

AEGIS NEWSLETTER March 2007

Radio spectrum management in many countries is evolving from the traditional “command and control” model to a less prescriptive, more market-led, approach. The details naturally vary from country to country but an increasing number of National Regulatory Authorities (NRAs) are seeking to provide greater flexibility and transparency in the management of spectrum through the introduction of technology-neutral allocations and assignments, use of auctions for spectrum award and in some cases the introduction of spectrum trading and liberalisation of the rules governing spectrum use. By adopting a more flexible approach, NRAs can ensure that spectrum users can respond rapidly to market and technology changes, enhancing the economic and social benefits that access to radio spectrum can provide.

Maximising these benefits requires clear and consistent policy goals and a forward-looking strategy for spectrum management, providing industry with the confidence to invest in the roll-out of new networks and provision of competitive services to the benefit of all. Evaluating potential future scenarios in terms of market development, technology evolution and external social and economic factors provides a useful tool that can assist in the development of a robust but flexible spectrum management strategy. Cost-benefit analysis can be used to ensure that policy decisions will provide benefits and avoid the implementation of changes that are unnecessary. Aegis, over the last year, has been involved in a number of projects that specifically addressed spectrum regulation and the implementation of market-based approaches.

Other high-profile areas of activity for Aegis have been planning for the introduction of Digital Broadcasting services and issues associated with the provision of mobile TV.

SPECTRUM REGULATION

Technology-neutral Spectrum Usage Rights

We reported last year that Aegis was leading a study for UK regulator Ofcom, in collaboration with Indepen and Transfinite Systems, into the implementation of technology-neutral spectrum usage rights.

The work involved:

- discussions with stakeholders
- discussions with spectrum managers in several countries that have already liberalised spectrum use
- development of a technical approach to defining technology-neutral spectrum rights
- analysis of the potential failures of the proposed use of markets
- testing of proposals against case studies.

The executive summary, final report and associated case studies can be found at <http://www.ofcom.org.uk/consult/condocs/sur/spectrum/>. This report was used to inform Ofcom's development of spectrum usage rights (SURs) and a consultation paper was issued in April 2006.

Subsequently, Ofcom has decided to develop specific proposals for SURs on one or more forthcoming spectrum awards. Further information is on Ofcom's Web site at http://www.ofcom.org.uk/consult/condocs/sur/next_steps2/ and a proposed implementation relating to the forthcoming 2.6 GHz auction can be found at <http://www.ofcom.org.uk/consult/condocs/2ghzawards/>.

Collective Use of Spectrum in the European Union

For the European Commission Aegis has worked with other consultancies to study the technical, regulatory and economic issues relating to collective use of the radio spectrum. Collective use is a spectrum management approach that allows more than one user to occupy the same range of frequencies at the same time, without the need for individual (exclusive) licensing. The term "spectrum commons" is often used to describe this scenario; however, collective use also covers various types of "light licensing" regimes such as those that some countries have introduced for fixed wireless systems in the 5.8 GHz ISM band.

The European market for collective use of spectrum is already large and growing rapidly, embracing many industrial and consumer applications.

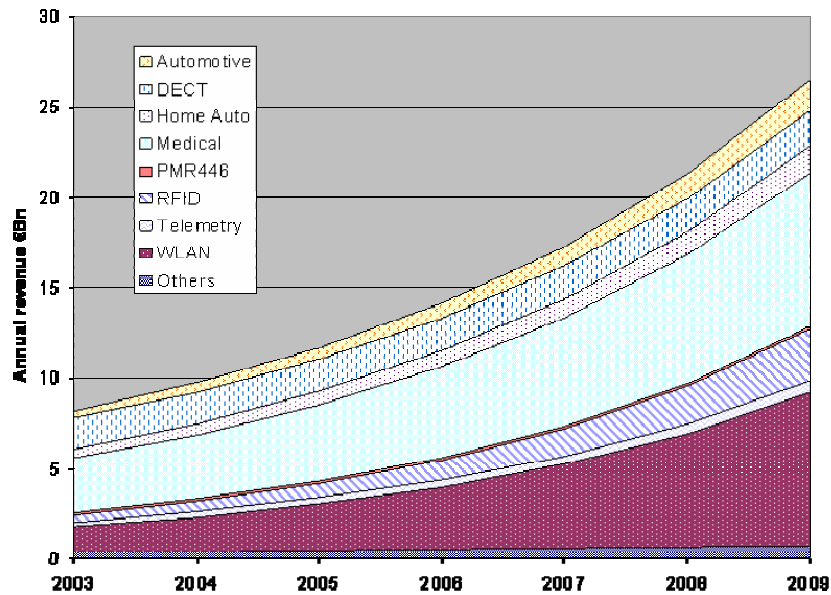


Figure 1: Indicative annual revenue estimates from collective use services

The results of the study were presented at a public workshop in Brussels in October 2006. Copies of the workshop presentations and the study report can be downloaded from the EU web site, which is at http://europa.eu.int/information_society/policy/radio_spectrum/index_en.htm.

Spectrum Policy Review

Aegis, in partnership with Ovum and Indepen, has undertaken a major spectrum policy review for the Commerce, Industry and Technology Bureau (CITB) in Hong Kong. The aim of the study was to examine the current spectrum policy and management in Hong Kong, with a view to:

- providing greater flexibility and transparency in spectrum management
- promoting the introduction of new technologies and services and thereby maximising economic benefit from the available spectrum
- strengthening Hong Kong's strategic position through provision of new wireless services while ensuring sufficient spectrum is made available for public services
- ensuring Hong Kong's regional and international spectrum obligations are met.

The study required an assessment of:

- the future supply and demand for spectrum
- whether spectrum trading should be introduced and if so how

- whether it was feasible to introduce spectrum liberalisation over the next 10 years taking into account the proximity of Mainland China
- the spectrum required for public services.

The executive summary and also the full report can be found at <http://www.citb.gov.hk/ctb/eng/paper/index.htm> under the Public Consultation on Proposed Spectrum Policy Framework (25-10-2006).

Spectrum Trading and Liberalisation

Aegis recently undertook a study in conjunction with Indepen for the Portuguese regulator Anacom, to advise on the implications of spectrum trading and liberalisation in the Portuguese environment. The work addressed:

- the rationale for adopting trading and/or liberalisation
- different approaches to trading and liberalisation
- a review of trading and liberalisation in other countries where it has already been implemented
- consideration of short, medium and long-term scenarios for the possible deployment of trading and liberalisation in Portugal.

Spectrum Allocation and Spectrum Management Policies

Aegis provided expert advice on spectrum allocation and management policies to another consultancy that was involved in a study for an NRA that was looking to increase competition in wireless services and adopt a more market-based approach to the management of the spectrum. Inputs were provided on specific issues including pricing, trading, refarming of spectrum and ensuring a joined-up overall policy including how to move from the current command and control model to a more market-oriented approach.

SPECTRUM FEES

Application of Administered Incentive Pricing (AIP) to Broadcasting

In collaboration with Indepen we have undertaken a study for Ofcom on the possible application of AIP to terrestrial TV and radio broadcasting. A key issue that was addressed was the implications of broadcasting policy for the application of AIP. The report can be found on the Ofcom Web site at <http://www.ofcom.org.uk/consult/condocs/futurepricing/aipstudy.pdf>.

Update of Fees for Portugal

For the Portuguese regulator Anacom, Aegis, with support from Indepen, undertook a review of the methodology and values currently used for spectrum fees in Portugal. This involved comparison with practices in other countries and development of a possible new methodology for setting fees for various radio services.

Update of Fees for Singapore

We are also involved in a study looking at the fees that are applied in Singapore for access to the radio spectrum and are advising on how these should be updated to reflect the costs associated with managing the spectrum and are also making proposals for the possible application of AIP where potentially demand could exceed supply.

Application of Administered Incentive Pricing to Aeronautical and Maritime Spectrum

In collaboration with Indepen we are currently undertaking a study for Ofcom looking at pricing of aeronautical and maritime spectrum. AIP is now applied to most congested frequency bands in the UK other than terrestrial broadcasting and aeronautical and maritime use (except where an auction has been used to assign rights of use). The Government has recommended that Ofcom introduces incentive pricing (subject to the results of public consultation and an impact assessment) for aeronautical radars (and possibly DME¹) and certain maritime licence classes from 2008. The figure below provided by Ofcom summarises the application of AIP at frequencies below 1 GHz to date and indicates pictorially the proportion of MHz occupied by each service. It is interesting to note that Ofcom apply AIP to a wide range of users including governmental organisations.

¹ DME – Distance Measuring Equipment

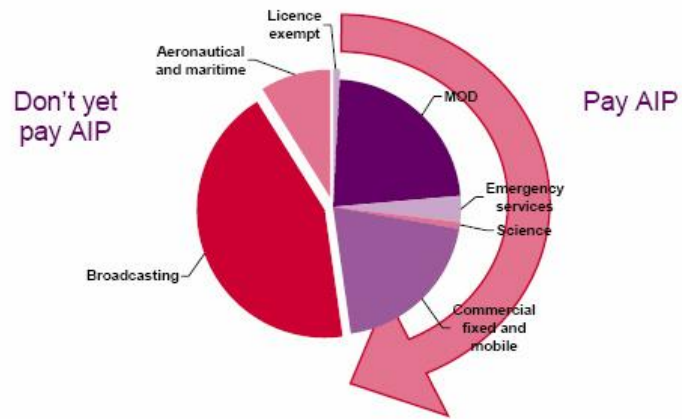


Figure 2: Ofcom summary of evolution of the application of AIP below 1 GHz in the UK

BROADCASTING AND MOBILE TV

Mobile TV

We have undertaken a study into the implications of 3G mobile enhancements (HSDPA and HSUPA) for the delivery of audio-visual services such as mobile TV.

Also for the GSM Association we provided a report on the different technologies available for the delivery of mobile TV, the deployments at that time (trial and live) and the spectrum used on a world-wide basis. Information was obtained from publicly available sources.

UHF Release Spectrum Packaging

Ofcom are currently conducting a "Digital Dividend Review" (DDR) to examine the regulatory options for the UHF spectrum freed up as a result of digital switch-over. One aspect of the DDR has been a substantial consultancy project for Ofcom, led by Analysys and including input on economic modelling by DotEcon and technical modelling by Aegis.

There is a great diversity of possible use for this spectrum including "traditional" digital TV, TV broadcasting to handheld devices (e.g. DVB-H), broadband fixed or nomadic systems (e.g. Wi-Max) and cellular services.

The work undertaken by Aegis focussed on understanding the technical characteristics of such candidate services, and modelling their mutual interference constraints. Software was specially written for this project to model the levels of incoming and outgoing interference between areas of the UK and the continent. This software took as one input the detailed results of the recent Regional Radio Conference (RRC-06) held in Geneva.

This consultancy project has informed the current Ofcom consultation, and the full report is available at:

http://www.ofcom.org.uk/consult/condocs/ddr/report_analysys/.

SHARING STUDIES

Recognised Spectrum Access Requirements

Recognised spectrum access is intended to provide a mechanism for the protection of uncoordinated receive-only satellite terminals from interference arising from other services using the same spectrum. Aegis undertook a study to develop a way of defining the protection to be afforded to such receivers. It involved undertaking a statistical modelling approach for different potential interference scenarios.

TDD / FDD Sharing Between FWA Systems

We investigated guard-band and separation distance requirements for FWA systems using TDD and FDD in 3.5 GHz band. The work involved derivation of Net Filter Discrimination (NFD) characteristics using base station and subscriber terminal emission and receiver selectivity masks. The NFD gives the overall discrimination afforded by the filtering as a function of transmit-receive frequency offset. The impact of additional RF filtering on interference between TDD and FDD base stations was investigated. A Monte Carlo simulator was developed to derive interference statistics of subscriber terminal interference scenarios.

Interference from UWB Devices into Airport Radars Operating in 3 GHz Band

A brief study was carried out to examine the implications of single and aggregate UWB interference into airport radars. Aggregate interference statistics were derived from a Monte Carlo simulator where interfering device population, activity factor and relative positions have been varied.

DVB-T Emission Masks

The implications of a number of proposed emission masks to be used by the operators of DVB-T transmission networks at UHF were examined. In the analysis, NFD values were calculated for different pairings of transmit-receive filter masks. Receive filter masks included a notionally 'perfect' filter with an 8 MHz bandwidth, pair of 8 MHz SAW filters and 6 & 8 pole 3.84 MHz Chebyshev filters.

RESEARCH STUDIES

Licence-Exempt Measurements

We have been investigating for Ofcom the extent to which licence-exempt frequency allocations in the range 160 MHz to 11 GHz are used. Measurements across this frequency range have been recorded by Mass Consultants at 20 sites across England covering urban, suburban, rural and industrial environments both indoor and outdoor. Analysis of the data provided information on utilisation across each band and indicated variation in usage through the day and night. A time and frequency metric was also used to give an objective measure of band utilisation at each site.

It was concluded that in general licence-exempt bands are lightly used and even at locations where greater utilisation might have been expected (e.g. 2.4 GHz in central London) it was concluded that building isolation and the non-coherent nature of the measurements prevented more devices from being detected.

It is interesting to note the link between this work, based on measurements, and work previously undertaken by Aegis regarding the occupancy of licence-exempt bands. The previous work modelled the interference environment in order to determine the number of devices in an area that represented 100% occupancy (i.e. the frequency band being full). We therefore have a distinction between utilisation (measured at a point and representing activity within the immediate area) and occupancy (calculated and representing activity over a wide area). One of the recommendations of the recent measurement work was to try to make an analytical link between the utilisation results obtained from these measurements and occupancy results obtained by modelling.

Licence-Exempt Economics

For this study with Indepen and Ovum a number of specific applications were considered in detail to understand the economic benefits afforded by licence-exempt spectrum. Specific applications included anti-collision radars in vehicles, building automation (lights, heating and ventilation), use of RFIDs in the retail sector, home communication networks and road usage charging.

A model was developed to assess the economic benefit of an application or mixture of applications operating in a licence-exempt band. This model was exercised for a number of applications based on demand forecasts but also taking account of interference constraints arising from the environment in which the devices operate.

While recognising that there is considerable uncertainty in the projections made, it was concluded that:

- The net present value of the applications considered varies significantly from £1 billion in the case of road user charging to over £100 billion for public access Wi-Fi.
- The three major applications, in economic terms, namely, automotive short-range radar, RFIDs in retail and public access Wi-Fi, are the applications for which international harmonisation is most important.
- Some of the major applications operating in licence-exempt bands have the potential to generate more economic benefit per MHz than licensed services such as mobile telephony and broadcasting.

Planning of Fixed Links

Our previous newsletter mentioned that Aegis, in conjunction with the Rutherford Appleton Laboratory (RAL), had commenced a study for Ofcom into the impact of introducing Automatic Transmit Power Control (ATPC) in point-to-point fixed service systems in bands above 13 GHz concentrating on rain fading effects. Information obtained from detailed rain modelling undertaken by RAL in the UK has been used in conjunction with current fixed links assignments in the 38 GHz band. The results of this study have now been published on the Ofcom Web site and can be found at <http://www.ofcom.org.uk/research/technology/overview/ease/atpc/atpcfina2.pdf>.

The software simulation developed to model links with ATPC has been extended to consider the potential benefits of “soft-boundary assignment”, in which potentially-overlapping communities of links are subject to variable assignment rules. In addition, links using adaptive modulation and coding have also been modelled.

Spectrum Aggregation

Aegis collaborated with QinetiQ and Indepen on a study for UK regulator Ofcom on the potential costs and benefits of spectrum aggregation, i.e. combining small fragments of spectrum to enable wider bandwidth services to be deployed. The study considered both the application of market mechanisms to aggregation (e.g. through the trading of spectrum fragments) and potential technical approaches to aggregation. The 100 MHz to 5 GHz spectrum range was considered. Spectrum identified as potentially suitable for aggregation included unallocated blocks (i.e. not currently allocated to a specific type of use such as cellular, fixed links etc.), unassigned frequencies (typically available on a localised basis away from major cities) and guard bands between services. The study concluded that spectrum aggregation is technically feasible but that the value of aggregated spectrum would largely depend on the type of service that could be deployed and the availability of other suitable spectrum. It was noted that data from spectrum auctions has shown that larger bandwidths are “valued” more than smaller bandwidths.

Impact of EMC Limits at Frequencies Above 1 GHz

The UK regulator Ofcom contracted a consortium led by ERA Technology and including Aegis and QinetiQ to perform a study into Permitted Interference and EMC limits above 1 GHz. The main aims of the work were to try to identify the risk to Ofcom of the increasing use of electronic equipment and radio devices in the home, office and other environments. Ofcom wants to ensure that there are sufficient standards in place to ensure that emissions from all noise sources do not degrade the quality of the spectrum.

Aegis undertook the modelling element of the study, creating Monte Carlo simulations of scenarios involving interference to a range of systems due to EMC and spurious emissions, and from UWB devices. To provide realistic inputs to this modelling process, the unwanted emissions from a range of devices were measured by ERA and QinetiQ. These measurements indicate that actual EMC emissions are at present some 10 to 15 dB below the CISPR average limit – at these levels, the models predicted no interference issues.

The full report of this study is now available on the Ofcom website at:

<http://www.ofcom.org.uk/research/technology/overview/specilib/permit/>

Revisions to ITU-R P.1546

Aegis staff formed part of the UK delegation to the last meeting of Working Party 3K of ITU-R Study Group 3, to present work undertaken under contract to Ofcom. One aspect of this work, undertaken by a number of contractors including Aegis, concerned possible revisions and improvements to the propagation model given in Recommendation P.1546.

This model (the successor to the widely-used Recommendation P.370) is an empirical model for point-to-area propagation below 3 GHz. Aegis has proposed revisions to the treatment of location variability within this model, partly based on earlier experimental studies.

Point-to-Area Propagation above 3 GHz

Aegis is currently leading a project for Ofcom to develop a new propagation model for frequencies above 3 GHz. The other members of the consortium are the Rutherford Appleton Laboratory, db spectrum and the University of Durham.

Many current point-to-area models, such as ITU-R P.1546 and Okumura-Hata, have an upper limit of 3 GHz or less. The aim of this study for Ofcom is to develop a new point-to-area model for frequencies above 3 GHz. Such a model will have applications in service planning, interference prediction and co-ordination, and in the assessment of the utility of these frequencies for a range of uses.

It has been determined that the new model should be symmetrical with respect to terminals (P.1546 and Okumura assume that the 'base station' is relatively high and uncluttered), and should make use of as much input data as is available, in a deterministic model. It is likely that the eventual model will take the existing Recommendation P.452 as a starting point.

A significant measurement campaign has been undertaken, involving fixed and mobile terminals, at frequencies between 2.5 and 6 GHz. Measurements were made in four areas of the UK, covering a wide range of environment types. The transmitter terminal was provided by RAL, the fixed (Land Rover & mast) receive terminal by Durham University and the mobile (car roof antenna) terminal by Aegis.

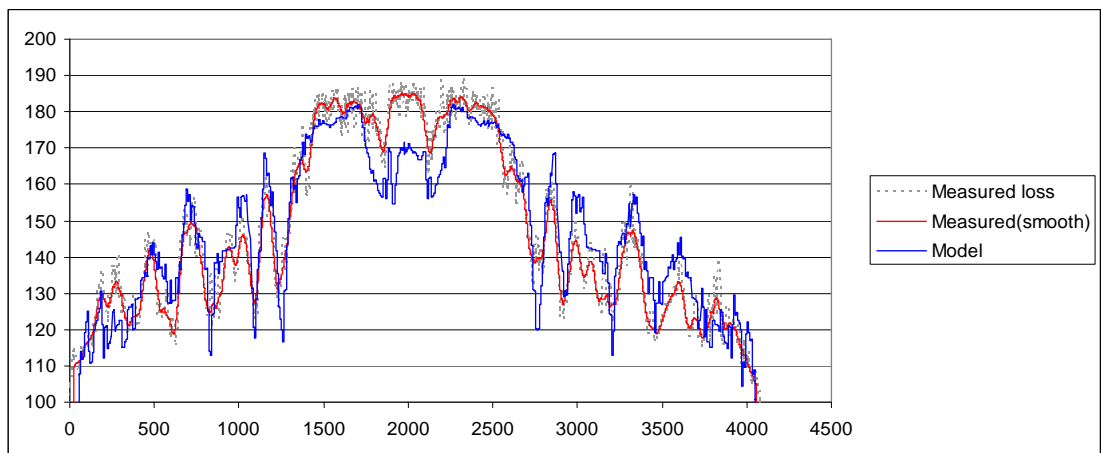


Figure 3: Sample prediction compared with measurements made at 3.4 GHz

This project is now nearing completion, and it is expected that the results will be contributed to ITU-R Study Group 3 in the Spring.

Time-varying interference

Aegis has recently been awarded a contract by a European regulator to study the impact of time-varying interference. In planning any radio service, it is necessary to take account of the inherent variability of signals. Allowance must be made for interference occurring for very short percentage times, including international interference often over sea paths which can enhance the unwanted signals. The current project will include a long-term measurement campaign, and will critically examine interference prediction methods. This study will run until Spring 2008.

OPERATIONAL STUDIES

EMC Implications of a Proposed 3G Cellular Base Station

Aegis was asked by a client to predict the potential for interference that a proposed 3G cellular base station would have on existing installed equipment. Additionally we were asked to determine the area around the new installation within which safety limits for non-ionising radiation might be exceeded.

BUSINESS ANALYSIS AND SYSTEM IMPLEMENTATION SUPPORT

Aegis has provided support to a European regulator in the process of procuring and implementing a spectrum management system. The initial work involved obtaining a good understanding of the products and associated business processes that would need to be supported by the spectrum management system and reflecting these in a Request for Proposal and then assisting the businesses in determining the preferred supplier. In the next phase of the project, Aegis has continued to provide expert support in the detailed definition of requirements and in the first stages of testing.

MEASUREMENT & EXPERIMENTAL FACILITIES

Finally, a reminder that Aegis Systems has, over the years, acquired useful facilities for field tests and propagation measurement, and is able to undertake both ad hoc investigations and formal measurement campaigns in a flexible and cost-effective manner.

We maintain a car fitted for mobile propagation measurements, in addition to a Land Rover fitted with 10 m and 16 m pump-up masts. We also have a helium balloon that can be used as an elevated platform for test transmitters.

We have a number of test sources and receivers, and have designed and built two wideband channel sounders operating at frequencies between 200 MHz and 4 GHz.

Please contact Richard Rudd (richard.rudd@aegis-systems.co.uk) to discuss any requirement you may have for such work.