# AEGIS NEWSLETTER—February 2009

In our previous Newsletter, March 2008, we considered the opportunities and challenges arising from the switching of television from analogue to digital technology. In Europe there is increasing interest in harmonising the use of the 790–862 MHz band (the upper part of the analogue TV band), in line with the views of the European Commission, with France being the first country to adopt such an approach. Aegis has continued to provide support in this area and is aware of the challenges facing Regulators in determining the approach best suited to maximising the benefit from the "digital dividend".

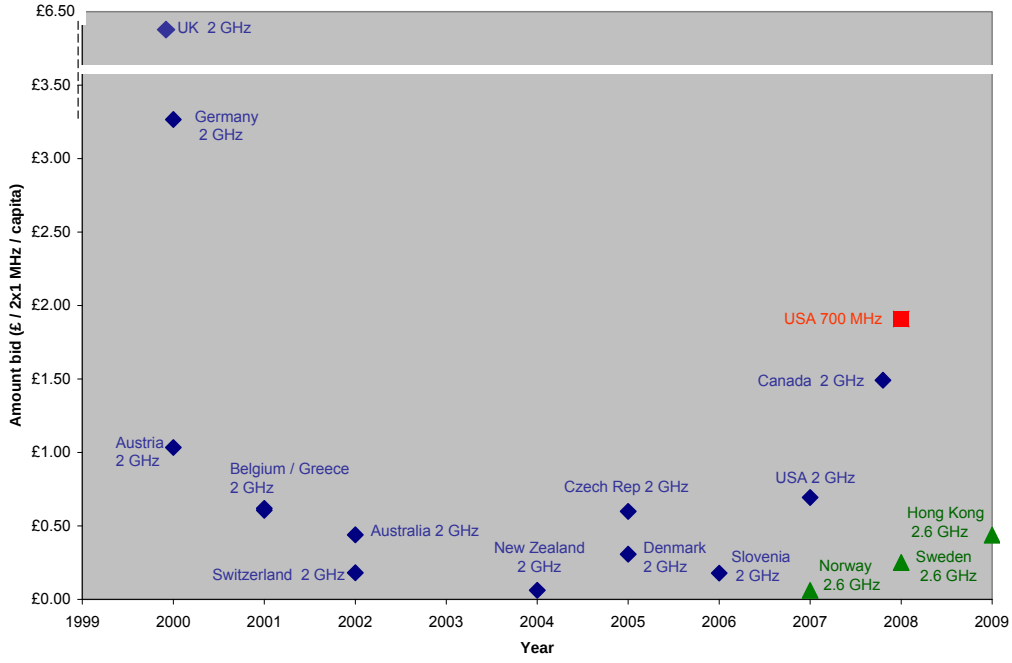
In this Newsletter, as well as providing information on some of our recent projects, we start with two articles: one looking at spectrum auctions and the other at licence reissue and spectrum liberalisation. We trust you will find them of interest. If you have any questions or require further information on topics mentioned in this or previous Newsletters, or if we can assist you in providing expert independent support, please contact either John Burns (john.burns@aegis-systems.co.uk) or Val Jervis (val.jervis@aegis-systems.co.uk) or enquiry-2009@aegis-systems.co.uk.

## *WHAT PRICE SPECTRUM?*

### *— John Burns*

It is almost a decade since the first European spectrum auctions were held and the recent round of auctions for newly released spectrum in the 2.6 GHz and 700 MHz band provides an opportunity to review the value placed on particular parts of the spectrum over time and in relation to different frequency bands. The first two high profile auctions were held in the UK and Germany at the start of the decade. Both attracted a high number of bidders and raised amounts many times greater than had been expected. Subsequent European auctions were much less frenetic and in some cases not all the licences were sold.

In the following graph we have compared the amounts paid by a typical bidder in various spectrum auctions over the last decade, on a per-MHz basis, normalised by population.




A number of trends are apparent from this comparison. After the initial euphoria of the UK and German auctions there was a steady reduction in the amounts paid for core 3G spectrum at 2 GHz, reaching a minimum around 2004. Recent auctions have seen some recovery in the prices paid, though in some cases this is a reflection of the reserve prices set rather than the result of competitive bidding activity. Of particular note are the recent auctions for 2 GHz spectrum in Canada and for 700 MHz spectrum in the US, where strong competition from existing market players and new entrants has resulted in prices similar to those paid in some of the earlier 2 GHz auctions. The relatively high price paid for 2 GHz spectrum in Canada probably reflects the fact that a sizeable portion of the spectrum was reserved for new entrants. The high price tag for the 700 MHz band reflects its attractiveness for extending rural and in-building coverage, compared to higher frequency bands.

Smaller amounts have been bid in those countries that have awarded licences in the 2.6 GHz band. This probably reflects the current lack of equipment to operate in this band and the less attractive propagation characteristics relative to lower frequency bands. In the longer term, as existing spectrum becomes more congested and demand for wireless broadband services grow, we would expect the value of these higher frequency bands to rise accordingly—indeed, this trend is already apparent from the three auctions held so far.

At Aegis we have been analysing trends in spectrum valuation and pricing over many years for both regulatory and industry clients. We can advise on effective ways to price radio spectrum either to reflect its market value or to ensure equitable recovery of management costs from licence holders.

## *LICENCE REISSUE AND SPECTRUM LIBERALISATION*

***— Val Jervis***

Administrations are increasingly having to make decisions on how and whether to reissue licences as expiry dates for licences issued for frequency bands such as the 900 MHz and 1800 MHz bands rapidly approach.

In the past the challenge facing administrations has been how to enable spectrum refarming to allow the deployment of alternative technologies and services. Licence expiry was seen as an ideal opportunity for reallocating and re-awarding the spectrum. However, in the case of technology-neutral licences it is likely that the licensee has invested in new technologies and upgraded services as they will want to optimise their return on the spectrum—minimise OPEX and CAPEX while maximising revenue. So what approach should be adopted here? There are three main options that could be adopted depending on the underpinning legislation and the extent to which the spectrum is being utilised:

| Option | Reason | Advantages | Disadvantages |
|---|---|---|---|
| Competitive re-award of all spectrum | Legislation may require licences to be terminated on licence expiry and the spectrum re-awarded. | Clear unambiguous approach. Provides the potential for entry of new players and opportunity for the market to re-evaluate optimal spectrum needed to deliver services (especially where trading has not been introduced). | Licensee may be unwilling to invest when close to licence expiry date. Potential disruption to subscribers if existing operator does not gain continuing access to the spectrum. |
| | Ensure spectrum used efficiently. | Provides the potential for entry of new players / alternative uses and opportunity for the market to re-evaluate optimal spectrum needed to deliver services (especially in those markets where trading has not been introduced). | Requires regulator to make judgement on what constitutes efficient use.<br>Licensee may have new plans that would utilise the spectrum efficiently but had not yet been implemented. |

| Option | Reason | Advantages | Disadvantages |
|---|---|---|---|
| Reissue licences for part of the originally licensed spectrum and competitive re-award of remainder. | Provide continuity of existing services to subscribers.<br>Ensure spectrum used efficiently. | Competitive re-award of part of the spectrum might provide the potential for entry of new players / alternative uses depending on the approach adopted.<br>Takes account of investment made in networks by existing licensees and provides the opportunity to ensure continuing services to subscribers.<br>Provides the potential to modify the amount of spectrum to "even-up" any historical differences and amend licence conditions. | Requires regulator to determine the amount of spectrum that should be re-licensed.<br>Ideally need to be sure that there are other interested parties in the spectrum. |
| Re-issue licences with no changes | Provide continuity of services.<br>Any inefficient use of spectrum can potentially be resolved through spectrum trading. | Encourages ongoing investment by licensees in new technologies and services. | May limit potential for entry of new players and approaches if spectrum trading does not occur or is not allowed. |

| Option | Reason | Advantages | Disadvantages |
|---|---|---|---|
| Re-issue licences with amended conditions. | Provide continuity of services.<br>Ensure operators are competing on a similar basis. | May encourage ongoing investment by licensees in new technologies and services.<br>Allows the relative competitive position of licensees to be reviewed and potentially changes made to the licence conditions to, for example, amend frequency bands and amount of spectrum or coverage requirements. | Proposed changes to licence conditions may have financial implications for licensees and be challenged. |

In the case where the licences that are due to expire are not technology neutral there may be other considerations that come into play. That is the situation in Europe where in the 900 MHz and 1800 MHz bands licensees have been required to deploy GSM technology. Administrations have been considering the possibility of liberalising the spectrum at the same time as deciding whether to allow the incumbents ongoing access to their currently licensed spectrum after licence expiry without a competitive award process or amendments to their licences.

Spectrum liberalisation has raised a number of issues:

- Should the 900 and 1800 MHz spectrum be redistributed between the GSM operators? There is considered to be significant benefit to operators in having access to 900 MHz spectrum because:
    - WCDMA / HSPA technologies are already available in the market-place in this frequency band but not at 1800 MHz.
    - Coverage is significantly extended in rural areas and also in-building coverage is improved, so it provides a lower-cost option (reduced CAPEX and OPEX over higher frequency bands) for the deployment of WCDMA / HSPA to support broadband services. The GSA (Global mobile Suppliers Association) has estimated that for the same service offering and coverage, the number of base station sites in the 900 MHz band can be reduced by 60% compared to that needed for 2100 MHz.

- Should spectrum be made available to potential new entrants or those “3G” operators that do not have access to any 900 or 1800 MHz spectrum currently?
    - In the case of the operators that only have access to 2.1 GHz spectrum there could be significant advantages in having access to the 900 MHz spectrum as noted above.
    - Whether there is a viable business case for any potential new entrants is unclear, especially with market penetration of over 100% in most cases. There would need to be synergies / economies of scale that would result in a new player entering the cellular market, especially with the current economic downturn.
- If licences are re-issued what fees should be charged? The current fees have generally been determined on an administrative basis or in a few cases are based on auction results. However, if the spectrum can now be used to deploy WCDMA/HSPA, LTE or GSM technologies should the fees be comparable to those for the 2.1 GHz band? For example, in France the annual fees for the 900 MHz licences of Orange and SFR, which are technology neutral, are the same as for the 3G (2.1 GHz) spectrum. Also, should there be an upfront fee if one was paid previously when the spectrum was first licensed?

It is early days and decisions are still to be made. Decisions to date have varied considerably and the following are some examples:

- Renewal of licences on a technology-neutral basis to the existing operators. This was the approach adopted in Finland and in addition the operators were required to transition to new allocations to remove the fragmentation in the 900 MHz channel plan.
- Auction of spectrum. This was the intention in Norway but there was no competition for the licences so they were renewed at the reserve price. A decision on whether to liberalise the spectrum was to be taken at a later date.
- Renewal of licences for a shorter duration to harmonise expiry dates. This approach has been adopted in the Netherlands, Germany and Switzerland.
- Reallocation of spectrum. This has been implemented or proposed in a number of countries including France, Germany, Switzerland and the UK.

Aegis has been involved in all aspects of licensing and spectrum refarming over many years. We have undertaken a number of projects that directly relate to the recent challenges of whether to reissue licences and if so on what terms.

## SPECTRUM REGULATION

### Entertainment Sector Study

Following the success of similar studies in the health and transport sectors, Ofcom commissioned Plum Consulting in association with Aegis and Quotient Associates, to carry out a nine-month study to:

- develop likely scenarios for the way digital entertainment services[1] are produced, delivered and consumed in the UK in 2018 and 2028
- assess the implications of these scenarios for demand for spectrum in the UK.

The study considered how, over the next 20 years:

- end-user demand for entertainment might develop
- the capability of end-user devices and distribution platforms for digital entertainment services might change
- the processes for production of these services might develop
- the value chains and business models of the industries that deliver entertainment might change.

A set of scenarios was produced which represented credible but distinct descriptions of the entertainment sector in 2018 and 2028 and was validated by expert review.

The findings of the study, due to be completed by March, will inform Ofcom's thinking on spectrum and other policy issues.

### Spectrum Benchmarking

In conjunction with Plum Consulting we have recently undertaken two studies for the GSMA related to spectrum licensing and economic efficiency in cellular mobile services.

The first report considers a fundamental question which confronts regulatory authorities around the world. How many spectrum licences should they issue to cellular mobile operators? We believe that there is a balance to be struck between two conflicting factors when considering increasing the number of licensed operators:

- more operators increases the intensity of competition and, as a result, leads to lower prices, better services and greater cost efficiency, but
- more operators lead to network duplication and less spectrum available per operator, both of which lead to higher unit costs.

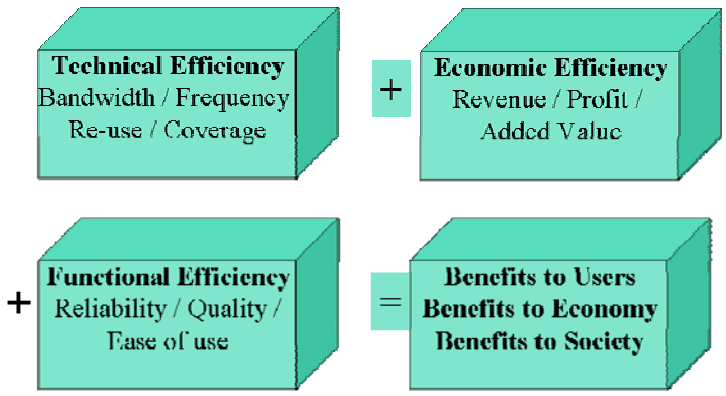
The report considers the factors that determine the appropriate balance for maximum economic efficiency in the delivery of mobile services and is particularly relevant for

[1] *Provisional definition: services and products which entertain through reading, watching, playing or listening but excluding non-leisure activities, learning, creative hobbies, travel, participation in sports or socialisation.*

authorities where market penetration of cellular services is still low and the decision on how many cellular operators to license is currently a live issue.

The second report specifically considers the situation in India, where there are more competing operators in the market than in other countries—in some areas there are nine or more operators (GSM and CDMA) assigned spectrum compared with three to five elsewhere. As a result, mobile operators in India have typically only a quarter of the spectrum available to mobile operators licensed in other countries and are therefore required to use the spectrum far more intensively and incur greater costs. The study estimates that, comparing the spectrum utilisation in dense urban areas of busy hour traffic per square kilometre per MHz, Indian operators deploying GSM technology are extracting around eight times more capacity than operators in the UK, Hong Kong, or Singapore. However, while this approach ensures technical efficiency (increases spectrum utilisation) it requires significant investment in base stations and additional spectrum optimisation techniques. The economic efficiency of the approach adopted in India is examined in this study.

Aegis has previously considered the topic of spectrum efficiency and presented a paper on this subject at the IEE conference "*Getting the most out of the radio spectrum",* in October 2002. In that paper we considered spectrum efficiency as consisting of three principal dimensions, namely technical, economic and functional, as illustrated in the following diagram:




**3-dimensional view of spectrum efficiency**

**Technical** efficiency essentially means conveying the maximum volume of data or voice traffic with a given amount of spectrum resource, which typically includes geographic area or volume as well as pure bandwidth. Hence parameters like erlangs/MHz/km$^2$ or MBit/s/MHz/km$^2$ may be used to compare the relative efficiency of mobile phone networks.

**Economic** efficiency can be expressed in terms of the maximum revenue, profit or added value that can be generated from a finite amount of spectrum resource. (CAPEX and OPEX will impact on maximising these values.)

Finally, **functional** efficiency may be regarded as the extent to which the use of radio spectrum meets a user's specific needs, so enabling a particular task to be carried out more efficiently or effectively than would otherwise be the case. For example, a

taxi firm or fleet operator's business may depend heavily on the ability to communicate instantly and reliably at minimal cost while on the move, which may not be compatible with a public network's objective to maximise overall traffic throughput on its network. Reliability and speed of connection are even more paramount for public safety applications such as the emergency services or air traffic control.

Typically all three of these aspects need to be considered when assessing how optimally spectrum is being used. For example, when comparing the efficiency of mobile radio services, cellular networks may score highly in terms of technical efficiency relative to private mobile radio, but the latter may well win out on functional efficiency.

The full paper can be found at:

http://www.aegis-systems.co.uk/download/ieespectrum1.pdf

**Licence Renewal Options**

What to do when current licences are nearing their expiry date is a topic increasingly faced by regulators. Usually there is some leeway (depending on national legislation) and the regulator will need to consider what option is best from the perspective of market players and consumers. The decision on whether and under what conditions to renew licences becomes more complicated where the spectrum is fully utilised, there are a significant number of customers using the networks and the operators have made significant investment in rolling out and developing the networks.

In a study led by Plum Consulting and with local support from Incyte Consulting, Aegis explored different options for the reissue of licences in Australia in a number of frequency bands used to supply wireless access and cellular services (i.e. 850 MHz, 1800 MHz, 2.1 GHz, 2.3 GHz and 3.4 GHz), which will expire from 2013 to 2017.

The licences under consideration are potentially of high value and the purpose of the study was to provide a robust framework setting out options for licence reissue and an analysis of issues that could form the basis of a dialogue with industry and other interested parties.

Specific issues considered included:

- options for renewal in the public interest and the criteria that should be applied
- options for price-based reallocation
- assessment of the implications of renewal and reallocation options in qualitative and quantitative terms, including the impacts on: consumers, industry, government, industry structure and competition and other regulatory policies
- assessment of the demand for the licences from existing and alternative uses
- assessment of options for changing licence conditions to promote more efficient and effective use of the spectrum
- identification of any transitional issues.

The analysis took account of:

- the spectrum management policy in Australia, where there is extensive use of market mechanisms, including auctions and trading, with spectrum licences being defined in a technology- and service-neutral manner
- economics literature on licence/franchise renewal
- options for reissue of spectrum licences used for wireless access services that have been considered and adopted in a number of other countries including the specific policy objectives and market circumstances that informed the decisions
- the views of key stakeholders which were gathered through interviews.

### Spectrum Liberalisation in 900 and 1800 MHz Bands

A study was undertaken for the Irish regulator ComReg to advise on technical issues associated with the liberalisation of spectrum in the 900 and 1800 MHz bands which are currently licensed to the cellular operators for the provision of GSM services.

### Spectrum Requirements for Emergency Service (TETRA) in the Republic of Ireland

A report provided an independent analysis of the amount of spectrum that would be required to roll out a national TETRA network in the 380–400 MHz band providing coverage to 98% of the landmass of Ireland for hand-portable terminals and 99% coverage for mobile terminals. The analysis undertaken was an estimation of the spectrum requirements to meet the specified coverage and capacity objectives in typical urban, suburban and rural environments. The first step was to determine the number of cells required in each geographic area to meet the required coverage objective, and then determine how many carriers were required at each site to meet the projected local capacity. Finally, the number of frequencies required in the network was determined by considering the frequency re-use factor (i.e. the minimum geographic separation required between cells operating on the same frequency to maintain the required carrier to interference ratio) that is likely to be achieved within the network.

## OPERATIONAL STUDIES

### WiMAX / Earth Station Co-ordination

This study examined the potential for mobile WiMAX to share spectrum with satellite Earth station downlinks in the 3.5 GHz band. The work undertaken quantified the separation distances required between WiMAX terminals and Earth station receivers at different probabilities and percentage-times. The Aegis spectrum planning tool was used in Monte Carlo mode to predict the interference at a chosen Earth station (real or hypothetical) from a population of WiMAX transmitters distributed randomly over a defined area. The interference from each base station, or the aggregate interference from the subscriber terminals associated with each base station, was recorded and associated with the base station distance from the victim receiver, allowing plots to be drawn showing the statistical relationship between interference power and path length.

It was found that provided the WiMAX base station has been successfully co-ordinated with a given Earth station, no harmful interference should be caused by the operation of mobile or fixed user terminals in a WiMAX system.

### Electromagnetic Safety of Cel-Fi System

Aegis was asked by US-based company Nextivity to examine the implications of a new product, the Cel-Fi 'picocell' system, with regard to electromagnetic safety, with particular reference to the European regulatory environment. Cel-Fi is designed to provide better indoor cellular coverage.

The first step was to identify potentially applicable CENELEC standards for human exposure to electromagnetic fields. The CENELEC standards ultimately refer to the exposure limits given in the publication of the Council of the EC, Council Recommendation 1999/519/EC. These limits are identical to those set out by the ICNIRP in 1998.

The limits are specified in different terms for different frequencies, reflecting the variety of physical effects and coupling mechanisms involved. Between 100 kHz and 10 GHz the 'Basic Restrictions' are set out in terms of Specific energy Absorption Rate (SAR). A whole-body average rate of 0.08W/kg is allowed, with local rates in the head and trunk, or the limbs, not to exceed 2 or 4 W/kg respectively.

Modelling of a 'representative' and 'pessimistic' case was then undertaken to confirm that the Cel-Fi system power flux levels at the user, in a range of different scenarios, were below the relevant ICNIRP safety limit for exposure of the general public.

## RESEARCH STUDIES

### Wide Range Propagation Model

Over the years, a large number of propagation models have been evolved by public bodies such as the ITU-R, and by private agencies, that, between them, provide a toolkit for modelling most scenarios of interest to the radio system planner or regulator.

A problem can arise, however, when it is necessary to undertake modelling that involves a large frequency range, or is concerned with the propagation conditions relating to arbitrary percentage-times, or over very different path lengths. While individual models may be available for each of these cases, large discontinuities in the results may arise when they are combined.

Ofcom is currently funding a research study to develop a new model that will be applicable over a very wide range of conditions. The study is being led by the Rutherford Appleton Laboratory in collaboration with Signal Science, db Spectrum Services and Aegis.

The Aegis contribution, to date, has largely been concerned with improving the modelling of tropospheric propagation enhancements at frequencies below about 500 MHz. It is intended to present the initial results of this study at the forthcoming meetings of ITU-R Study Group 3 in Geneva.

### Wind Farm Interference Study

There has been a rapid growth in the deployment of wind turbines to generate electricity in many countries including the UK. This has led to concerns about the interference to radio systems (ranging from aeronautical radar to broadcast television) caused by energy re-radiated from the turbine structure.

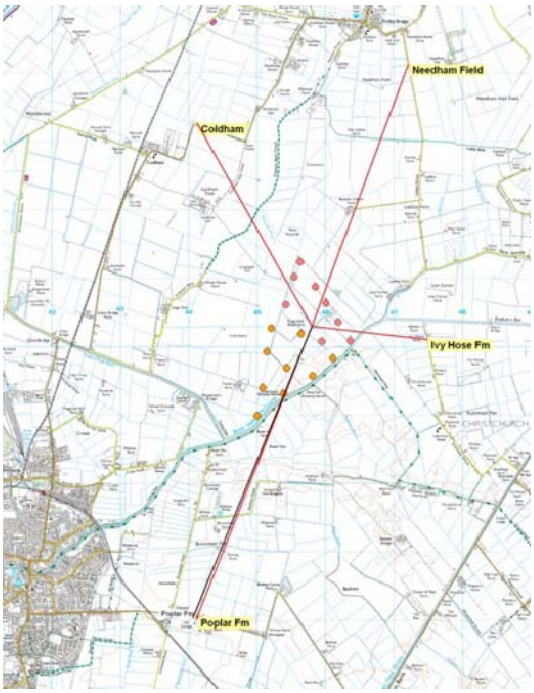
Last year we participated in a study for Ofcom, led by ERA Technology that had the aim of validating some assumptions often used by the industry when undertaking the planning of wind farms with respect to fixed-link systems.

**Aegis and ERA vehicles with distant turbine**

The Aegis part of the work sought to determine values for the radar cross section (RCS) of typical wind turbines. While some RCS measurements have been made before, these have generally been in the context of radar interference, and have only considered *backscattered* energy.

For fixed links and broadcast systems, forward- or side-scattered energy is more important, and to predict this requires an understanding of the so-called *bistatic* RCS of the turbines. Aegis used a tri-band channel sounder (operating at 436, 1477 and 3430 MHz) to isolate the energy scattered by individual turbines within a wind farm. For the pure forward-scatter case, it is not possible to resolve the individual turbines, and, instead, the aggregate effect was measured using a CW transmitter and receiver.


**Interior of Aegis vehicle**




**Typical measurement geometry**

It was found from the limited set of measurements that were possible under this study that scattering of energy from wind turbines is most significant in the forward direction and interference occurs due to the interaction between the direct and forward-scattered energy from the turbine(s). The values measured for the radar cross section varied between 40–60 dBm², which was significantly larger than the physical cross section of the turbine blades. The findings of the study will be presented in a paper at the forthcoming European Conference on Antennas and Propagation (EuCAP) in Berlin in March.

**Time Varying Interference**

In our previous newsletter we noted that we were undertaking a project on behalf of Ofcom, aimed at understanding issues connected with time-varying interference to digital television. The study was noteworthy because it linked engineering measurements by Aegis with consumer attitudes research undertaken by our partners, i2 Media Research at Goldsmiths, University of London (http://www.goldsmiths.ac.uk/i2/).

The mechanisms and statistics of short-term propagation enhancements, studied during the initial planning and roll-out of UHF television services in the 1950s and 60s, have been incorporated in planning models such as ITU-R Recommendation P.370. Such models allowed analogue networks to provide adequate protection from short-term, long-range interference.

The impact of interference on digital television is different, with a rapid and complete loss of picture for a small change in interference. This implies that a more stringent protection criterion is necessary for DTT services, and a value of 1% time has generally been adopted. The current study sought to determine whether this criterion is appropriate.

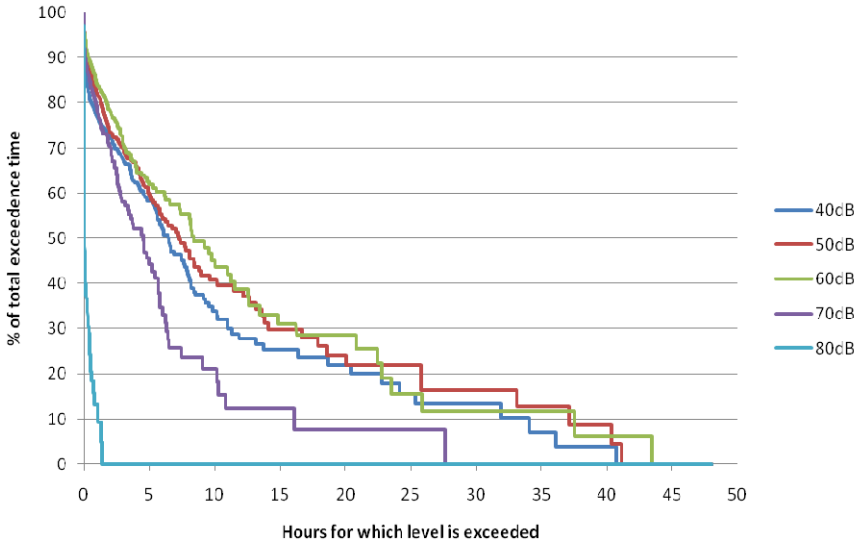
Engineering measurements of overseas transmissions were made to derive new statistics on interference event durations at a resolution not previously available. Follow-up consumer interviews explored attitudes to such interference and its impact on reception choices for digital television.

The study revealed that interference at 1% time can mean interruptions to DTT reception of several hours in an evening, potentially over consecutive days, and that the interruptions are unlikely to affect all DTT multiplexes simultaneously. During the study we carried out continuous logging of continental transmissions over a number of mixed paths across the English Channel and the North Sea.

Specific findings showed that:

- The annual statistics of path loss are reasonably in agreement with the existing ITU-R models (P.1812 and P.1546).
- Severe interference events are most likely, for these sea paths, to occur in the evening and early part of the night—generally when most people are watching TV.

The figure below shows the length of time for which a range of interference threshold values are exceeded. It can be seen that, for example, half the time for which the 40 to 70 dBμV/m levels are exceeded were due to events that lasted for between 6 and 10 hours.




The findings of the study relating to radiowave propagation will be presented in a paper at the forthcoming European Conference on Antennas and Propagation (EuCAP) in Berlin in March. The long-term monitoring has been continued beyond the end of the study, and it is planned to undertake further measurements to investigate other aspects of short-term ducting effects.

## RADIO SPECTRUM FEES

Over the past year we have been involved in a number of studies associated with estimating the value of spectrum to determine appropriate administrative fees or reserve prices associated with auctioning of spectrum and the studies below are two examples of this work.

### Spectrum Pricing for Australia

The purpose of this study was to provide the Australian regulator ACMA with an opportunity-cost pricing method that is efficient, practical and transparent. The recommended methodology was applied to two case studies: the frequency band 403–520 MHz used primarily for private mobile radio (PMR), and 7425–8275 MHz used for fixed links, and for two different geographic areas, namely Sydney which is high density and Perth which is medium density.

As well as benchmarking against other approaches it was necessary to consider the data that was available to ACMA before recommending the most appropriate approach.

### Value of Broadcast Spectrum in Singapore for MDA

This study, undertaken with Plum Consulting, estimated the value of UHF spectrum in the frequency range 518 to 614 MHz. The study assessed the value of the spectrum and reserve prices assuming that the spectrum can be used for any purpose consistent with the Singapore frequency allocation table and that a ten-year licence is issued.

## DIGITAL DIVIDEND

### Update UHF Band Plan Options for Cellular Mobile Services

We have updated a previous study that investigated the impact on the delivery of Digital TV in Europe if frequencies in the upper part of the band, notably Channels 61–69 (790–862 MHz), were utilised for cellular mobile services in line with current proposals being pursued in Europe.

Not surprisingly it was found that refarming these channels would have an impact on individual country digital TV plans, though the effect varies significantly from country to country. Spain, Portugal and Belgium are likely to be particularly affected as they make significant use of these channels; other countries such as the UK will lose one or two channels at certain locations. Most EU countries plan to deliver up to six national multiplexes on completion of switchover and our analysis suggests that across the 25 EU countries up to 25% of transmitter sites would no longer be able to deliver six multiplexes if this spectrum is refarmed, under the current ITU frequency plan. In many countries only a single multiplex would be affected and it is likely that the coverage shortfall could be recovered by reaching bilateral agreements with neighbouring countries to use alternative channels. In other cases (such as the countries noted above) more comprehensive re-planning would be required.

### Digital Dividend

Aegis continues to support Ofcom regarding the release of spectrum following switchover to digital TV. Our recent work examines the implications of DVB-H interference into DVB-T systems for a range of assumed protection ratios. DVB-H interference into both main and relay DVB-T systems is investigated. This work is intended to inform discussions regarding the definition of Spectrum Usage Rights in released spectrum that would be necessary to protect digital TV services at the edges of the retained spectrum.

The analysis is based on deriving DVB-T receiver failure rates within the DVB-H coverage area for a number of DVB-H and DVB T transmitter separation distances using a probabilistic approach where wanted and interfering power levels were calculated at uniformly distributed random points within the simulation area over a number of Monte Carlo trials. Overall failure rates were then calculated on the basis of integration over the entire DVB-T coverage area. In order to derive realistic failure estimates, UK household/population databases were incorporated into the modelling.

Results showed that interference into low-power DVB-T transmitters operating as relay stations (with the same polarisation as the interfering DVB-H transmitter) is more severe than interference into high-power main DVB-T transmitters (with the opposite polarisation to the interfering DVB-H transmitter).

**Spectrum for Mission Critical Wireless Systems**

The aim of the study was to develop a series of documents, ranging from a short executive summary to a comprehensive White Paper, highlighting the importance of providing additional spectrum to the emergency services from the Digital Dividend. The study was led by WiK Consulting (Germany).

The White Paper examines the social welfare that could be gained through the reallocation of digital dividend spectrum to Public Safety Services mission-critical networks. It also includes a detailed view of the technical and operational characteristics for next generation PSS radio systems based on interviews with interested parties to fully understand how the use of radio spectrum facilitated the emergency services in meeting the demands of their operational activities and how they foresaw that changing over time.

Most mission-critical operations depend on voice communications and currently have only two 5 MHz-wide blocks available in the harmonised spectrum. The opportunity to utilise broadband wireless communications was considered important to provide the opportunity to move human resources into the field. This would increase situational awareness and facilitate command and control by collecting and disseminating 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, 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 personnel in the field
- relaying of ad hoc video and surveillance camera real-time information to patrol cars responding to incidents
- 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 and is one reason why the digital dividend spectrum is particularly of interest as it can economically support the larger ranges needed to provide geographic coverage including rural areas.

The reports can be found at http://www.public-safety-first.eu/.

## OTHER

### Optimising Use of spectrum by the Public Sector in the EU

We have previously mentioned this study, which was undertaken for the European Commission under the leadership of WIK Consulting (Germany), in an e-mail in October 2008. The study addressed how technology developments and more effective regulation could yield improvements in how spectrum is used in the defence, transport and public safety sectors. Public-sector users account for approximately half the allocated spectrum and are also facing increased spectrum demand within their own sectors.

Aegis provided a presentation to a workshop organised by the UK Digital Communications Knowledge Transfer Network (DKTN) which can be found on the Aegis Web site at http://www.aegis-systems.co.uk/library/presentation.html. Also the presentations provided at the public workshop in Brussels on 1st October 2008 can be found at http://ec.europa.eu/information_society/policy/radio_spectrum/workshops/pus_workshop/index_en.htm.

### Joint Probability Distributions

This study further developed a joint PDF method for fixed-link planning that would potentially improve spectrum efficiency by using the correlated statistics of variations in wanted and unwanted powers.

Aegis was responsible for extending an existing fixed-link planning simulator to implement the new method and apply it to assignment data supplied by Ofcom. The simulator was successfully extended to model the 1.4, 7.5 and 18 GHz bands in addition to the existing 38 GHz capability. The joint-PDF method ultimately proved too slow for practical implementation within the project constraints and particularly at the lower frequencies where the path lengths increased.

### Post Code Checker

Ofcom, the UK regulator, wished to review certain aspects of the 'postcode coverage checker' on the Digital UK Web site, which could be used by the public to identify, for example, whether there was digital TV coverage in their area and who were the service providers. The checker is likely to be a valued and important resource for keeping consumers well informed in their preparations for digital television switchover. The work was primarily undertaken by i2 media, with Aegis managing the work and contributing technical comments on the functionality and user interface of the postcode checker. The Web site can be found at http://www.digitaluk.co.uk/postcodechecker/.

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