modulation method adopted for terrestrial broadcast of the ATSC digital television standard.

More generally, as exemplified by the discussion in the United States, but also in the implementation of sharing method in Europe (e.g. between radars and Wi-Fi at 5 GHz or between UWB and cellular systems in the 3 GHz bands), any sharing scheme is to be carefully assessed and confirmed, including by testing, before it can be put in place. This includes not only compatibility with other services such as terrestrial TV and PMSE equipments but also the consequence in terms of possibility of evolution of terrestrial TV planning and technology.

Therefore, proposals from industry and supporting evidence for the capacity of sharing need to be further analysed. The sharing schemes based on cognitive techniques would have to be defined very precisely and should be subject to testing to demonstrate their effectiveness. An example test plan framework to assess compatibility of white space devices with PWMS is provided in Annex 1.

It should also be considered that there might be different ‘priorities’ of licence exempt operation. For example, PMSE might get a higher priority even if this use is also licence exempt. When demand and use of PMSE is high (e.g. during program making or special events), other licence exempt use might be limited or even not possible due to lack of free spectrum.

Coexistence between various categories of licence-exempt usage should also be investigated. For example, the use of ‘asymmetric’ powers needs to be studied because in a ‘listen before talk’ system, a high power system (e.g. 1 W) might not hear a low power device (e.g. 50 mW) and commence a transmission. However, due to the higher power of this device, the low-power device might be interfered with.

4.2.2 Implications

Devices using cognitive techniques should be able to sense their environment and adjust their operating parameters (e.g. transmit power and frequency) to communicate with other devices on a non-interfering basis.

With regard to any possible use of white spaces in Europe by licence-exempt devices, the concerns are multiple:

- **Interference into terrestrial TV (analogue and digital)**

  The principle of licence-exempt operation is that the CR device should be able to "detect and avoid" the used frequencies in the concerned area of operation. Such detection, which would be made by the CR device itself, will depend not only on the detection threshold set in the device (example of limitations foreseen by the FCC in the USA is -116 dBm/6 MHz) but also on the reception conditions which vary largely between indoor portable, outdoor portable and fixed roof-top reception. However, the issue of the European environment is still to be tested.

  In any case, the required detection levels should be set adequately to ensure the protection of the primary services taking into account that:

  (i) The WSD are likely to be operating in a multi path environment.

  (ii) Detecting DVB-T signal in the time allowed may prove harder than ATSC digital television signal (i.e. 8-VSB), which has a residual carrier and sync pulses.

  (iii) The hidden node problem may occur.

  In addition to the problem of detection, even if an unused channel is correctly detected, the transmission of the CR device will cause interference to adjacent channels (first and second) according to the tests made by FCC. This type of interference is similar to the one that could be caused by mobile phones using adjacent channels.

- **Interference to PMSE services**

  PMSE services already make extensive use the white spaces in the current analogue and digital worlds on a secondary and temporary basis. The operators of these services are normally obliged to refer to the current TV frequency plan and to tune their equipments to the frequencies not used for TV reception in a specified area. However, as mentioned above the white space prototype devices submitted to the FCC for testing showed very poor performances in detecting radio microphone signals.

  It should be also noted that the response time clearing a CR device operating in the interleaved spectrum is essential to protect PMSE service when a mobile CR device is moving towards PMSE equipment in use or PMSE equipment is switched on to start transmission on a frequency occupied by a CR device.

The operating conditions (e.g. technical parameters) for the white space devices need to be specified both through the harmonised standards and through the licensing regime to ensure interference free operation towards licensed or other licence exempt users. White space devices put on the market should comply with the Directive 1999/5/EC to ensure effective use of spectrum and avoidance of harmful interference.

CR techniques may offer some possibilities for white space device operation in the future, provided they meet the appropriate regulatory regimes. Similarly, effective geographic (location) controls might be developed in the future and may also offer possibilities. However, these techniques are in experimental stages at present and are unproven, so these systems must not be permitted until their mitigation techniques prove to be effective.

The pressure on the 'white space' spectrum will increase in coming years, so it is important that all the use is as efficient as possible. The introduction of more efficient PMSE systems needs to be investigated or promoted in order to facilitate as many users as possible in the 'white space' spectrum.

As an EMC issue not a spectrum management issue, within a given area, licence-exempt white space devices may use the same channels as the cable TV service. This could cause co-channel interference to the cable TV service, as suggested by the FCC tests [12] on the susceptibility of cable TV reception to interference from devices that might operate within the white space spectrum.

5 CONCLUSION AND RECOMMENDATIONS

5.1 Conclusions

CEPT identifies white space as a part of the spectrum, which is available for a radiocommunication application (service, system) at a given time in a given geographical area on a non-interfering non-protected basis with regard to primary services and other services with a higher priority on a national basis.

White space in the UHF band refers to the 8-MHz segments of spectrum between active stations in a given area and in a given time. The use of white space by PMSE under general or individual licences, depending on the category of PMSE, is expected to continue in the foreseeable future, taking into account the development of digital broadcasting in the frequency band 470 - 862 MHz. In order to maintain current services in the UHF- band PMSE should continue to have controlled access to white space spectrum.

Introduction of new cognitive radio applications for interleaved deployment in this band has been considered based on discussions which have emerged in the United States based upon ATSC 8-VSB transmissions. This technology is still under development and these matters will need a further review in the future.

The feasibility of cognitive sharing schemes has not yet been conclusively demonstrated. It is too early in the development cycle to judge the final capabilities of cognitive radio technology for white space devices. Any sharing scheme will have to be carefully assessed and confirmed, including by testing, before it can be put in place. This includes compatibility with other services such as terrestrial broadcasting and PMSE equipment but also the consequence in terms of possibility of evolution of terrestrial broadcasting planning and technology.

Based on the decisions of the RRC06 and WRC'07 related to the UHF band, the potential for white space spectrum availability is being gradually reduced. The re-planning and move to digital broadcasting under the GE06 Plan has resulted in far less white space being available than previously under the analogue ST61 environment. Moreover, a potential harmonisation of a sub-band for fixed/mobile applications will diminish the amount of white space spectrum available for interleaved services in the band 470 - 862 MHz.

Since the CR technology is at a very early stage the CEPT recommends looking further into the requirements within the European environment for CR devices to be deployed in white space spectrum in order to facilitate the further development of CR technology.

The current CEPT view is that any new white space applications should be used on a non protected non interfering basis.

5.2 Recommendations

The CEPT may also need to investigate the possible use of duplex and guard bands in the harmonized sub-band by other systems/services. Decisions will depend on the results of such investigations and on the final band plan proposed for implementation by an administration.

ANNEX 1: Example Test Plan Framework to Evaluate Compliance of Licence-Exempt White Space Devices in the Band 470 - 862 MHz with PWMS

The following tests cover the currently known parameters of white space devices (WSDs). As more features and specifications become known, more tests may be deemed necessary. Consideration should be given to having the work undertaken by an accredited test laboratory.

The following tests should be performed:

1. LABORATORY TESTS

All laboratory tests should are on a conducted basis

1.1 PWMS Detection

Test that the WSD's can reliably detect the presence of a PWMS emission at a level of -116 dBm.

1.2 Behaviour of WSD's When PWMS Are Detected

Test that the WSD takes appropriate corrective action within an acceptable time limit when a PWMS emission appears in the same TV channel

1.3 Measurement of WSD Emission characteristics

Test that Transmit Power Control (TPC) operates correctly in the presence of PWMS or broadcast emissions:

- In the same TV channel;
- In lower and upper adjacent TV channels

Test that the EIRP transmission mask of the WSD does not exceed specified power levels in the co and adjacent channels.

2. FIELD TESTS

For the field tests, all tests are on a radiated basis. Calibration accuracy should be better than 6dB.

2.1 Venues

Tests should be undertaken:

- in a variety of environments and usage models;
- in several locations and;
- several different environments;
- outdoor and indoor;

2.2 Sensing of PWMS by White Space Devices.

Test that the WSD can reliably detect the presence of a PWMS emission,

- in isolation and
- in the presence of strong DTV signals on adjacent channels.

2.3 Dynamic Frequency Selection (DFS) Behaviour of White Space Devices When PWMS Emissions are Detected

Test that the WSD takes corrective action within an acceptable time limit when a PWMS emission appears in the same TV channel.

ANNEX 2: List of References

[1] GE06: Final Acts of the Regional Radiocommunication Conference for planning of the digital terrestrial broadcasting service in parts of Regions 1 and 3, in the frequency bands 174 - 230 MHz and 470 - 862 MHz (RRC-06).

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[3] EC Mandate to CEPT on Technical Considerations Regarding Harmonisation Option for the Digital Dividend, 2007.

[4] Radio Regulations (http://www.itu.int/)

[5] Final Acts of European VHF/UHF Broadcasting Conference**,** Stockholm, 1961

[6] CEPT Report 22 / CEPT Report B: Final Report from CEPT to the EC on Technical feasibility of harmonising a sub-band of bands IV and V for Fixed/Mobile applications (including uplinks), minimising the impact on GE06, 2007.

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[8] ERC/REC 70-03: Relating to the use of Short Range Devices (SRD), 2008.

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