

Radio Rights and Wireless Technical Innovation

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Introduction

For better or worse, wireless technology is one of the most regulated technologies in our modern world. In classic wireless regulation, such as was in place in the US prior to the mid 1970s, almost all innovative technologies needed positive regulatory action before they could be used in operational systems. The ultimate goal of a radio rights regime is to stimulate capital formation for wireless technical innovation while at the same time providing enough certainty for the capital formation of incumbent spectrum users to build out and operate their systems. While these goals are not contradictory at their root, they certainly partially conflict. This conflict explains the difficulty regulators have had in devising such a regime in a way that pleases all parties involved. However, this goal is so important in our information age society and economy that it is vital to move forward towards it no matter how difficult.

Spectrum regulation began in the aftermath of the 1912 *Titanic* disaster and the formal regulation of radio in the US began in the 1920s. The basic prescriptive regulation of wireless technology made sense when relatively little spectrum was available for commercial operations due to lack of technology to reach “high frequencies”¹, when there would be few choices for modulation, and for when wireless systems were not widely expected throughout our society and industries.

At the time the new FCC started down the path of detailed prescriptive regulation after its formation in 1935, the New Deal resulted in a great faith in government as the “solution”, not as the “problem”. It was simple for FCC to propose and adopt rules under its original legislation. Furthermore, FCC could adopt “guidance”, like its former “Standards of Good Engineering Practice”² that had the impact of regulations without even formal approval by the Commission.

¹ Note that the “High Frequency” band, 3-30 MHz was so named when this *really* was a “high” frequency.

² FCC v. WJR, The Goodwill Station, Inc., 337 U.S. 265 (1949)

The end of World War II changed the foundations of this system. The great military technology advances in the war opened up higher and higher frequency bands and set in motion a movement that now has FCC rule provisions as high as 95 GHz and commercial production systems as high as 86 GHz. The following explosion in wireless technology also resulted in a myriad of technology choices in modulation and channel access technology as well as in source coding. The small number of prewar technology choices soon became nearly infinite.

At the same time these choices were exploding, the aftermath of the New Deal and the partisan changes in Washington resulted in the 1946 Administrative Procedure Act/APA that brought formal checks and balances to administrative regulation in the federal government by requiring notice and comment in rule makings and formalizing the process of court review of agency actions. Court decisions of the next 2 decades clarified what “notice and comment”³ and “arbitrary and capricious”⁴ meant in practice. The net result of the APA and its case law was that the ability of the FCC in the 1930s to readily update its wireless rules slowed, as if immersed in molasses, just as the need to update them increased tremendously due to movement to ever higher frequencies and expanding technological options.

Wireless Technical Innovation and Regulation

The early 20th century model of detailed regulation of wireless technology and a prescriptive approach towards new technology became increasingly inappropriate in the second half of the century. While the certainty resulting from enumerated allowed technologies and slow adoption of new ones helped established industry players make long term research, development and manufacturing plans it also was a serious disincentive for new entrants to the field since new technology could only be implemented after a multiyear regulatory battle in which the new technology would be subject to detailed public review and criticism by established players and their allies.

When the author joined FCC in 1979 it appeared that major incumbents sometimes used abuse of process at FCC strategically to control the pace of allowed innovation in an anticompetitive way. This way they could both minimize the threat of potential new competitors as well as assure that they could fully amortize the cost of new product development before the product became obsolete.

After the prolonged battle by the entrepreneurial proponents of a new private land mobile technology, amplitude compandored single sideband/ACSB, to get market access in the early 1980s, Congress passed Section 7 of the Communications Act⁵ to try to level the playing field for new technologies. This new legislation boldly declared:

³ 5 U.S.C. 553

⁴ 5 U.S.C. 702

⁵ 47 U.S.C. 157

“It shall be the policy of the United States to encourage the provision of new technologies and services to the public. Any person or party (other than the Commission) who opposes a new technology or service proposed to be permitted under this chapter shall have the burden to demonstrate that such proposal is inconsistent with the public interest.”

Section 7 then goes on to require that the Commission determine if a new technology is “in the public interest within one year” in both the case of petitions and FCC self initiatives. In reality, Section 7 has been a total failure in that the Commission has totally ignored it in the 27 years since it was adopted. Indeed, it might even have been worse than a total failure in that it may have given unreasonable expectations to innovators and entrepreneurs during this period to launch hopeless attempts to get questions of new technology resolved in a timely way. Such failures may well have made capital for innovative technologies harder to obtain rather than easier.

Reviewing Section 7 and its track record shows that it is not a perfect piece of legislation. The author has urged the Commission to review its record in this area and either to recommend changes to Congress in Section 7 to make it more workable or to recommend its repeal.⁶ To date, the Commission has never even acknowledged the existence of any problems in implementing Section 7. At times, the author has wondered whether this section is actually redacted from all copies of the Communications Act acquired by FCC since FCC had not request these provisions.

The movement of the FCC towards technical deregulation of wireless technology and “technical flexibility” begun in the late 1970s was an attempt to get out of the need for case-by-case adjudication of new wireless technologies. However, at its core was the need to make some general findings about the interference potential of new technologies as the previous new technology rulemakings were really *ad hoc* determinations of this issue. A general threshold for interference potential would allow complete transparency for new technology as well as protect incumbents. This, in reality, is a near impossible goal - particularly in the present policy deliberation structure.

Harmful Interference

FCC has a longstanding tradition to allow new wireless technologies if they do not cause harmful interference to other spectrum users. While “harmful interference” is mentioned several times in the Communications Act⁷, it is not defined there. The only explicit definition is the same one used in the ITU Radio Regulations and incorporated verbatim into the FCC Rules⁸ and the NTIA “Red Book”. This definition states that harmful interference is “(i)nterference which endangers the functioning of a radionavigation

⁶ Comments of Marcus Spectrum Solutions LLC, Docket 09-157, September 24, 2009 (<http://fjallfoss.fcc.gov/ecfs/document/view?id=7020039289>)

⁷ 47 USC 302a, 303(y), 337, 354, 922, 923, 1100

⁸ 47 C.F.R. 2.1

service or of other safety services or seriously degrades, obstructs, or repeatedly interrupts a radiocommunication service operating in accordance with [the ITU] Radio Regulations.”

This definition contains in it two subcases. First for the case of “a radionavigation service⁹ or of other safety services” harmful interference is something that “endangers the functioning” of the service. For the cases of other radio services, harmful interference is something that “seriously degrades, obstructs, or repeatedly interrupts” the service.

As part of President G. W. Bush’s Spectrum Policy Initiative begun in May 2003 to “promote the development and implementation of a United States spectrum policy for the 21st century”, NTIA attempted to identify “interference protection criteria”/IPC for wireless systems. This was intended to be a two part study with the first part surveying national and international precedents in this area and in the second NTIA intended to “review the relevant federal government policies and practices regarding IPC and recommend regulatory and technical refinements that may improve IPC application’s scope, utility, clarity, or effectiveness.”¹⁰ In the five years since the Phase I report, NTIA has never produced the phase II report. While it is tempting for an FCC alum like the author to dismiss this as “typical NTIA inaction”, the reality is that making real progress on either IPC or “radio operating rights” is a **really hard problem** and is made more difficult by the fact that many key players whose participation is needed in the usual consensus development just do not see any advantage to them in moving away from the *status quo*.

In the Wireless Innovation NOI the FCC recognized the importance of clarifying what is harmful interference saying:

Spectrum allocations and access often hinge on controlling interference between new services and incumbent services, as do licensing and service rules to some extent. The resolution of disputes about potential or actual interference in rulemakings can pose a major impediment to the introduction of new services, devices and technologies, either as a result of long delays in the establishment of service rules or the imposition of onerous and perhaps unachievable technical standards. What are the best ways to balance the interference protection rights of incumbents against the opportunities for access to spectrum, and how do interference protection considerations affect innovation? Radio services are generally afforded protection from “harmful interference” on either a primary or secondary basis depending upon their status in the Table of Frequency Allocations. ...The trend of more radio services and devices seeking to use extremely weak signals and mobility bringing products in closer proximity to each other is making the risk of interference a more acute problem. A challenge for the Commission is that application of these criteria often devolves to a case-by-case interpretation of conflicting data. What criteria should be specified and how would they be quantified? ...The viability of spectrum access for new radio

⁹ Radionavigation is in turn defined as “Radiodetermination used for the purposes of navigation, including obstruction warning.” “Safety service” is defined as “(a)ny radiocommunication service used permanently or temporarily for the safeguarding of human life and property. - 47 C.F.R. 2.1

¹⁰ NTIA, “INTERFERENCE PROTECTION CRITERIA Phase 1 - Compilation from Existing Sources”, NTIA Report 05-432, October 2005, (http://www.ntia.doc.gov/osmhome/reports/ntia05-432/IPC_Phase_1_Report.pdf)

services often centers on whether the new service may cause harmful interference to incumbent services. This can lead to delays through protracted rule making proceedings that can create uncertainty and discourage investment.¹¹ (Footnotes omitted)

In the *status quo* FCC makes determinations of harmful interference from a potential new system based on the cryptic definition in its Rules and on vague past precedents. In general, there isn't even agreement in many cases which past precedents are applicable. This sets up a legal confrontation between the incumbents and the proponent of the new technology. Since the deadlines of Section 7 of the Communications Act are essentially ignored as discussed above, this confrontation can go on indefinitely. Assuming the incumbents have ongoing businesses using the spectrum and the proponent is funded by venture capital or comparable funding, the regulatory battle could divert a small fraction of the incumbents income and profits while denying the proponent *any income* and pushing any potential profits further into the future. Sooner or later it is just a question of when the proponent will "bleed out" all of its capital and drop by the wayside. In the case of ultrawideband technology, the 3 proponents managed to survive the rulemaking process, but the 2 most active succumbed to bankruptcy within a year. In the recent case of the AWS-3 band, the proponent begged the FCC to give a clear signal 5 years into its deliberations, and with a telephone call¹² there proposal was dismissed without ever resolving either the technical or nontechnical issues in their proposal.¹³

In contrast to this endless process for harmful interference deliberations, FCC has adopted an "informal guideline" for its consideration of corporate mergers.¹⁴ The Commission's website gives a nominal schedule and makes the following statement about this timeline:

The timeline represents the Commission's goal of completing action on assignment and transfer of control applications (i.e., granting, designating for hearing, or denying) within 180 days of public notice. Routine applications should be decided well within the 180-day mark. More complex applications may take longer. It is the Commission's policy to decide all applications, regardless of whether they are highlighted on the web page, as expeditiously as possible consistent with the Commission's regulatory responsibilities. Although the Commission will endeavor to meet its 180-day goal in all cases, several factors could cause the Commission's review of a particular application to exceed 180 days. Delay in action beyond the 180-day goal in a particular case is not indicative of how the Commission ultimately will resolve an application.

¹¹ Notice of Inquiry, Docket 09-157, August 27, 2009 at para. 34-35

¹² "What's Next for M2Z?", *Wireless World Blog*, 9/2/10 (<http://www.wirelessweek.com/Blogs/Wireless-Week-Blog/What-s-Next-for-M2Z-/>)

¹³ The nontechnical issues involved a "freemium" plan under which M2Z would receive a license at no auction cost but with a condition to supply service at a basic rate to anyone seeking it and then charge for high rates and any special content. The technical issues focused on whether time division duplex (TDD) use of the AWS-3 band was possible without harmful interference to the lower adjacent AWS-2 band, generally licensed to T-mobile.

¹⁴ See <http://www.fcc.gov/transaction/timeline.html>

Furthermore the website even has a “shot clock” for such applications.¹⁵

There is no statutory requirement for any specific schedule in merger approval while Section 7 does have a clear, explicit, quantitative time limit that is routinely ignored. While the corporate entities involved in multibillion dollar mergers certainly incur extra costs while the mergers are pending, entrepreneurial firms seeking approval of innovative wireless technologies in harmful interference/radio rights determinations are even in more of a life or death battle of beating the clock before they literally expire! As long as Section 7 remains the “law of the land”, should it not get as much attention and respect as corporate mergers/”major transactions”?

Technical Flexibility

Since the 1980s, the Commission has had a policy of technical flexibility in contrast to most other major countries. While the initial 1G AMPS/TAC analog cellular technology was mandated in reasonable detail by FCC rules, the opening of the PCS band in 1987 involved a deregulatory approach that permitted any wireless technology that met general rules on out-of-band emissions. Proponents of GSM, and others, will argue endlessly that this was a foolish decision and that the CEPT-enforced GSM monoculture in Europe was a far superior policy. But the heart of CEPT’s technology monoculture approach is consensus standards development integrated with an industrial policy that is antithetical to the tradition of innovative technology, entrepreneurship and free markets that has served this country well for most of its history.

By its very nature, consensus standards development is consensus oriented and does not take well to “disruptive innovation”. Even though all the world’s 3G standards now use CDMA technology, CDMA was definitely the underdog in 1980s 2G standards deliberations because it was commercially unproven and extremely controversial, even among the experts of the technical community. The spread spectrum standard adopted by IEEE 802.11 for 802.11(b)/Wi-Fi was adopted by a standards group that was much much smaller than today’s broadly based IEEE 802. Consensus standards groups do not deal gracefully with disruptive innovation. Intellectual property issues are also very divisive in consensus standards development. But, with the limited exception of the ATSC digital TV standard, FCC has avoided codifying nonsafety-related consensus RF standards for most of the past 3 decades, relying instead on technical flexibility.

But technical flexibility then focuses attention on harmful interference/radio rights issues. For the rest of this paper we will discuss current issues in this area.

Who Adjudicates Radio Rights?

Under present procedures FCC is the final arbiter of harmful interference to nongovernment systems and NTIA for federal government systems. In practice, FCC

¹⁵ For example, <http://www.fcc.gov/transaction/comcast-nbcu.html> gives the shot clock for the Comcast/NBC Universal merger

uses notice and comment rulemakings supplemented sometimes by testing of its own Laboratory. In practice NTIA relies almost exclusively on the deliberations of its nontransparent Interdepartmental Radio Advisory Committee/IRAC¹⁶ composed of representatives of the major agencies with wireless systems.

Sometimes harmful interference determinations involve straight forward applications of well known concepts while at other times there are novel interference issues. Examples of the later were the Northpoint/MVDDS , ultrawideband, and AWS-3 controversies. In the Northpoint/MVDDS case, Congress ordered FCC to get an outside party to evaluate the novel technical issues involved¹⁷ and make a recommendation. When selection mechanism in the legislation for the outside party was unworkable and all affected entities agreed that MITRE Corporation was an acceptable contractor. The resulting MITRE report¹⁸ contained key recommendations for the technical controversy that in turn were generally adopted in the FCC rules¹⁹. While the FCC had also used a study by the National Academy of Science/National Research Council to set the basis of C band (4/6 GHz) sharing between terrestrial fixed users and satellite users in the 1970s, the use of outside studies like this in FCC spectrum formulation has been exceedingly rare even though such studies are much more commonly used by other regulatory agencies with technical jurisdiction.

Other agencies with technical jurisdiction also routine use advisory committee of technical experts in the field to advise on complex and novel technical decisions. While FCC and NTIA now have technical advisory committees, they are not composed of the leading wireless technologists but rather are representative of key industry players with a few academics and public interest figures thrown in. These committees have never been involved in an advisory role on novel spectrum policy deliberations. By contrast, a detailed study by The Brookings Institution shows how other regulatory agencies use technical advisory committees as part of their deliberations.²⁰

While the author believes strongly in the transparent notice and comment process for many public policy determinations, its near exclusive use without any outside independent studies in harmful interference/radio rights issues is inappropriate and results in great part from the lack of funding at FCC for any alternative. While NTIA has its own well respected laboratory, the Institute for Telecommunications Sciences/ITS, it

¹⁶ <http://www.ntia.doc.gov/osmhome/iracdefn.html>

¹⁷ Novel key issues in this controversy included the exact sensitivity of DBS home antennas in operational use in directions other than the intended direction of the satellite system, the impact of heavy rain falls on both the DBS signal path to the receiver and the MVDDS interference path to the DBS receiver as well as when or whether infrequent interference became “harmful”.

¹⁸ MITRE Corp., “Analysis of Potential MVDDS Interference to DBS in the 12.2–12.7 GHz Band” , MTR 01W0000024, April 2001 (http://www.fcc.gov/oet/info/mitrereport/mitrereport_4_01.pdf)

¹⁹ 47 C. F. R. §§101.1401,1440

²⁰ Bruce L. R. Smith, *The Advisers: Scientists in the Policy Process*, The Brookings Institution, 1992

mainly functions as a research contractor for other government agencies and NTIA has little funding to support studies at ITS in support of its own mission. In some cases where ITS did studies in support of FCC/NTIA deliberations on interference from nongovernment system to government systems there have been unproven suspicions that ITS staffers were pressured to produce reports supporting IRAC positions.

In the case of NTIA, the nontransparency of the IRAC as well as the incentives for the IRAC member agencies under present legislation to optimize their own spectrum use without considering the overall “public interest” is a real problem. Current legislation sets up an idealized role and idealized goals for NTIA²¹ that are unrealistic given the realistic power of an Assistant Secretary of Commerce over more powerful cabinet agencies. In addition, NTIA, like FCC, does not have access to the top level technical advisory committees and outside study resources that other regulatory agencies do and in most cases is reduced to acting as the “IRAC secretariat”.

In order for any new “radio rights” regime to be workable with respect to federal government spectrum or shared G/NG spectrum, there probably has to be a more objective and transparent decision making authority than the present NTIA/IRAC structure. Alternatively, part of the President’s 47 U.S.C. 305 authority to regulate federate spectrum use might be moved back to the Executive Office of the President where it resided prior to the creation of NTIA in 1978. Note that this could be done without moving most of the NTIA staff by just formally acknowledging the role of the Commerce employees as the “IRAC Secretariat” rather than as apparent regulators of other agencies.

Key Issues in a Radio Rights Regime

In this section we will divide the issue of a radio rights regime into subproblems that would have to be specified in order to define the rights of an incumbent and determine what is allowed for a new entrant. The division below is not the only way it can be done and may not include all the issue, but shows the complexity and multiple facets of the problem.

I/S Protection at Receiver

Fortunately, the issue of how much protection a receiver needs has gotten much simpler in the today’s digital age. NTIA’s survey study found “(o)ne common feature was that for continuous, long-term interfering signal levels, nearly all established IPC were based on an interference-to-noise power ratio of -6 to -10 dB”.²² In the days of analog signals, acceptable I/S ratios varied all over the place depending on the nature of both the desired and interfering signals. Indeed, analog NTSC TV needed I/S less than -40 dB for some

²¹ 47 U.S.C. 901

²² NTIA Report 05-432, *op. cit.*, p. ii

types of interfering signals. So there is relatively little uncertainty for most digital signals about how much protection they need at the receiver.

However, for CDMA systems such as 2G and 3G cellular, I/S translates directly into cell site capacity as the cellular industry repeatedly reminded the FCC during the UWB²³ and Interference Temperature²⁴ rulemakings. This is because of the nature of CDMA where the receiver sees multiple signals overlapping in frequency and sorts them out by processing gain. While ideally the CDMA signals are orthogonal, in reality there is some intersignal leakage in the receiver and thus the amount of noise in the receiver limits how many CDMA signal can share the same spectrum block for a base station. So in effect, the impact of interference to CDMA systems is very different than the impact to other systems where it either causes interference or doesn't.

In the UWB proceeding cellular interests tried to argue that for very strict emission limits and allowable interference from UWB to PCS. Qualcomm said FCC should define harmful interference as any UWB emission that is greater than 6 dB below the thermal noise floor of the PCS receiver. Motorola based its definition of harmful interference on a PCS receiver as any signal that causes a 1 dB rise in the receiver thermal noise floor, i.e., resulting from an UWB device that produces signal in the PCS receiver that is 6 dB below the thermal noise floor.²⁵ FCC ultimately decided that “a PCS received signal level of – 96 dBm/1.25 MHz adequately characterizes a low level PCS signal level based on real world applications” and “that a S/I of about a 6 dB is required to prevent interference to a PCS system”.²⁶

Such decisions for CDMA systems are very difficult but they are the core of the radio rights issue. One motivation for the ill fated “Interference Temperature” rulemaking²⁷ was to solve this problem in a the more general case so that licensees would have a clear and long term understanding of how much interference they would have from other signals and natural sources. Ultimately the FCC found that “(c)ommenting parties generally argued that the interference temperature approach is not a workable concept and would result in increased interference in the frequency bands where it would be used.”²⁸ Unfortunately for clarifying harmful interference or radio rights one has to make this type of decision one way or other.

²³ ET Docket 98-153

²⁴ ET Docket No. 03-237

²⁵ FCC, *First Report and Order*, Docket 98-153, (Feb. 14, 2002) at para. 152-161 “UWB R&O”

²⁶ *ibid.*, at para. 162

²⁷ *Notice of Inquiry and Notice of Proposed Rulemaking*, Docket 03-237, (Nov. 13, 2003) (http://hraunfoss.fcc.gov/edocs_public/attachmatch/FCC-03-289A1.pdf)

²⁸ FCC, *Order*, Docket 03-237 May 2, 2007 (http://hraunfoss.fcc.gov/edocs_public/attachmatch/FCC-03-289A1.pdf)

The incumbents would prefer that it never be made because they hope that in the present decision making process they can outlast new entrants seeking to encroach into their spectrum and use the present ambiguity and uncertainty to either let them die off of fiscal exsanguination or get them to accept in desperation a “compromise” that favors the incumbent.

Unfortunately the lack of transparency in such a system is a major disincentive to capital formation for any wireless technology that has any adverse impact on any incumbent.

I/S Field Strength at the Antenna vice I/S Power at the Receiver

In the past, mobile antennas were omnidirectional and other antennas had fixed patterns. In such a scenario, one could reasonably consider the worst case transfer of I/S field strength ratio at the antenna to I/S power ratio at the receiver to be the same. However, MIMO antenna technology is now well established in the commercial world and will be even more important in the future. MIMO and other adaptive antenna technologies can readily change the I/S ratio at the receiver by preferentially passing the desired signal and not the interference. Thus for system that either use or can be reasonably be expected to use such technology any radio rights regime will have to consider how much to budget for I/S reduction attributable to the antenna system.

Propagation Models

Assuming one know what I/S ratio at the receiver antenna would be acceptable, how would one translate that into acceptable geometries and transmitter power for the new entrant? This involves projecting geometry and power with both scenarios and propagation models.

Propagation would be simple if all radio waves behaved like light in a vacuum with monotonic predictable decrease in field strength with path length increases. *Some* radio signals are actually rather close to that ideal theory: satellite links at high elevation angles in clear weather and fixed microwave links with high gain antennas in clear weather. However, other radio systems have much more complex propagation and uncertainty resulting from multipath propagation and weather related phenomenon. Thus agreeing on a propagation model is a major issue. This was shown in the TV White Space proceeding²⁹ where the broadcast interests kept insisting on the R-6602 model³⁰ that is the basis for the FCC’s Grade B contours. The “66” part of “R-6602” comes from 1966 – the year the model was first published prior to the computer age. While this model was a brilliant breakthrough for its time, it pales before today’s propagation models that can be run on desktop PCs.

²⁹ ET Docket 04-186

³⁰ J. Damelin, W. Daniel, H. Fine and G. Waldom Development of VHF and UHF Propagation Curves for TV and FM Broadcasting, FCC, Office of Chief Engineer, Research Div., Report No. R-6602, September 1966 <http://www.fcc.gov/oet/info/documents/reports/R-6602.pdf>

So realistic radio rights will depend on realistic propagation modeling – something that segments of the wireless community would like to avoid if traditional models give them a better position.

MCL vice Stochastic Modeling

The issue of “minimum coupling loss”/MCL is also key in any radio rights formulation. In the AWS-3 proceeding, incumbent licensees argued that protection from proposed AWS-3 band TDD emitters to incumbent lower adjacent band FDD downlink mobile receivers must be based on MCL – the worst case scenario. In stochastic modeling, geometries are considered along with their probabilities yielding a probability estimate for interference. Generally incumbents prefer MCL analysis as it precludes *any* probability of interference independent of any public interest factors. New entrants, on the other hand, would like to show that interference is minimal and does not meet with the “seriously degrades, obstructs, or repeatedly interrupts” part of the harmful interference definition.

At present FCC does not have a clear policy on when MCL or stochastic models should be used. This policy absence was a definite factor in the prolongation of the AWS-3 deliberations.

It appears that NTIA insists on MCL for all “safety services” although it is unclear if NTIA considers *all* federal government spectrum use to be a safety service or not.

Minimum Protection Distance

A close relative of the MCL issue is the question of minimum protection distance. Or how physically close a new entrant might be in space to an incumbent’s receiver. Since propagated radio signals’ strength is often proportional to $1/d^n$ where d is distance from transmitter to receiver and $2 < n < 4$, simple math shows that as $d \rightarrow 0$ the received power become infinite! In the real world there are either minimal physically possible distances or minimum distances beneath which a user is causing interference to only himself.

In the Commission’s landmark 1979 decision on regulations of unintentional emissions from PCs and other “digital devices” stated that “we are assuming that the home computing device is at least 10 meters from the receiver. The separation distance is a basic parameter in computing tolerable levels of signal that may be radiated by a computer.” And then picked an emission level that would not cause interference to TV receivers at 10m distance even though industry recommended a 30m minimum protection distance.³¹ In the UWB case, FCC limits were based on an assumption of 2m minimum

³¹ *Report and Order*, Docket 20780, (Sept. 18, 1979), 79 F.C.C.2d 28, at para. 53

separation distance between portable UWB transmitters and GPS receivers³² and 1.8m away from PCS receivers.³³

In the AWS-3 case, cellular interests argued that minimum separation (and MCL determination of its impact) should be 0.5m, based on a scenario where two cell phone users are in adjacent seats on a bus or train and hold their cell phones to opposite ears so that the interphone spacing small. As this proceeding ultimately was dismissed with an undocumented phone call there was no determination of what the minimum separation distance should have been.

Acceptable Interference Statistics

What does the harmful interference definition mean with respect to interference that “seriously degrades, obstructs, or repeatedly interrupts”? This has rarely come up in FCC deliberations, but was a key issue in the MVDDS/Northpoint proceeding. DBS satellite systems have natural outages that result from excessive desired path lost during heavy rain. For typical home antennas in the Washington DC area, this comes to about 120 minutes/year. The DBS operators argued that *any* increase in outages over this naturally occurring level would be harmful interference. The Commission ultimately decided that *de minimis* increases would not be harmful and based its technical rules on an objective of increasing rain related outages by no more than 10%³⁴ over the naturally occurring outages - actually the naturally occurring outages predicted by a standard ITU-R model.³⁵

The Commission tried hard to limit this outage increase precedent to only the MVDDS issue at hand, this is a key point in radio rights. Is interference caused by any new entrant that is *de minimis* with naturally occurring outages in space or time really “harmful”? While most incumbents want to believe that they have perfect coverage within their nominal service area in most cases they don’t due to factors such as multipath propagation, terrain shielding, limits of real receiver with respect to dynamic range and selectivity, and weather-related phenomena.

Thus in the case of the low power FM rulemaking, incumbent broadcasters pointed out expected coverage losses near low power entrants on adjacent frequencies when typical receivers’ performance were considered. However, they were not interested in

³² *UWB R&O* at para. 107

³³ *ibid.*, at para. 162

³⁴ Memorandum Opinion and Order and 2nd Report and Order, Docket 98-206, April 11, 2002 at p. 29

³⁵ In reality, heavy rain statistics vary greatly from year to year. Also the ITU-R model only has data for a grid points about 60 miles apart and uses linear interpolation between data points. As a result actual rain rates and the resulting satellite outages during a given year at a given place may vary widely from the predicted data and the real impact of a 10% increase would be impossible to differentiate over the base case.

comparing the magnitude of these outages with existing outages with typical receivers in the base case without the new entrants, instead preferring to focus on their idealized “cookie cutter” coverage.

In considering a radio rights regime, NTIA and FCC should consider the realistic coverage and reliability of a nonsafety service incumbent, along with an estimate for its improvement with new technology, as the base case to compare the impact of any lost resulting from a new service. This would be a useful generalization of the MVDDS 10% increase case with the percentage change in allowed outages considered in the context of the incumbent service and the new service.

Developing a Specific Radio Rights Proposal

The author doubts when FCC could develop and adopt a realistic and constructive radio rights proposal using the standards notice and comment rulemaking procedure normally used. Similarly, the normal procedures of NTIA and IRAC under present legislation and practices focus so much on the rights of the individual member agencies of IRAC that the overall “public interest” of the Communications Act gets inadequate attention. While any proposal will need notice and comment rulemaking for its final implementation, it is necessary to develop a compromise solution that advances the public interest and that is unlikely in the present FCC and NTIA.

It is interesting to look at spectrum management in Europe where there are two separate spectrum management entities, the traditional CEPT³⁶ that developed from the classic monopoly PTTs and the newer Radio Spectrum Policy Group/RSPG³⁷, a European Commission organization. In CEPT, as in FCC and NTIA, the incumbents have disproportional influence over the direction of policy particularly with respect to protection of incumbents from either interference or competition. By contrast, RSPG is more focused on contributing to overall European economic and social goals and less concerned about the near term impact on incumbents. Until FCC and NTIA start behaving more like RSPG, any spectrum rights proposal will probably meet the same fate as “interference temperature” – which actually could be viewed as an attempted initial step in this direction.

In the 1970s, when FCC faced challenging paradigm shifts with respect to both satellite/terrestrial sharing of C band and telephone interconnection/Carterphone policies, it turned to the well respected National Academy of Sciences/National Research Council to develop policy proposals for its consideration and based the ultimate rules in Part 25 and Part 68 in great part on those recommendations. This type of bold step is necessary to break from the past deadlock. Alternatives might include the appointment of a blue ribbon commission by the President to consider spectrum reform or using a subcommittee

³⁶ <http://www.cept.org/>

³⁷ <http://rspg.groups.eu.int/>

of the President's Council of Advisors on Science and Technology (PCAST) to formulate basic recommendations.

Conclusions

The US has a nominally deregulatory policy for wireless technology. It has brought us leadership in areas such as Wi-Fi and CDMA. But innovation is impeded by excessive regulatory uncertainty resulting from the vague definition of "harmful interference" and the inability to resolve novel questions in a time and transparent manner.

By contrast, our foreign competitors operate in spectrum policy systems that are a form of "state capitalism" and where spectrum policy is a key aspect of national industrial policy. The consensus nature of these processes inhibits wireless "disruptive innovation" but eliminates almost all regulatory risk. If the US can not make its deregulatory spectrum system function reasonably for innovative technologies, the private sector funding for innovative research may well dry up as capital sources seek less regulated fields or fields with more transparent regulation, e.g. FDA-regulated pharmaceuticals and medical technology.

Thus maintaining the long term competitiveness of the US wireless technology base may reduce to two stark choices:

- Adopting a radio rights regime that stimulates research and product development which providing reasonable regulatory certainty to incumbents, *or*
- Moving to a regulatory scheme more like that of Europe where all new technology gets filtered through consensus standards making so the US becomes part of a group rather than a leader.

Biography

Michael Marcus is a native of Boston and received S.B. and Sc.D. degrees in electrical engineering from MIT. Prior to joining the FCC in 1979, he worked at Bell Labs on the theory of telephone switching, served in the Air Force where he was involved in underground nuclear test detection research, and analyzed electronic warfare issues at the Institute for Defense Analyses.

At FCC his work focused on proposing and developing policies for cutting edge radio technologies such as spread spectrum/CDMA and millimeterwaves. Wi-Fi is one outcome of his early leadership. He also participated in complex spectrum sharing policy formulation involving rulemakings such as ultrawideband and MVDDS. Awarded a Mike Mansfield Fellowship in 1997, he studied the Japanese language and spent a year at the FCC's Japanese counterpart.

He retired from FCC in March 2004 after servicing a senior technical advisor to the Spectrum Policy Task Force and codirecting the preparation of the FCC's cognitive radio rulemaking. Immediately after retirement he lived in Paris France for 3 years, consulting for US and European clients. In 2006 he was appointed Special Advisor to Mrs. Viviane Reding, European Commissioner for Information Society & Media.

He is now Director of Marcus Spectrum Solutions LLC, an independent consulting firm based in the Washington DC area and focusing on wireless technology and policy. He has been recognized as a Fellow of the IEEE "for leadership in the development of spectrum management policies" and received IEEE-USA's first Electrotechnology Transfer Award (1994) "For his pioneering work in the conception, drafting, and enactment of the Federal regulations that legalized commercial spread spectrum radio under FCC Part 15, the rules governing unlicensed devices; thus spawning a multimillion dollar, worldwide, wireless industry."