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Response to Ministry of Defence's "UK Defence Spectrum Management: A Consultation on: An Implementation Plan for Reform" Issued: 30 May 08

This response has been constructed by Metranet Communications Ltd as the communications infrastructure partner of a South East England Development Agency (SEEDA) £1.8M Intelligent Transport Services (ITS) Research & Development project. This response has been approved by SEEDA and other project partners including Peter Brett Associates and Reading Borough Council.

Overview

The consultation on UK Defence Spectrum Management Reform is welcome for being both timely and well presented. The overall impression is that the time since the 'Cave Audit' has been well spent and the framework for the future has been well thought through. The questions posed by this consultation are relevant and are answered in order at Annex A to this response. The detail of this response is dedicated to the one area that seems to have been neglected in the handover from the Ofcom team to the MOD – the trials programme.

Results of the MOD/Ofcom Trials Programme

The MOD trials programme in preparation for the potential sharing and release of spectrum saw its public launch at a seminar at the Defence Evaluation and Research Agency test range at Funtington on 6 November 1999. In the ten years between the industry launch of the trials programme and the probable first public spectrum being commercially shared there will have been over £9 million of public funding invested in trials and research. More recently the public investment has been matched by a corresponding commercial investment in the same trials.

The handover between MOD, the Radiocommunications Agency, Ofcom and back to MOD/industry has involved a convoluted management chain but it would be negligent to lose the thread at this late stage.

The most recent events in this ongoing programme have been the success of the operational trials during Exercise Neptune Warrior, the publication of the radar protection criteria report and the go-live of the test bed network in Reading.

The trials programme and reports that led up to these three events is summarised in the Bibliography below and illustrated graphically at Annex B and the detail of how they apply to MOD's immediate and future spectrum management framework is given in more detail at Annex C.

The Implications of the Trials Results

To those taking part in the trials it has become increasingly obvious that Ofcom have been absolutely correct in their long term vision for spectrum. Safety justified sharing using correctly trialled technology means that spectrum will no longer need to be released in only a single one of temporal, spatial or frequency domains. Sophisticated monitoring and cognitive control of devices that are constructed to well written standards will result in the flexible spectrum that will respond to market forces.

It may seem strange that the public spectrum and particularly the MOD portion should be the first area to benefit most from a cognitive/traded approach but the technology that will manage this spectrum is military in origin and has been proved to be safe and secure on military test ranges. Thus the MOD has seen the future come to fruition well in advance of the Ofcom theoretical predictions.

Conclusion

MOD will not be required to relinquish any spectrum and will only be required to apply for the minimum RSA necessary for its core functions. Bandsharing technology made possible by the use of test beds such as the one in Reading are the way to release public spectrum safely and securely. Test beds are also the way to make industry see the exploitation and implementation routes that are newly available in public spectrum and then to apply the economics of the free market to their individual technological offerings.

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Annexes:

- A. Detailed answers to the consultation questions.
- B. The History of Trials, Research and the Route to Reading
- C. Trials reports, results and conclusions.
- D. Cave Audit Radar Pricing Flowchart.

Bibliography:

Considering the Concept of Spectrum Efficiency as applied to Radar – MOD 2001 (Input to WP8b)

Investigation of the Compatibility Between the Terrestrial (WCDMA) Component and the Satellite Component of IMT-2000 in the 2 500 to 2 690 MHz band - Transfinite Systems 2002

The Report of an Investigation into the Characteristics, Operation and Protection Requirements of Civil Aeronautical and Civil Maritime Radar Systems – AMS 2002

Report on UK/US Maritime Radar Trials – QinetiQ 2002

Assessment of the technical, regulatory and socioeconomic constraints and feasibility of the implementation of more spectrally efficient radiocommunications techniques and technology within the aeronautical and maritime communities – Helios 2004

Study into Mixed Sharing - Converged Solutions – Roke Manor 2004

A study into techniques for improving radar spectrum utilisation - QinetiQ 2004

Study into Spectrally Efficient Radar Systems in the L and S Bands - BAES 2006

Compatibility Study Between Radiolocation Radars And FWA Systems In The 3 Ghz Band – ANACOM 2005

Improving the Sharing of the Radio Spectrum – CDS 2005

Review of Bandsharing Solutions - Roke Manor 2005

Independent Audit of Spectrum Holdings – Cave 2005

Bandsharing Concepts – QinetiQ 2005

Radiated UWB Interference Trials on Radars A and B at Portsmouth Technology Park. – ERA 2005

Radiated UWB Interference Trials on Marine Radars at Funtington – ERA 2005

Government Response and Action Plan – HMG 2006

Radiated UWB Interference Trials on Maritime Radars – ERA 2006

Initial Bandsharing Trial – ERA 2006

Neptune Warrior Bandsharing Trials – ERA 2007

Study to establish measurement parameters for testing radar bandsharing performance – QinetiQ 2007

**Annex A To:
Consultation
Response
Dated 27th August
2008**

Detailed Answers to the Questions Posed

Question 1. Do you agree that the MOD has identified the options and factors that MOD should consider before deciding whether or not to extend the audit of the spectrum it uses?

In view of the millions of pounds of testing and supporting research sponsored by the public sector the consultation does not contain a sufficiently detailed analysis of the mitigation potential of new technology. It has been shown beyond doubt that a level of interoperability (in military terms) or bandsharing (civil terminology) can be achieved with no degradation whatsoever to the incumbent systems if mitigation is applied.

A safety case, either civil, such as those used by the aviation world, or a military operational assessment, can be made for many mitigation technologies and this should be taken into account. Historical objections have now been overcome by testing and current methodologies are more than adequate for bandsharing.

Question 2. Do you have any views on the priority with which MOD should audit its spectrum use?

The Cave Audit report included an algorithm for pricing radar spectrum by assessing alternative use and for quick reference this has been added at Annex D. Industry has had access to this algorithm for almost three years and has been able to prioritise bands by assessing their commercial value. The resulting desirability of spectrum need only be assessed in light of mitigation technology costs for a much clearer view on the priority for band release to emerge. Running the high priority bands (assessed from their commercial value) through a test bed and applying mitigation is the best route to spectrum sharing.

Question 3. Do you agree with the phased approach to applying for RSA that the MOD is proposing?

The phased approach is the best approach so long as the MOD keeps in mind the emerging technologies and mitigation techniques that modelling and testing validates over the same period. The widespread use of mitigation technology that enables a new service and an incumbent to share spectrum fully and invisibly will make the details of an individual system's RSA quite interesting. Full 'release' of a band for new services while having it invisibly retained by the MOD incumbent would negate the requirement for an AIP payment. In this case RSA should be granted at no cost.

Question 4. Do you agree with the MOD's plans for releasing and sharing the spectrum it uses?

The MOD's plans have already been broadly welcomed in the covering letter and this is reiterated here. Pilot trials (we think at a test bed) were well heralded by Ofcom during the immediate aftermath of the Cave Audit and industry fully supported the idea from the start. It should be noted that test bed would be a zero cost option for MOD as the incomers will have the burden of safety case trials and subsequently costs will lie where they fall.

It is imperative that an open mind be kept on the results of pilot trials as, when they are conducted in a fully audited way (e.g. using the PSSTG methodology) they can yield both optimum and cost saving methods of spectrum sharing. The live test bed in Reading is already showing spatial sharing at 3.3GHz right now and with a full programme of frequency and time testing (see Annex C) will show true bandsharing over the next 12 months. In our view, it would be premature of the MOD to make any decisions on spectrum management without cognisance of the consequences of these results.

Question 5. Do you agree with MOD's priorities for releasing and sharing spectrum?

Our suggestion is that the MOD re-examine the spectrum release priorities in view of the depth and quality of testing information already available for certain bands. Any indication of bands being released to satisfy financial pressures but that do not have a suitable safety case will prove extremely embarrassing if subsequently safety or security problems are encountered.

At times this may appear counter intuitive. Surely bands where military radar guard our skies would be more sensitive when being considered for release? Additionally the use of internationally agreed (e.g. NATO) bands for commercial services must be problematical? Not so when you consider the extensive tests, trials, technology demonstrations and modelling that has taken place. Ofcom SES research has shown that some forms of sharing are far more benign than others and it is not apparent from the consultation and supporting references that this has been taken into consideration.

Finally it is not clear if the designated safety assessment body, the PSSTG, has given any indications of the bands which would be most ready for assessment against their sharing safety methodology. If the PSSTG continues to act as the overseeing authority and it allows industry to bring forward data and safety cases (as opposed to soliciting them) the MOD will find that a successful market based approach will fall out naturally from industry trials. Commercial demand, independent safety assessment and the MOD's

willingness/ability to share bands must work in harmony. At all costs there must not be a misalignment between MOD and the PSSTG on the priority with which bands can be assessed for release.

Question 6. Do you agree with MOD's outline timetable for initial spectrum releases?

No. This is not supported by evidence from industry that the bands will be useful, safely usable or worth competing for with the incumbents. It appears that MOD are using a model that assumes high spectrum demand at the start and a long tail off. Evidence from the Cave Audit Demand Study seems to suggest that there is a long steady growth in the demand for spectrum which is satisfied in the short term by the Ofcom programme of spectrum release. A slower process, based on minimal MOD disruption and maximum pre-testing for incomers, would satisfy the industry demand and preserve maximum value for MOD and therefore tax payers.

The consultation is very comprehensive and well presented but lacks the one key step to give true spectrum efficiency. The public sector has funded £20million worth of theoretical and modelling work and Ofcom has published this in its SES archive. By allowing industry to complete the real world testing of much of the SES theory and then subsequently validating the models a spectrally efficient future can be assured in the MOD bands.

Question 7. Do you agree that MOD has correctly and fully identified the factors and options that should be considered before deciding to release and acquire spectrum in the market?

No. At the risk of overly repeating the points made above, mitigation technology has been well proven at military test ranges (Portsmouth, Shoeburyness, Funtington and Fraser) over the last nine years. Too little attention is being paid to trials of mitigation technology, both historical and ongoing. The MOD may need to make very little change to its spectrum usage; invisible sharing can be proven in sufficient instances to meet all current spectrum demands. The effect of spectrum sharing, to users, whether incomers or on AIP applied to incumbents, has not been fully investigated and will certainly influence spectrum values.

Question 8. Do you agree that MOD has correctly and fully identified the factors and options that should be considered before deciding the best means with which to interact with the market?

This response is primarily based on the views of those promoting tests and trials and may be a simple reiteration of the points made in previous answers. The market has been given an example of how it should value spectrum by way of the algorithm at the back of the Cave audit report (Annex D). This may or may not be the basis by which MOD AIP is subsequently set but it is certainly a useful guide at this stage.

It should be possible to both minimise MOD AIP and preserve value for the tax payer by preventing un-necessary re-farming. Mitigation technology will prevent the “alternative use” value being set too high and keep AIP reasonable by using technology to give invisible sharing on both sides.

For each band and its associated military incumbent a mitigation technology can be proposed and an incoming sharing service selected which is compatible with this form of mitigation. Industry can then make an assessment of the full cost of deployment (including mitigation) for such a service. This will decide if a band is attractive to a particular type of service. MOD’s band manager can then be presented with the safety case (including the military effectiveness impact assessment) and can decide if the incomer is acceptable. Testbed trials will already have taken place to prove the safety case and the spectrum efficiency measures that are claimed will have been validated.

Finally the MOD’s band manager can confirm the RSA requirement to share with the incoming service and decide if indeed any RSA needs to be claimed at all (invisible sharing should require none). This generates maximum spectral efficiency of any incoming service and reduces tax payers’ costs to the absolute minimum.

Question 9. Can you identify any different approaches for the MOD to manage the spectrum it uses and engage with the market to deliver better value for money for defence and the taxpayer?

For any proposed incoming service (including mitigation) an independent third party band manager can be given the responsibility for assessing the safety case and impact on military effectiveness. Such a third party should also be given the responsibility for spectrum monitoring, policing and enforcement such that there are zero costs to the public sector.

Question 10. Which options (from paragraph 6.7) should be considered, or discounted, and if so why; either in respect of options already identified in section 6, or additional options, not identified?

This answer is given from the point of view of the test and evaluation programme already funded by the public sector. It is absolutely clear that MOD should:

“continue to manage and use spectrum and reform Defence-related spectrum management for military use of spectrum whilst using a Third Party to manage, exploit and acquire spectrum on the commercial market.”

as the only option that supports the Cave Audit recommendations.

Question 11. Which issues relating to section 6 should be considered when evaluating options, and if so why; either in respect of issues already identified in that section, or additional issues, not identified?

The MOD have done an excellent job of capturing the essence of the Cave Audit in this consultation and all measures that take spectrum management out to an independent third party are welcome. A third party with responsibility for all aspects of the spectrum management process would be optimal and the integration of the elements of monitoring and trials assessment into the function of such a third party would result in an excellent market within which to trade spectrum.

Question 12. Is the scope of decisions required against each of the four questions at paragraph 6.3, as indicated in section 6, sufficient and, if not, how and why it should be extended?

A form of pioneer licence that allows trials and testbed services to be extended to become commercial systems would be extremely welcome. The extension of the market by allowing privately funded testbed activities to morph into operational systems is an idea that Ofcom have hinted is in the pipeline. MOD embracing such an idea and allowing it to become a tool to open up new markets would be a greater confidence builder than for example simply publishing lists of spectrum to be released.

MOD should let industry take the financial risk and demonstrate interest in new spectrum services at their own cost under a T&D licence. Then when services show technical viability, have had no operational impact on the MOD spectrum usage and are de-risked commercially, a pioneer licence can be used to add them to the market.

The granting of pioneer licences should be added to the role of the third party band manager.

**Annex B To:
Consultation
Response
Dated 22 Aug 2008**

The History of Trials, Research and the Route to Reading

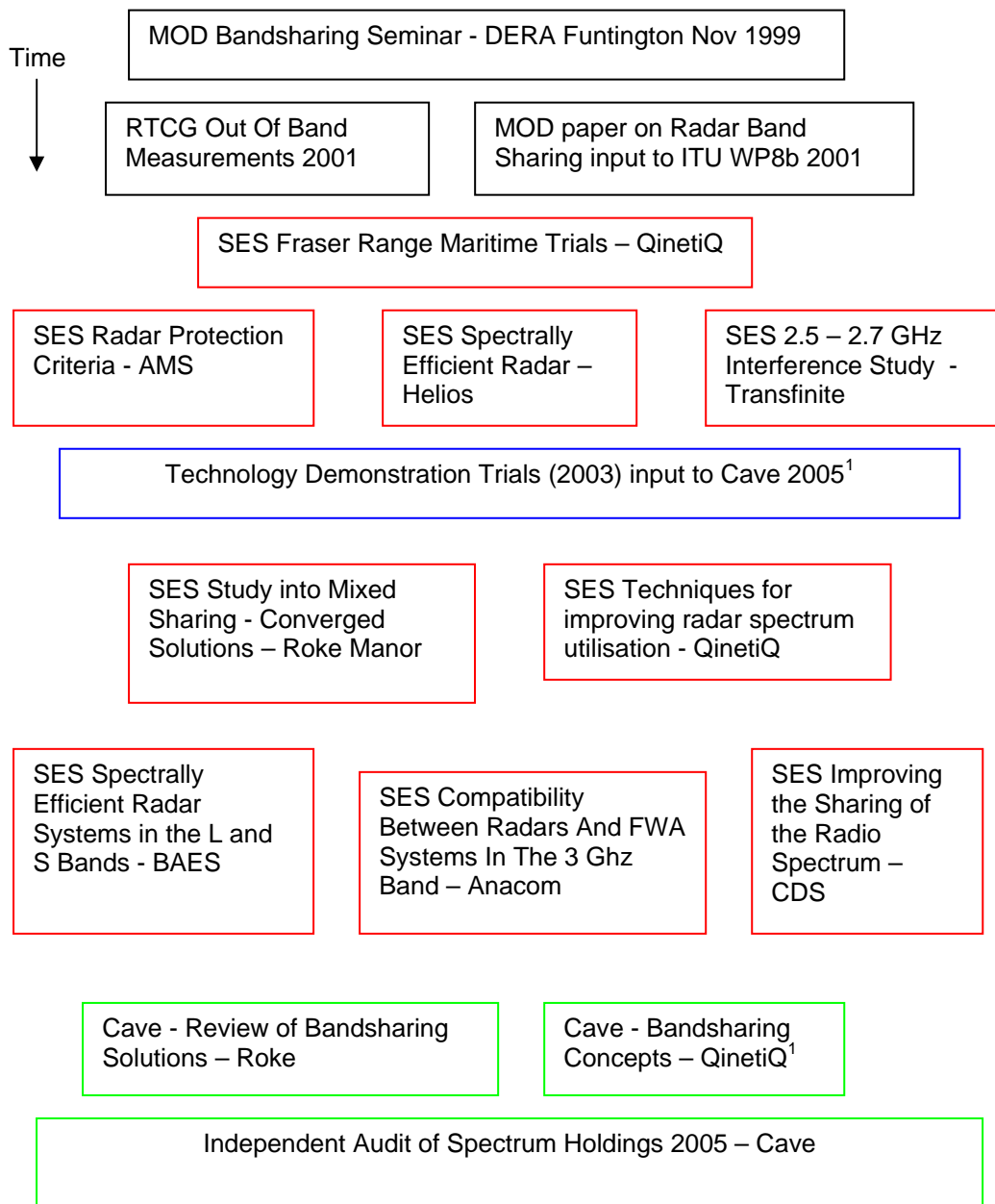
Key:-

Treasury SES Funded

Ofcom/MOD Funded

Private Funded

Cave Audit Funded



Continues below...

Time
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Radiated UWB Interference Trials on Radars at Portsmouth Technology Park. – ERA

Radiated UWB Interference Trials on Marine Radars at Funtington – ERA

SES Spectrally Efficient Radar in L and S band – AMS

SES Interference Cancellation – Roke

SES Software Defined Radio – Mobile Applications QinetiQ

SES SMART Antennas - Culham

SES Improving the sharing of radio spectrum – CDS

Radiated UWB Interference Trials on Maritime Radars – ERA

SES Generic Radio Modelling Tool - Transfinite

SES Cognitive Radio – QinetiQ

Generic Bandsharing Trial - QinetiQ PTP test range - April 06.

Measurement campaign - Consultation Award of Available Spectrum 2.5 – 2.690 GHz Mar 07

Initial Maritime Bandsharing Trial – QinetiQ, Shoeburyness - June 2006

SES Spectrum Aggregation – QinetiQ

Maritime Trial – Oban Scotland, November 2006 – ERA

SES AMS Business Case – Sagentia

Radar Protection Criteria Theoretical Study – QinetiQ 2007

SES Decentralised Spectrum Access – Roke Manor

MOD exercise Neptune Warrior radar bandsharing trials - April 2007

Reading Testbed Go-Live – April 2007

**Annex C To:
Consultation
Response
Dated 22 Aug 2008**

**Reading Test bed, Neptune Warrior Trials,
and Radar Protection Criteria**

Since the publication of the Cave Audit report, there has been a need to define Recognised Spectrum Access (RSA) for public spectrum holdings. This Annex summarises some of the more recent trials for the background environment measurement and modelling in support of the definition of Recognised Spectrum Access (RSA) in bandshared spectrum.

Reading Test bed

The South East England Development Agency (SEEDA) has instigated a public private partnership research & development transport information project in Reading costing £1.8M.

The project is dependent on a test bed that set out to allow the definition of RSA by environmental measurement and validated modelling. This section of the Annex describes the proposed method for testing and modelling to define RSA.

The project supports the principle of trials towards freeing up spectrum that will benefit wider applications and this response to the MOD consultation therefore has the backing of all of the project partners who include SEEDA, Reading Borough Council, Metranet Communications and Peter Brett Associates.

Defining the environment through testing

Measurements will be made of the emissions of the testbed equipment plus any detectable S band (2.7 to 3.4 GHz) ARNS civil radars and any other RF transmissions in the target spectrum as laid out below. The work will capture the RF environment in order to assess the emissions falling in the bands:

- 2.5 GHz to 2.69 GHz. Currently PMSE, this band is proposed for use as either/both for cellular telephony (UMTS) or technology neutral allowing users such as WiMAX.
- 2.69 GHz to 2.7 GHz as used by ESS and subject to RSA.

- 3.4 to 3.6 GHz as formally used by MOD, PMSE and future WiMAX operations.

Results from this trial will be used to show the emissions that are required for radars to operate in transmit mode and the background RF levels that can be tolerated when they are in receive mode.

Defining the environment through modelling

The existing models (eg. Ofcom GRMT or military models) for radar emissions will be run to create, as closely as possible, the same environment as that measured on the test range in the same frequency range.

Comparison of testing and modelling

The output of the modelling and the results of the testing will be compared to see how closely the modelling correlates with the actual RF environment measured. If the correlation is close (results to be submitted to PSSTG) the first validated assessment of the RSA for radars will be available.

Validity of the process

The results will be analysed to see if it is possible to define the RSA required for effective operation of radars can be defined (and compared with the Ofcom and MOD results outlined below) by the output of this real life environmental testbed.

Exercise Neptune Warrior

Ofcom commissioned a measurements trial to take advantage of the Ministry of Defence (MOD) Neptune Warrior exercise undertaken in the vicinity of Loch Ewe between 23rd April and 4th May 2007. The trials program had three primary aims:

- To start the process of engagement between the MOD, the regulatory bodies and industry concerning bandsharing radar trials;
- To assess the impact of radar on land-based communications equipment by obtaining statistical information on spectrum quality during the Neptune Warrior exercise;
- To obtain initial information on indicative interference levels from commercial bandsharing sources into naval radar (2.7 – 3.4 GHz NATO E/F band).

The MOD provided significant resources, for the sole purpose of bandsharing testing, including 4 dedicated hours of a warship with about 10 MoD staff actively involved throughout the trial, 9 Falcon aircraft runs, pre- and post-trials planning and support from the

Maritime Warfare Centre. The total cost of this trial to the MOD is thought to be in the region of £1M.

A report has been prepared by ERA Technology for Ofcom that provides an overview of and example results obtained from the bandsharing aspect of the trial.

The aim was to cause deliberate interference to the radar, under normal operating conditions, with the intention of demonstrating whether an aircraft target could be removed from the radar Plan Position Indicator (PPI) display. The radar was operated in different modes, including both normal and anti-jam modes, and the power of the interference source was varied to determine the points at which different interference effects occurred. The standard MOD methodology for assessing radar performance was used.

In addition, spectrum monitoring data was measured which, together with communications equipment performance measured in the laboratory, will give an indication of the likely quality of the spectrum in and around the radar bands.

Measurements were carried out to investigate the potential impact of the MOD S-band and L-Band radar on communications systems which could potentially share these radar bands. Considerable data was gathered on the received power from MOD ships at a number of distances. Based on the levels measured, and from available information on typical protection criteria for 3G and WiMAX systems from radar emissions, it was estimated that there was a low probability of interference from naval radar to communications equipment.

QinetiQ Radar Protection Criteria Study

Ofcom and the Public Spectrum Safety Test Group (PSSTG) are working together to ensure efficient use of public spectrum. One way of maximising spectrum use in any given band is through bandsharing – by allowing new systems to operate in bands of spectrum currently allocated exclusively to existing systems.

The spectrum allocated to public sector systems is often used for applications which provide security or safety of life. It is therefore essential, before allowing bandsharing, to determine the levels of interference which can be tolerated by existing systems without having any impact on their efficacy.

A study was commissioned by Ofcom to develop and refine, through the use of modelling techniques, a methodology to assess the potential impact of bandsharing technologies on the performance of S-band radars operating between 2.7GHz and 3.4GHz.

If it can be demonstrated that S-band radar systems can continue to operate, with no perceived degradation in operational performance, in the presence of secondary technologies, then this spectrum range could be one of the first public spectrum bands to allow bandsharing.

The methodology defined will allow the performance of radar systems to be tested in the presence of the type of interference generated by secondary technologies.

In order to define the methodology, it was essential to identify the appropriate parameter, or set of parameters, which are most effective in measuring radar performance. The 'protection criteria' for radar systems can then be described in terms of appropriate values of this parameter / these parameters. The protection criteria define the maximum allowable level of degradation of such parameters, under controlled test conditions, which a radar system can tolerate in the presence of a secondary technology operating in the same frequency.

The study report identifies suitable parameters for use as protection criteria, determines at what measurable value of these parameters there is no perceived operational degradation in radar performance, and establishes a test methodology for testing whether these protection criteria will continue to be achieved in the presence of the type of interference likely to be generated by secondary technologies.

Conclusions from Reading Test bed, Neptune Warrior Trials, and Radar Protection Criteria

The above abstracts and descriptions give a flavour of how Industry, MOD, PSSTG and Ofcom have been working together since the Cave Audit to demonstrate safe bandsharing. The Reading testbed in particular shows the willingness of industry to fund speculative trials with new technology. A similar willingness is shown by the regulators to allow spectrum access for such trials.

In assessing the responses to this consultation sufficient weight should be given to the real world activities that are already happening in support of MOD spectrum efficiency.

It is increasingly obvious that MOD do not need to give up spectrum to achieve the aims of the Cave Audit.

Cave Audit Radar Pricing Flowchart.

