

Reading List
“Defining Out-of-Band Operating Rules”
A Silicon Flatirons Summit on Information Policy
Boulder, 8/9 September 2009

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Radio regulators have been slow to develop comprehensive, generic rules on out-of-band interference. This issue has been dealt with on an ad hoc, band-by-band basis. This worked while technologies/services were relatively static, users were more or less immobile, and there was less rivalry between frequency-adjacent radio users with divergent technologies and business models.

The goal of this meeting is to develop a general approach to defining rights and obligations in out-of-band operation that will facilitate investment in radio systems, and the resolution of conflicts among rights holders.

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Introduction and definitions

Dale Hatfield & Phil Weiser, *Property Rights in Spectrum: Taking the Next Step*, 15 Geo. Mason L. Rev. 1025 (2008) available at http://papers.ssrn.com/sol3/papers.cfm?abstract_id=818624.

Discusses the issues arising from applying a property rights model for spectrum, including a lack of clear boundaries, harmful trespass injunctions, and the use of predictive models under the current enforcement system. This paper was part of a debate with Tom Hazlett.

Tom Hazlett, *A Rejoinder to Weiser and Hatfield on Spectrum Rights*, 15 Geo. Mason L. Rev. 1031 (2008), available at http://www.law.gmu.edu/assets/subsites/gmulawreview/files/15-4/05-HAZLETT_II.pdf.

The final paper in the spectrum property rights debate, Hazlett responds directly to Phil Weiser and Dale Hatfield.

Society of Broadcast Engineers, comments on the Third Notice of Proposed Rulemaking Concerning Advanced Wireless Services in ET Docket No. 00-258, April 14, 2003, *available at* <http://www.sbe.org/FCCLiaison/+ET%2000-258.Master.2.pdf>.

The SBE's comments regarding the Third Notice of Proposed Rulemaking regarding Third Generation Wireless Systems provide a useful introduction to interference mechanisms between cellular and BAS systems; note in particular the definitions and discussion in paragraphs 3-7 of adjacent-channel interference ratio (ACIR), adjacent channel leakage ratio (ACLR) and adjacent channel selectivity (ACS).

Michael Whittaker, *Space-Centric Management: A General Solution for Equitable Access to Radio Spectrum Space under Conditions of Flexible Use* (presentation at ITU workshop on market mechanisms for spectrum management, Geneva, 22-23 Jan. 2007), *available at* [http://www.itu.int/osg/spu/STN/spectrum/workshop_proceedings/Background_Papers_Final/Michale%20Whittaker%20-%20space_centric_management_spu\(mjw\).pdf](http://www.itu.int/osg/spu/STN/spectrum/workshop_proceedings/Background_Papers_Final/Michale%20Whittaker%20-%20space_centric_management_spu(mjw).pdf).

Outlines the "space-centric" approach developed in Australia. Section 4 provides a useful categorization of interference types, and section 6 summarizes benchmarks for out-of-band interferences.

Regulatory Approaches

There is no FCC comprehensive OOB policy – indeed, this is the reason for this conference. Instead, the Commission has dealt with the issue on a more-or-less ad hoc and band-by-band basis. The following cases provide some examples of its approach.

Carlos Nalda on behalf of the Satellite Industry Association, the Intelligent Transportation Society of America, and the American Association of State Highway and Transportation Officials, *Written Ex Parte in WT Docket No. 01-90 and EB Docket No. 98-95: DSRC/FSS Earth Station Spectrum Sharing Protocol*, February 18, 2008, *available at* http://fjallfoss.fcc.gov/prod/ecfs/retrieve.cgi?native_or_pdf=pdf&id_document=6519841842

A Spectrum Sharing Protocol that was jointly submitted to the Commission in February 2008 by an ad hoc group of representatives from DSRC and FSS services. While acknowledging the potential for interference to DSRC from FSS operations in the adjacent, conventional C-band, the Protocol does not propose coordination between DSRC operations in the 5.9 GHz Band and FSS operations in the adjacent, conventional C-band. Bob Kelly – a long time DC communications attorney, to whom thanks for this reference – notes that parties to the Joint Technical Committee simply could not agree on this, and thus the understanding was that all parties should use "best practices" in system siting and design. The lack of material FCC support for adjacent band coordination was significantly limiting to the ability of the ITS community in seeking agreement on this issue (as was the lack of operating DSRC facilities).

FCC, Order regarding the applications of the National Science and Technology Network, Inc., DA 07-2815 (2007), *available at* http://hraunfoss.fcc.gov/edocs_public/attachmatch/DA-07-2815A1.pdf.

In ruling on a dispute over the introduction of a new trunked Industrial/Business Pool station at Corona, CA on 472/475.5250M Hz, the Commission cites with approval the use of a technical protocol for evaluating adjacent channel interference between the 421-430 MHz and 470-512 MHz Bands for land mobile operations under Part 90. The Order references two 1997 documents:

- a letter from the Land Mobile Communications Counsel (dated September 10, 1997) announcing an industry consensus to use a technical protocol for new assignments in the 470-512 MHz Band, *available at* http://fjallfoss.fcc.gov/prod/ecfs/retrieve.cgi?native_or_pdf=pdf&id_document=1909610001;
- a subsequent Commission Public Notice (DA 97-2006) that supported the industry consensus, *available at* http://www.fcc.gov/Bureaus/Wireless/Public_Notices/1997/da972006.txt.

The significance of these materials is that they describe a situation where, rather than requiring formal coordination of adjacent band interference, the FCC urged industry to develop its own technical solution, which the FCC then endorsed. (Thanks to Bob Kelly for this, also.)

Other regulators, particularly in Britain and Australia, have tackled interference issues in an arguably more rigorous way

Ofcom, *Spectrum Usage Rights: A Guide Describing SURs*, June 4, 2008, *available at* <http://www.ofcom.org.uk/radiocomms/isu/sursguide/sursguide.pdf>.

Describes the UK's spectrum usage rights, whereby the amount of interference is regulated instead of the level of transmission.

Michael Whittaker, *Authorizing Dynamic Spectrum Access Under Space-Centric Management*, Futurepace, Feb. 2009, *available at* <http://www.futurepace.com.au/lib/pdf/DSA.pdf>.

Discussion of the space-centric approach taken in Australia, summarized in section 2. Different interference types are described in section 3, and benchmarks are given in section 5.

Michael Whittaker, *Commercial Certainty in Spectrum Right Formulation*, Futurepace, Feb. 2009, *available at* <http://www.futurepace.com.au/CCMar.pdf>.

Includes a comparison between the Australian and British approaches, from a developer of Australia's space-centric management method; see Table 1 and section 6.

EUROSTRATEGIES & LS TELECOM, *STUDY ON RADIO INTERFERENCE REGULATORY MODELS IN THE EUROPEAN COMMUNITY*, (2007) *available at* http://ec.europa.eu/information_society/policy/ecomms/radio_spectrum/document_storage/studies/interference/interference_final_report.pdf.

Study exploring interference management and addressing whether spectrum management techniques controlling interference instead of transmitters can make spectrum use more effective in the European Community. The study reaches the following findings and provides recommendations accordingly:

- The term "harmful interference" and some closely related terms can be usefully redrafted on a case by case basis to make them more meaningful. The concepts of harmful and permissible

interference may be extended to provide a way of defining spectrum rights for license holders and offer a means of enabling liberalization through trading.

- Regulating receivers and transmitters by specifying characteristics will not enhance spectrum efficiency alone, but there is spectrum efficiency benefit to be gained from making them 'work harder.'
- The remit of compatibility studies should be modified to answer questions based on a flexible interference framework instead of providing 'go/no go' decisions on whether two systems can work together.
- Technology and service neutral licensing (as would be supported by Interference based licensing techniques) offers significant benefit for end users, but not necessarily for spectrum owners and network providers.
- The scope and detailed implications of EU Decisions and Directives which consider harmful interference and electromagnetic disturbance are not widely understood and needs additional clarity.
- Methods of managing risk, vulnerability and performance may be used in considering the scope and application of compatibility studies to support more flexible decision-making.

Case study: Nextel/800 MHz

Overview

Matthew Lasar, *FCC Gives Spring Nextel a Break in the 800 MHz Spectrum Makeover*, ARS TECHNICA , June 19, 2008, <http://arstechnica.com/old/content/2008/06/sprint-nextel-asks-fcc-for-break-in-800-mhz-spectrum-makeover.ars>.

In order to prevent interference with public safety wireless needs, the FCC is relocating Sprint Nextel in the 800 MHz. Sprint is paying for some of the cost, for which they are receiving spectrum in the 900MHz band and beneficial modifications in their 1.9GHz space. Sprint is having a hard time moving because the public service groups in their new portion of the spectrum have not moved.

FCC Gives Satellite Go-Ahead with New Sprint BAS Relocation Deadline, Telecom A.M., June 15, 2009, available at http://www.colorado.edu/law/media/siliconFlatirons/FCC_GivesSatelliteGoAhead.pdf.

Discusses some of the issues arising with regard to the spectrum reallocation, and notes that the FCC is now reconsidering how they will allocate the cost of the transfers.

Current State of Affairs

FCC, Report and Order and Order and Further Notice of Proposed Rulemaking, June 12, 2009, available at http://hraunfoss.fcc.gov/edocs_public/attachmatch/FCC-09-49A1.pdf.

Further delays Sprint's move deadline to 2010, and allows MSS operators to begin working and addresses interference this may cause with BAS, and waives rules governing when MSS operators may provide Ancillary Terrestrial Component in relation to commercial wireless service. They also propose that MSS operators help share with Sprint the cost of BAS relocation under certain circumstances, propose clarification that MSS operators still have to help relocate BAS incumbents, seek comments on

MSS secondary operation where BAS incumbents have not be relocated and regarding incentives to get BAS licensees to move.

Sprint Nextel comments on Report and Order and Order and FNPR, July 14, 2009, *available at* http://fjallfoss.fcc.gov/prod/ecfs/retrieve.cgi?native_or_pdf=pdf&id_document=7019909153.

Supports MSS paying a 57% pro rata share of BAS relocation costs. They would like to de-link the reimbursement period from the reconfiguration period and modifying the sunset date. The reimbursement would instead align with BAS relocation timelines, or as MSS operators receive invoices.

TerreStart Network comments on Report and Order and Order and FNPR, July 14, 2009, *available at* http://fjallfoss.fcc.gov/prod/ecfs/retrieve.cgi?native_or_pdf=pdf&id_document=7019909146.

Stating the position of MSS that they do not think the FCC should apply the traditional *Emerging Technologies* principals to the BAS relocation because it would result in the total cost of relocation falling on MSS operators. Because Sprint was so involved with the BAS relocation plan, MSS costs should be limited to those associated with relocation in the top 30 markets and fixed links. Sprint should only be allowed to collect the pro rata share from each MSS operator, with the operator have the chance to review and challenge the expenses at the end of the true up period. MSS also believes BAS operators remaining after the deadline should have secondary status.

Association for Maximum Service Television and the National Association of Broadcasters comments on the Report and Order and Order and FNPR, July 14, 2009, *available at* http://fjallfoss.fcc.gov/prod/ecfs/retrieve.cgi?native_or_pdf=pdf&id_document=7019909036.

BAS position supporting protection for BAS providers against interference until they move. This would require that they maintain their primary status. Also stating that MSS operators have not aided in the relocation.

Case study: DARS/WCS

Overview

Chris Sewell, *Band-to-Band Combat*, TELEPHONY ONLINE, April 29, 2002, http://telephonyonline.com/mag/telecom_bandtoband_combat/.

Sirius and XM radio, worried that OOBE of the unlicensed devices in the adjacent spectrum will cause interference, asked the FCC to revise their rules. WCS companies that have spectrum adjacent to DARS want the FCC to force DARS to reduce their power levels because their towers are creating interference for WCS.

Paul Kirby, *Parties Make Final Case on AWS, 2.3 GHz Band Sharing, E911' Items*, TR DAILY, Dec. 12, 2008, *available at* <http://www.colorado.edu/law/media/siliconFlatirons/PartiesMakeFinalCasesOnAWS.pdf>.

DARS would like to delay ruling due to lack of proper independent testing, but WCS believes the record is complete and are ready for a ruling. TR Daily suggests the need for transparency because the wrong technical conclusion will severely impact satellite radio customers, and there is no technology that will prevent WCS interference with DARS services. The article also summarizes the positions of third parties on the issue.

Paul Kirby, *WCS Coalition, Sirius XM Disagree on Results of Interference Testing*, TR Daily, Aug. 4, 2009, available at http://www.colorado.edu/law/media/siliconFlatirons/WCS_CoalitionSiriusDisagreeOnTestingResults.pdf.

The difficulty of testing yielding agreement: Sirius XM and the WCS Coalition disagree about whether interference testing showed that WCS devices can operate without causing interference to satellite digital audio radio service (SDARS) receivers under rules proposed by the coalition.

FCC Position

FCC, Notice of Proposed Rulemaking, and Second Further Notice of Proposed Rulemaking, Dec. 18, 2007, http://fjallfoss.fcc.gov/edocs_public/attachmatch/FCC-07-215A1.pdf.

Notice of Proposed Rulemaking requesting additional comments regarding the licensing of SDARS repeaters in general and the interference issues between SDARS and WCS licensees in particular. FCC intends to resolve the outstanding issues in light of push to develop WiMAX technologies.

Sirius arguments

Sirius Satellite Radio comments on the Notice of Proposed Rulemaking, Feb. 14, 2008, http://fjallfoss.fcc.gov/prod/ecfs/retrieve.cgi?native_or_pdf=pdf&id_document=6519841386.

Sirius requests “blanket approval” of terrestrial repeaters and wants to manage interference through ground-level emission limits for terrestrial repeaters and WCS base stations, with more restrictive ground-level emission limit for operations in the WCS C and D blocks that are directly adjacent to satellite radio operations. Sirius also recommends that the Commission grandfather its existing network of repeaters.

WCS arguments

WCS comments on the Notice of Proposed Rulemaking, Feb. 14, 2008, available at http://fjallfoss.fcc.gov/prod/ecfs/retrieve.cgi?native_or_pdf=pdf&id_document=6519841393.

WCS requests the FCC modify or eliminate the OOBE restrictions in Section 27.53(a), and adopt rules governing WCS and SDARS terrestrial repeater power levels (restrict level to 2,000 Watts average EIRP) to protect against intolerable interference. If Sirius suggestions are adopted, WCS will not be able to use the spectrum for broadband. WCS does not want the FCC to set information exchange requirements, or adopt a rule requiring WCS to give DARS 90 days advance notice of the technical parameters of base station facilities. Also, WCS wants a 12 month limit on bringing terrestrial repeaters into compliance once the FCC sets its restrictions.

Case study: AWS-3

Overview

Matthew Lasar, *FCC Moves Ahead with Plan for Smut-Free Wireless Broadband*, ARS TECHNICA, June 22, 2008, available at <http://arstechnica.com/old/content/2008/06/fcc-starts-proceeding-on-smut-free-wireless-broadband-plan.ars>.

Discussing a 2008 FNOPR issued by the FCC proposing "public access to free, nationwide, high-speed wireless broadband Internet services [with minimum download speeds of 768Kbps] using a portion of the winning bidder's network in the 2.1GHz Advanced Wireless Services (AWS) spectrum." Instead of giving the block to M2Z, it will be up for auction. The Notice includes a requirement that the auction winner must "filter[] or block[] images and text that constitute obscenity or pornography, andany images or text that otherwise would be harmful to teens and adolescents."

INTERNATIONAL TELECOMMUNICATION UNION, COEXISTENCE BETWEEN IMT-2000 TIME DIVISION DUPLEX AND FREQUENCY DIVISION DUPLEX TERRESTRIAL RADIO INTERFACE TECHNOLOGIES AROUND 2 600 MHZ OPERATING IN ADJACENT BANDS AND IN THE SAME GEOGRAPHICAL AREA, 2003, available at http://www.colorado.edu/law/media/siliconFlatirons/ITU_TDD_FCC.pdf.

Considers the coexistence between TDD FDD radio interfaces, specifically, the interference properties between IMT-2000 CDMA Direct Spread (also called WCDMA or UTRA FDD) and IMT-2000 CDMA TDD (also called UTRA TDD). It further describes base station to base station (BS-BS) interference for both proximity and co-location scenarios. It describes transmitter and receiver characteristics, the relation between the external interference level and coverage and capacity, and the methodology of the deterministic BS-BS and MS-MS scenarios.

FCC position

FCC'S OFFICE OF ENGINEERING AND TECHNOLOGY, ADVANCED WIRELESS SERVICE INTERFERENCE TEST RESULTS AND ANALYSIS, Oct. 10, 2008, available at http://hraunfoss.fcc.gov/edocs_public/attachmatch/DA-08-2245A2.pdf.

Results of the testing and likely result of M2Z/T-Mobile issue.

FCC, Further Notice of Proposed Rulemaking, June 20, 2008, http://hraunfoss.fcc.gov/edocs_public/attachmatch/FCC-08-158A1.pdf.

Further Notice and Proposed Rulemaking for the AWS spectrum in the 1915-1920 MHz, 1995-2000 MHz, 2020-2025 MHz, and 2175-2180 MHz (AWS-3) bands.

T-Mobile position

T-Mobile *Ex Parte* notice to FCC, June 6, 2008, available at http://fjallfoss.fcc.gov/prod/ecfs/retrieve.cgi?native_or_pdf=pdf&id_document=6520013015.

T-Mobile addressed its concerns about operations in the AWS-3 spectrum, calling for an interference study to be performed, and discussed the need for power limits and out-of-band emission protections to protect incumbent AWS-1 operations.

M2Z position

M2Z *Ex Parte* response to T-Mobile/AT&T position, June 17, 2008, available at <http://www.m2znetworks.com/xres/uploads/documents/2008-06-17%20ExParte%20Response%20to%20ATT%20and%20T-Mo.pdf>.

M2Z's *ex parte* response to T-mobile and AT&T's position. M2Z supports allowing TDD/FDD and applying the OOB restrictions adopted in the 700MHz band.

Cognitive Radio Approaches

Preston Marshall, *Extending the Reach of Cognitive Radio*, 97, No. 4 IEEE 612 (2009).

There has been significant research progress reported over the last few years in the development of cognitive radio technologies. This paper reviews some of these results, describes several critical issues to integrate these results in usable products, and describes the large-scale Defense Advanced Research Projects Agency efforts to further develop and exploit dynamic spectrum access, and initiate development and operational use of cognitive networking and a new generation of affordable wireless technology. This paper also describes future research needs to fully exploit cognitive radio technology and addresses the challenges that will arise with its large-scale deployment.

Preston Marshall, *Cognitive radio as a mechanism to manage front-end linearity and dynamic range*, 47, No. 3, IEEE Communications Magazine 81 (2009)

This article describes the use of dynamic spectrum access (DSA) to resolve challenges in achieving wireless and cognitive radio operation in dense or energetic spectrum. It also demonstrates that the use of DSA can significantly reduce requirements for linearity and dynamic range in the radio front-end, and reduce the intermodulation induced noise floor through integration of DSA with the selection of front-end filter settings. This material is summarized in Marshall's slide deck for the meeting.