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Study for the
Public Safety & Security Community

Safety First

Reinvesting the Digital Dividend in Safeguarding Citizens

Executive Report

(A full version of this report is also available.)

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1 Introduction

The Digital Dividend is one of the most important and far reaching opportunities for communications policy issues of the past several decades, and even possibly for several decades to come. The term Digital Dividend refers to the portion of the radio spectrum which will become available as decades old analogue terrestrial broadcast television migrates to digital systems (DTV). These frequencies can be utilised by any number of services due to their excellent technical and propagation characteristics.

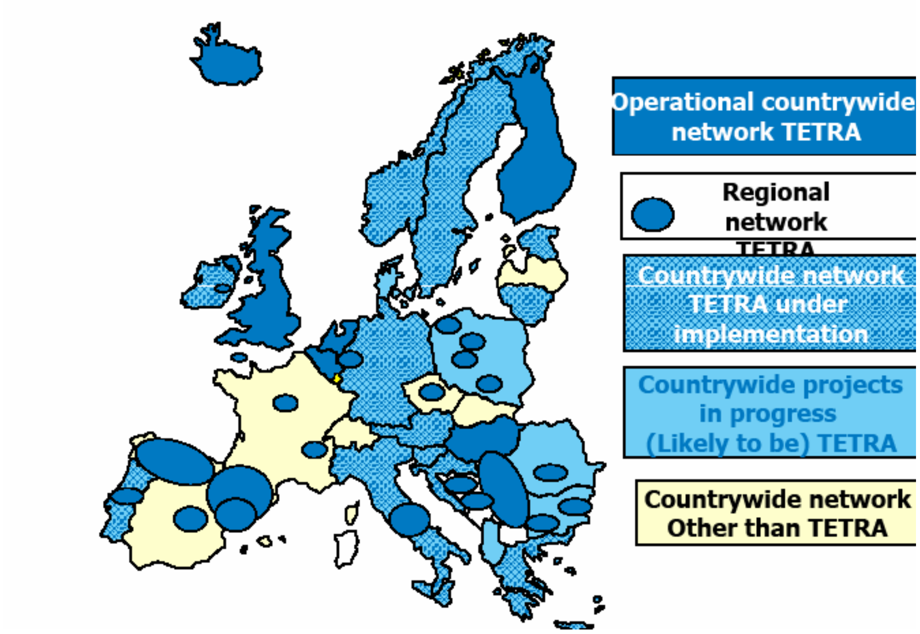
As Europe decides how to take advantage of this nearly unprecedented opportunity, one possible user of the Digital Dividend spectrum has received surprisingly little attention. Given its importance to society, it is shocking that Public Safety and Security (PSS) use is not a top priority in reallocating this spectrum.

PSS services are indispensable. Responders include police, fire and other emergency services. Each individual in our society has the growing expectation of, if not the right to, emergency services. In turn, society expects that its government will expend the necessary resources to aid those in emergency need. The provision of emergency services extends beyond the social contract and invokes a moral obligation to protect life, welfare, and property regardless of one's ability to pay. Not only must society provide PSS organizations with the resources they need to complete their jobs, but it must also provide the necessary modern tools which will minimise the risks to PSS personnel themselves.

In order to fulfil this obligation to save lives and property, PSS organizations require mission critical communications and information. PSS operations require wireless access, while on the move, and also because of the nature of the activities these networks have to be secure, reliable, resilient and available across a wide geographic area regardless of population density. Thus, the European Union has taken several measures to ensure that PSS organizations have the communications resources they require. Most notable, in 1996, ERC and ECC decisions produced a harmonized allocation of PSS spectrum. This resulted in widespread adoption of Europe-wide PSS communications systems – using either TETRA or Tetrapol. For more than a decade, these decisions have been an unqualified success. Interoperable voice and narrowband data services have been available to PSS organizations, increasing in functionality and price performance. Figure 1 below, from the TETRA Association, shows the Public Safety networks in Europe in the first quarter of 2007. In Europe, most emergency services have already deployed TETRA, with the exception of a few countries like France, which have adopted Tetrapol.

Narrowband services have been successful because harmonised spectrum was identified at an early stage providing the necessary certainty to industry to develop equipment to meet the needs of PSS organisations. There has been a wide range of cost effective equipment that has been developed and marketed to meet the specific needs of PSS organizations. However, the forces of change are now raising challenges to that continued success. In our primary research, we consistently heard from the PSS community that given their growing communications demands on this spectrum it is already clear that the current allocations will not suffice in the future. In fact some existing networks in European cities are already operating at full capacity and there is insufficient spectrum now. The future needs are also being fuelled by an ever-growing appetite for broadband services and applications.

Figure 1: European PSS Networks First Quarter 2007



Source: Tetra Association

So, how can the European Union repeat the 1996 success and make an efficient choice between competing demands when reinvesting the Digital Dividend? This White Paper offers informed guidance with a detailed view of the technical and operational characteristics of PSS radio services necessary to achieve an optimal spectrum allocation to take advantage of the latest technical advances, international harmonization, economies of scale, and to ensure sufficient spectral resources for PSS.

This study was funded by a consortium of European Aeronautic Defence and Space Company (EADS) and Motorola, two leading and respected suppliers of PSS solutions for Europe. This paper gives voice to the concerns raised by PSS organisations in respect of their need for access to higher speed data services and therefore access to further spectrum so they can continue to provide us with indispensable police, fire and other emergency services. To give voice to these concerns, our research methodology relied extensively on discussions and interviews with individuals in the community. These individuals represented a diverse set of organizations including first responders, equipment manufacturers, network operators and government regulators. The information provided in this report has been obtained through these interviews, case studies and from documents available in the public domain.

2 PSS Mission Critical Needs and Radio Technology

PSS users include police, fire, ambulance, security, and customs and border control. Other users such as the lifeboat service may also share PSS networks as they deal with safety of life issues. Public Safety Organisations address 3 types of operation that have been defined as:

- PP (Public Protection) 1 – Routine day to day operations within the agencies jurisdiction (normally within the geopolitical boundary) and as such the networks require wide area coverage on a permanent basis providing voice, narrowband and wideband communications.
- PP (Public Protection) 2 – Large emergencies or public events where it may be necessary to use resources from other agencies outside the jurisdiction (including across national boundaries). Examples of PP2 include transportation incidents or military exercises.
- DR (Disaster Relief) – The disaster may be natural or caused by human activity and there is a need for rapid deployment of incident networks in addition to the PP communications systems.[1]

Each of these three types of operations requires 'mission critical communications'. By definition, mission critical communications is any information which must be transmitted because it is crucial to the successful resolution of the operation. Mission critical networks require:

- Communications coverage everywhere, rural as well as densely populated geographic areas;
- Instant access to communication resources;
- Fixed and deployable networks;
- Ability to support mixed traffic (voice and data);

1 ECC Report 102, "Public Protection and Disaster Relief Spectrum Requirements".

- Flexibility;
- Security;
- Resilience; and
- Extra-network operation (Direct Mode Operation “DMO”).

Dedicated, proprietary networks currently provide PSS responders with immediate, secure and reliable radio communications for day-to-day operations and emergency situations in EU Member States and other developed nations. These mission critical systems are special-purpose networks for the exclusive use of PSS services, controlled by the Government and operated and maintained either by the Government or by a dedicated entity. From a variety of standpoints – operational, managerial and engineering – a dedicated network in a dedicated spectrum band is the best way to ensure secure, robust and immediate radio communications,. This is what is widely used today.

In Europe, the current generation of trunked radio systems are capable of supporting voice communications, and also are capable of supporting light data functionalities such as slow IP packet data and short text messaging. However, three ongoing trends apparent in the area of PSS radio communications present significant challenges going forward. These are:

i) migration from analogue to digital technology;

ii) consolidation of disparate, service-specific networks to single, shared and interoperable networks; and

iii) increasing reliance on data and multimedia capabilities in parallel to voice communication.

What we have heard consistently from the PSS community is that given the growing PSS communications demands on this spectrum it is already clear that the current allocations will not suffice in the future. Despite improvements in spectral efficiency through the deployment of new technologies which will yield some relief to the spectrum shortage, demand growth for frequencies is likely to outstrip growth of supply into the foreseeable future. The spectrum available to existing PSS systems will not satisfy future needs for these essential services. One example of this is the current situation with TETRA TEDS in that not all EU Members States are able to identify radio channels. Therefore, communications policy must evolve to empower new systems by reallocating spectrum from the Digital Dividend to PSS mission critical communications.

This decision is not to be taken lightly since it sits on the critical path for numerous other decisions necessary before deploying next generation PSS networks. Historically, it has been the usual practice to identify suitable spectrum well in advance because of the timescales for releasing the spectrum, development of standards and equipment. Adding to the urgency of the matter is the growing need for new services to emerge due to the increase in terrorist threats, frequency of natural environmental disasters, and normal population growth. The early identification of spectrum for narrowband systems made possible the deployment European wide of PSS networks supporting the needs for voice and low rate data services. Unless suitable spectrum is allocated for wideband and broadband systems there will be limited opportunities for PSS organisations to utilise new services that will increase their effectiveness in the field.

3 Dedicated Broadband Spectrum for PSS Communications

It has become widely accepted that we should never be without access to e-mails, the Internet, even photographs and videos. Broadband communications are rapidly becoming an essential input for PSS operations as well. Next generation services will vary according to the type of PSS agency, but most organizations will seek an efficient mobilization of its workforce.

3.1 Overview

PSS mission critical broadband communications will empower PSS organizations to move human resources into the field, increasing situational awareness and facilitating command and control. Broadband communications will be used to collect and disseminate timely information such as medical records, details of dangerous substances, maps, pictures and video to the various emergency responders. Broadband communications can, for example, support

- remote checking of information such as passport and biometric details:
- the sending of detailed photographic images of children lost or people wanted to officers out in the field so they can act on requests immediately;
- providing access to the Fire services Gazetteer, a document which contains information on what hazardous materials might be kept on a premises;
- transmission of live video information to the central command and control personnel so they can have access to the same visual information as their personnel in the field;
- relaying of ad-hoc video and surveillance camera real time information to patrol cars responding to incidents; or
- sending of full data on a patient’s condition from the ambulance to the hospital.

Whether a wireless network can economically provide broadband communications is based on physical constraints directly connected to the available frequency band and the amount of spectrum (bandwidth) available. Most mission critical operations depend on voice communications and currently have only two 5 MHz-wide blocks available in the harmonised spectrum. There are already problems with supporting voice traffic at major incidents and planned events. Some countries have already started to provide access to further spectrum in the 400 MHz band to support voice services.

The Digital Dividend spectrum is ideally suited to meet the developing needs of PSS PP1, PP2, and DR. One of the requirements that differentiate PSS networks from public networks is the need for ubiquitous coverage. Spectrum between current PSS allocations (around 380 MHz) and 862 MHz is essential to cost effectively meet this need because the achievable cell radius is much larger in lower frequency bands and RF waves can go around small obstacles so line-of-sight is not always necessary. Considering the frequency bands that have recently been awarded or may be awarded shortly, that there is potentially a 350% increase in cell radius when comparing the 700 MHz and 5.8 GHz frequency bands. In order to cover the same geographic area using the 5.8 GHz band would require 23 cells[2], while employing frequencies in the 700 MHz band would require only one cell.[3]

The cells employing lower frequencies also do so with fewer “dead spots” in coverage. Although between 700 and 800 MHz there is currently a need for additional cell sites to provide the same coverage as the 400 MHz band it is anticipated that technical solutions will become available that allow the existing sites to be re-used.[4] Indeed, simply moving up the tuning range from the 400MHz to 700 / 800 MHz bands could double the required investment.[5] An allocation at 450 MHz would be ideal as can re-utilise existing sites, leased lines etc. but much of this spectrum is already fully utilised by other services. While the 800 MHz band would be less efficient, there is a greater potential in terms of amount of bandwidth available.[6]

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2 A cellular network is a radio network made up of a number of discrete radio base stations. The term “cellular” network derives its name from fact that these radio base stations are organized in a system of localized sites to give overlapping coverage, fitting together like cells in a tissue. *See* A Michael Noll, PRINCIPLES OF MODERN COMMUNICATIONS TECHNOLOGY at 191-94 (2001).

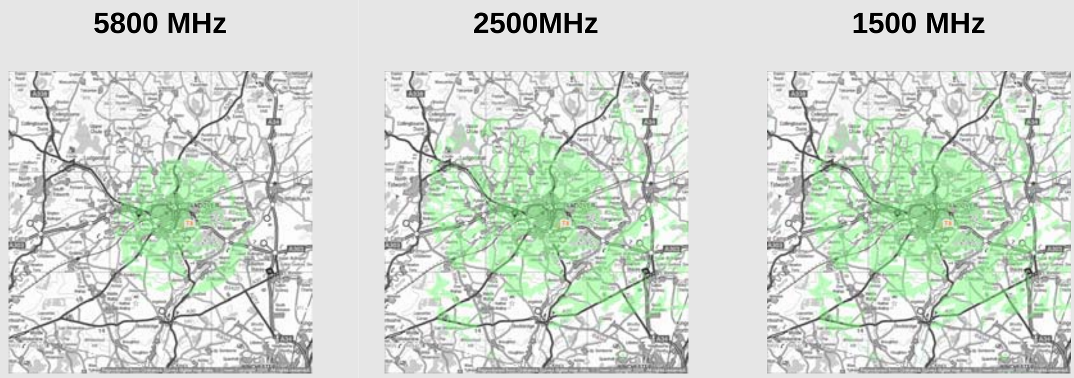
3 In most commercial networks frequency reuse is an important design criterion, thus it may be preferable to utilise cells of smaller sizes and use higher frequency bands. However, mission critical PSS networks require wide area coverage and non-line-of-sight penetration and hence lower frequency bands.

4 Comments from C2000 interview.

5 Comments of Jaakko Saijonmaa, EADS.

6 Comments from C2000 interview.

Figure 2: Comparison of Propagation Characteristics with Frequency



Frequency (MHz)	Outdoor (km^2)	Indoor (km^2)
2500	48	7.9
1500	90.4	14.4
900	140	23
500	252	40

Source: Aegis Systems Ltd.

Figure 2 demonstrates the propagation characteristics of different frequency bands, using engineering data. The maps were created using the new ITU-R propagation model P.1812 to predict effective cell coverage (in green) based on propagation loss.[7] The table uses the COST Hata rural model and provides indicative values for rural areas of the outdoor and indoor coverage that could be provided by a 120 degree sector antenna in different frequency bands.[8]

7 The predictions have been arranged to give the same median received power (-69dBm) at the receiver, assuming an isotropic antenna (1.5m above ground) at all frequencies. Transmit power is 200W ERP at all frequencies, from an aerial at 25m above ground.

8 For indoor coverage it is assumed that there are additional losses which have been assumed to be around 15 dB.

3.2 Policy

A dedicated network in dedicated spectrum band is needed to provide secure, robust and immediate communications for PSS radio systems, from a variety of standpoints – operational, managerial and engineering. This is what is widely used today. Current generation mission critical networks are based on essentially network designs, technologies and allocations from the 1990s. They will prove wholly inadequate for future needs and, in some cases, existing networks in European cities are already operating at full capacity. The arguments which support a policy undertaking to reallocate adequate dedicated Digital Dividend spectrum for mission critical PSS communications are as follows:

- **Moral Obligation -** Public safety and security (PSS) services responders provide indispensable police, fire and other emergency services to respond to emergency situations ranging from the routine (sports events, automobile accidents, house fires) to the extreme (terrorist attacks, earthquakes, massive floods). Each individual in our society has the expectation of, if not the right to, emergency services. In turn, society expects that its government will expend the necessary resources to aid those in emergency need. The provision of emergency services extends beyond the social contract and invokes a moral obligation to protect life, welfare, and property.

- **Social Cost** - Aside from being simply tragic, the loss of life and property bears societal cost. Further, the loss of infrastructure as well as the intellectual capital of the individual (education, training, intelligence, etc.) limits growth for us all. Modern society holds a moral obligation to provide PSS services to its citizens regardless of their ability to pay. Here, we choose principal over economic efficiency.

- **Risk Profile for PSS services** - Overall, Governments present the best risk profile for deploying and managing public safety networks. With their power to levy and assess taxes, governments can spread costs across diverse populations and geographic regions. The essential thing is maintaining control of the service level agreements, quality of the service, information security and related issues in the Government domain and ensuring continuation of the service under any circumstances.

- **International Harmonization** - One of the driving forces at the heart of the European Union is that of harmonization. Such harmonization can take place along a variety of different dimensions. Notable to our discussion is harmonization across rules and policy regarding spectrum usage. This is important for achieving economies of scale and for resolving cross-border interference issues. The Digital Dividend is an ideal opportunity for longer term harmonization, leading to the development of technical solutions that would allow the re-use of existing sites and needed economies of scale. A dedicated, harmonized band for PSS systems encourages a single market since vendors are more likely to view the market as sufficiently large to justify product development. Harmonization has benefited the PSS community with competition, innovation, specialized products and improved cost-benefit performance.

- **Technical and Operational Considerations** - There are several technical concerns regarding the design, deployment, and management of mission critical PSS communications networks which warrant separate and dedicated spectrum allocations. When lives are in the balance and every second counts, especially stringent requirements will be placed on the deployment and management of communications networks and these include coverage, capacity, reliability, availability, redundancy and reconfiguarbility. These requirements differentiate PSS networks from commercial networks; therefore, the PSS community has typically eschewed shared public and commercial network solutions. While cellular mobile networks can fulfil certain of PSS communications needs, and are currently used by some organizations, those networks are optimized for different objectives, namely meeting consumer experience, service and price demands. These networks are not hardened and designed to cater to the stringent requirements of PSS organizations. Under certain limited conditions it may be possible for commercial services to ride on spectrum and networks dedicated to PSS communications, but not *vice-versa*.

- **Corporate Form** - For-profit corporate organizations are poorly suited to providing the types of public goods which government bodies can offer. Private corporations will offer a level of services which maximizes profit, while government organizations will offer a level of service which it believes to be a public optimum. Further, the level of investment required to bring commercial networks up to these stringent requirements would not be economically viable without government support, which will have the inevitable effect of distorting competition. PSS organizations must be assured the continuity of service from its mission critical communications provider. The level of control necessary for a PSS network may inhibit the competitive responses of the corporate entity and may make it a *de facto* a governmental organization, though it may be a private corporate form. Control of the service level, quality and availability of the service etc should remain within the public sector to secure the right service to the right users in the right places every day. How the practical operation and maintenance of the network is organised is more a national option depending on the political preferences and economical capabilities in each country. We recognise that a fully Government owned and managed system would be the contractually and logistically simplest solution to manage.

- **Current Allocation Insufficient for Future Needs –** Opponents to any further PSS spectrum allocation often point to the current allocation between 380 – 470 MHz.[9] However, of this allocation, only two 5 MHz-wide blocks are available for use by PSS in many countries because the remaining spectrum is already assigned to other users. The effect of this limited spectrum allocation is that there has always been an issue with capacity at major incidents and planned events. The integrated broadband data services which are emerging as an important PSS need require more bandwidth. Ideally, to provide broadband mobile access for PSS communication requires two 15 MHz-wide blocks. Some may suggest that such an allocation would be a waste. PSS spectrum usage tends to be markedly different from that of other radio users. The utilization rate of public spectrum ranges from near constant (e.g. some radar systems and fixed point to point radio links), to mostly idle (e.g. some emergency communications spectrum). The regulator making an administrative determination regarding the amount of spectrum to set aside for PSS may regard average utilization and decide that much of PSS spectrum is "unused" at any given moment. However, unlike commercial uses of spectrum, looking at an average level of usage gives regulators little guidance as to how much radio spectrum and which bands to allocate to PSS. Despite the fact that the particular carrier waves in the band are not being utilized to transmit information at any given moment; this spectrum is merely idle, not unused. Much like an "idle" fire extinguisher, the spectrum is being used to provide the benefit that it could be instantly available should an emergency arise. Also as the use of data is increasingly used in day-to-day operations, the amount of idle time is likely to decrease and we will see that in emergency situations the spectrum will be re-deployed to meet the new urgent requirements of dealing with an incidence. The wide variability of use necessitates a further allocation of dedicated spectrum.

- **Dedicated Networks and Dedicated Spectrum -** Beyond the question of the corporate form of the organization running the PSS network, the questions whether spectrum and networks should be dedicated to PSS use or shared with commercial users warrants serious consideration. These are separate, albeit related, decisions, but based on a single concept: of effective control of the network. In the past, it was not permissible to use shared networks (with commercial subscribers) for mission

9 A total of two 5 MHz-wide blocks (or a total of 10 MHz) have been allocated to PSS use in Europe. By comparison, in the United States, PSS organizations have access to more than 97.2 MHz of spectrum - a nearly ten-fold difference in allocation. (Kevin J. Martin, Chairman, Federal Communications Commission, *Report to Congress on the Study to Assess Short-Term and Long-Term Needs for Allocations of Additional Portions of the Electromagnetic Spectrum for Federal, State aAnd Local Emergency Response Providers, Submitted Pursuant to Public Law No. 108-458* (December 19, 2005)). As part of the transition to digital television in 2009, the US Federal Government intends to plans to transfer 24 MHz to public safety use. (Jon M. Peha, "Improving Public Safety Communications", Issues Science and Technology, (Winter 2007).) Furthermore, the spectrum available to PSS organizations in Europe is fully used by voice traffic and some data usage. The Wideband Decision in Europe for 380-470 MHz does give the PPDR community some extra data capability, but the actual spectrum situation does not enable high speed data as required for future enhancements of public investments.

critical PSS communications. This was due to the exacting demands of a public safety network. However, advances in technology may now afford some relief. Sharing networks with commercial subscribers would allow for shared network and maintenance costs, and the ability to piggyback on commercial R&D by using off-the-shelf technologies. However, rights and privileges of the PSS users must be clearly defined and any shared elements of the network would have to be subject to so-called ‘ruthless preemption’. In other words, PSS users must be able to easily and instantly override other communications at the push of a button. Moreover, PSS communications must have its own spectrum in order to ensure sufficient capacity, coverage and reliability. Thus, the future may see dual use networks, but if and only if, these networks incorporate dedicated spectrum for mission critical PSS users. In an emergency the focus of activities would change and so could this basic spectrum’s focus. The ‘Golden Rule’ in disaster management is never use a system that is dedicated for that instance as it is essential that all the users are fully cognisant with the operation and services that can be provided through daily use and so the users are comfortable with the system when they will be force to work with it under stress conditions.

3.3 Market-Based Spectrum Policy

It is generally agreed that market economies are much more efficient at distributing scarce resources to their highest value use than command economies. We do not dispute that; however, markets cannot solve all problems. The modernisation and liberalisation of spectrum policy in recent years has sought not only to encourage efficient spectrum use, but efficiency in assignment of licenses as well. This has been accomplished by introducing market signals in the form of price information into policy determinations. Since 1994, governments have increasingly used auctions to determine efficient assignments. Auctions have worked quite well with regards to commercial users. Nonetheless, spectrum assignments for PSS users have continued to be administrative decisions, which can oftentimes produce economically suboptimal distributions of resources. Thus, following on the successes of auctions for commercial assignments, there has been discussion to extend auctions to all spectrum users, both public and commercial. In the UK, a report drafted by the distinguished professor Martin Cave argues convincingly that in the future it is expected that the spectrum requirements of PSS organisations will be met via market processes.

> “At first sight it may seem incongruous to require a public sector body such as a fire service or a defence force to compete in a market place for spectrum with commercial providers of services such as mobile broadcasting. However, this is exactly how public sector organizations acquire other inputs – such as employees, vehicles, and office space. In relation to these inputs (with the

> exception of a compulsory military draft in the case of labour) public sector bodies have to go into the market, for example, buying or selling land, hiring workers, or leasing buildings."[10]

The analysis surrounding PSS spectrum is somewhat more complicated than this suggests. While the approach presented in the Cave Report is well reasoned, it remains to be demonstrated whether it mitigates the significant risk that in basing the award of spectrum on price, PSS organizations may fail to obtain sufficient spectral resources, thereby reducing the ability to provide their indispensable services to society as a whole.

Certain concerns make PSS entities ill suited to participating in such auctions. First of all is an ever-present budget pressure. The acquisition of spectrum requires significant planning, unlike the acquisition of fuel or vehicles. PSS organizations at the present moment have neither the financial nor administrative nor experience to participate effectively in complicated and expensive auctions. This is in part because of their independent and diverse financial, operational and budgeting structures. Also, transaction costs to aggregate sufficient PSS spectrum to meet all demands could be prohibitive and could lead to fragmented spectrum. Are we to believe that according to economic logic, PSS users are not high value users since they do not have the budgetary resources necessary to compete in auctions for spectrum real estate against the deep pockets of commercial organisations?

Considering these characteristics, traditional market mechanisms may fall short in determining an appropriate allocation of spectrum to PSS communications. We do not argue, however, that PSS organizations should get a "free ride" on all spectrum assets. Recent studies have argued that even a modest increase in the financial cost of access to spectrum, by applying administrative incentive pricing (AIP), can lead to organisations increasing the efficiency of its use. Methods have been developed to place an administrative price on the spectrum by comparing with comparable fees per unit of spectrum with similar frequencies used for commercial services. The method of calculation of AIP charges in the case of PSS spectrum could be set, for example, at a level that may exceed the opportunity cost of the alternative service opportunities. AIP raises funding and incentive issues for publicly funded PSS organizations who would need further funds to cover the costs of increased spectrum fees, but it is still likely to improve efficiently of spectrum use.[11]

10 Martin Cave, et al, "Is public sector spectrum management different?", in Essentials of Modern Spectrum (Cambridge University Press 2007).

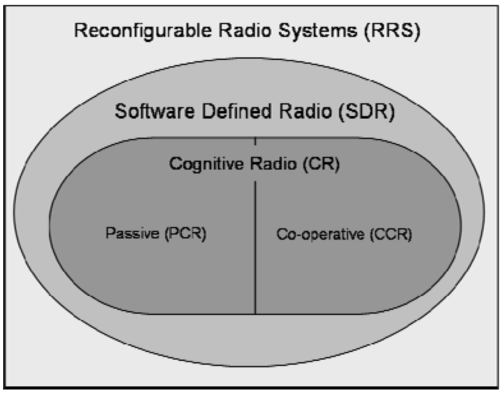
11 See, Independ Consulting, Ltd and Aegis Systems, Ltd., Aeronautical and Maritime Spectrum Pricing, (April 2007) available at: http://www.aegis-systems.co.uk/download/1824/aipreport.pdf.

3.4 Technology-Based Spectrum Policy

Another important policy trend is an increasing reliance on technology to solve spectrum use issues. There is a sort of cognitive dissidence in certain circles that technology will solve all problems and obviate the need for spectrum policy. Yet, through this lens, we can see the transition from analogue terrestrial broadcast television to digital as being in context of a much broader transformation of wireless communications. This is really the first of a series of “Digital Dividends” paid for by emerging technologies which can afford ever-increasing spectral efficiency by employing filtering, sharing, and opportunistic use technologies. This accelerating technological trend will enable new sources of spectrum to meet society’s most important needs, not by creating new spectrum, but by wasting less.

There are a number of new pre-emptive technologies including cognitive radio (CR) and Software Defined Radio (SDR) which are expected to solve problems associated with access priorities and spectrum sharing. SDR enables the cognitive radio to reconfigure its emissions characteristics to enable the radio to adapt its behaviour according to the environment in which it operates. Cognitive radios, also called “smart radios” can sense the presence of other transmissions in the local area and automatically switch to unused channels. The cognitive functions are performed by applying a process where a sequence of ‘observe’, ‘orient’, ‘decide’ and ‘act’ is implemented. SDR enables the cognitive radio to reconfigure its emissions characteristics to enable the radio to adapt its behaviour according to the environment in which it operates. In future, it may be possible for cognitive radios to interact or negotiate with other, existing spectrum users but it is too early to base mission critical communications on the deployment of such technologies. The fact that the introduction of new efficient technologies will eventually free other spectral resources does not lessen the need to get this transition right and reinvest the Digital Dividend in the uses most likely to generate the best returns for society.

Figure 3: Spectrum Sharing Technologies



Source: wik-Consult GmbH

In addition, a part of technology-based spectrum policy is an effort to find permissible uses for the "TV White Spaces". These frequencies are allocated, but unassigned frequencies between broadcast television channels. The White Spaces are used as guard bands to prevent interference to existing television services and are currently under utilized. Since digital television is more robust to sources of interference than conventional analogue broadcast television, it may be possible to offer wireless broadband and other innovative services in these bands. It may be possible to make use of individual TV frequencies in areas where these are not being used locally for broadcasting. As already noted, there could be scope for the sharing of frequencies with TV services in the UHF band, either on a pre-emptive or geographically co-ordinated basis.

3.5 Preemptable Spectrum Allocation

We observe that a dedicated band is the only approach that will fulfil the needs of PSS mission critical communication. However, it is possible that the Commission or NRA may be unable or unwilling to allocate as much spectrum as PSS could ideally use. Thus, one future way in which market signals and sharing technologies may be introduced to PSS spectrum in Europe could be through a preemptable spectrum allocation. Preemptable spectrum is spectrum that can be cleared for public safety use during emergency situations.[12] This allocation of preemptable spectrum for PSS use would be in addition to core dedicated, exclusive spectrum, and would only be accessed in certain limited circumstances. Preemption can only work in one direction, with commercial services taking advantage of spectrum and networks dedicated to PSS communications, and with PSS being able to 'ruthlessly' invoke emergency use at the expense of commercial use.

The availability of workable preemption networks is beyond the time horizon of our analysis. However, to begin with it has to be recognised that virtually all spectrum assignments are *de jure* preemptable. Under all modern spectrum regulatory regimes, the government can at its discretion withdraw license permissions and/or issue Special Temporary Authorities to address the needs of a crisis. Operationalizing this policy into a set of rules for dynamic day-to-day use, enables PSS uses to be matched with commercial uses.[13] Certain NRAs are already entertaining these debates, and should consider augmenting an allocation of exclusive use spectrum with a larger allocation of "burstable" spectrum that would be pre-empted in an emergency situation. The economic arguments for such an approach seem to be strong, but one would have to carefully weigh (1) the risks that pre-emption fails when needed, (2) the cost of loss of

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12 Mark M. Bykowsky and Michael J. Marcus, "Facilitating Spectrum Management Reform via Callable/Interruptible Spectrum", Federal Communications Commission (September 13, 2002) at http://tprc.org/papers/2002/147/SpectrumMgmtReform.pdf.

13 Comments of Robert Gurss, APCO International.

service during pre-emption, (3) the impact on service providers, users and manufacturers of designing pre-emption and (4) the attractiveness of such spectrum to commercial organisations. Careful attention must be paid to the practical matters of how such an arrangement might function.

Despite certain engineering drawbacks, premptable, non-core PSS spectrum allocations promise significant economic benefits. Properly designed preemptable spectrum policy can, to some degree, introduce market signals which lead to efficient use by lowering the economic cost of idle spectrum. It allows highest value commercial use, but retains priority for PPS uses.[14] Like Wi-Fi, spectrum still has value even if it cannot be used all the time. Such highly desirable spectrum would be attractive for “best efforts” networks or networks which are not used during emergencies. Examples of such networks might include fixed broadband consumer Internet access or fleet radios for a private company’s dispatch operations.

Since it is more complicated, an interruptible system requires more expensive equipment and engineering. A radio which comprises all these functions may have an unacceptable impact on cost, form factor and performance. These costs could be offset with funds from commercial use. However, some consideration should be paid on how to handle the revenues derived from commercial use of preemptable PSS spectrum and it would be preferable not to make PSS organizations spectrum resellers, adding conflicting or perverse incentives. In addition, there must be a penalty to ensure PSS users do not misuse or abuse their powers of preemption. This is akin to penalties for making false alarms. In sum, a balance between market driven solutions and the requirements of people’s lives and national security must be struck. Spectral efficiency cannot and should not be the sole consideration.[15]

3.6 Findings and Recommendations

The Digital Dividend provides an ideal opportunity for policymakers to repeat the success of the 1996 decisions, and perhaps even more so. An appropriate allocation of spectrum to broadband mission critical communications could help protect billions of Euros worth of property and save thousands of lives every year.

PSS organisations require this dedicated spectrum and their own networks because of the flexibility it affords – the ability to meet their own specific requirements so that they can maximise the advantages provided by broadband services. Dedicated networks employing a dedicated spectrum band are widely used today because it is considered the best way to provide secure, robust and immediate communications for PSS radio systems. The integrated broadband data services which are emerging for PSS

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14 Ibid.
15 Comments of Malcolm Quelch, Sepura plc.

organizations require more bandwidth. Ideally, the allocation would be harmonized across Europe. In arriving at the recommendation, it is not our intent to favour any particular technical standard, but to provide maximum flexibility for PSS services and allow technologies, networks and services to evolve over the longer term.

Therefore, we recommend an allocation of Digital Dividend spectrum to public safety first. This is the preferred allocation, since under certain circumstances commercial users can take advantage of PSS communications network, and not the other way round. In an ideal situation, Public Safety Services would have two blocks of 15MHz allocated between 400 MHz and approximately 800 MHz. This allocation should be Pan-European even though different parts of the same frequency bands might be utilised in each country. Such an allocation is roughly equivalent to spectrum allocations from the release of analogue TV in the US.

The spectrum released can provide access to spectrum in the amounts and within the timescales needed by PSS organizations. Spectrum needs to be made available, or at a minimum identified, over the next 12 to 18 months. Early announcement of the available spectrum for PSS would help underpin the potential for an evolutionary path and provide users with certainty to begin planning their next generation systems and services.

We may regard the PSS communications policies for the Digital Dividend as a widow to the future. However, if we return to first principles, we find that the essential need for emergency communications to have been the mother of spectrum policy, nearly a century ago. The basic framework for nearly all wireless communications regulation today finds its origins in the sinking of RMS Titanic in April of 1912. In the wake of this tragic disaster and staggering loss of life, governments around the world began to put in place the rules necessary not only to enable wireless communications but also to ensure that those in peril have the ability to make distress calls. Could there possibly be anything more important?