TRAGEDY OF THE REGULATORY COMMONS: LIGHTSQUARED AND THE MISSING SPECTRUM RIGHTS

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ABSTRACT

The endemic underuse of radio spectrum constitutes a tragedy of the regulatory commons. Like other common interest tragedies, the outcome results from a legal or market structure that prevents economic actors from executing socially efficient bargains. In wireless markets, innovative applications often provoke claims by incumbent radio users that the new traffic will interfere with existing services. Sometimes these concerns are mitigated via market transactions, a la "Coasian bargaining." Other times, however, solutions cannot be found even when social gains dominate the cost of spillovers. In the recent "LightSquared debacle," such spectrum allocation failure played out. GPS interests that access frequencies adjacent to the band hosting LightSquared's new nationwide mobile network complained that the wireless entrant would harm the operation of locational devices. Based on these complaints, regulators then killed LightSquared's planned 4G network. Conservative estimates placed the prospective 4G consumer gains at least an order of magnitude above GPS losses. "Win win" bargains were theoretically available, fixing GPS vulnerabilities while welcoming the highly valuable wireless innovation. Yet transaction costs—largely caused by policy choices to issue limited and highly fragmented spectrum usage rights (here in the GPS band)—proved prohibitive. This episode provides a template for understanding market and non-market failure in radio spectrum allocation.

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TABLE OF CONTENTS

INTRODUCTION

Scarcity of private spectrum, the limitations of commons networks, and the waste of public spectrum go a long way toward explaining bottlenecks in U.S. wireless broadband.[1]

In early 2012, regulators at the Federal Communications Commission (FCC) took an abrupt about-face with respect to a key, if obscure, public policy. In 2003 and 2004, the agency had authorized the use of satellite frequencies, allocated to the so-called L Band, to also be used in terrestrial wireless systems known as "cellular."[2] The ruling mandated continued performance under the license's original terms for satellite phone service, while permitting the carrier to additionally supply land-based cellular service—rights called the "ancillary terrestrial component"("ATC").

Through a complicated set of actions involving satellite licensees, bankruptcy courts, investors, and additional FCC rulings, the opportunity permitted in 2004 was finally coming to fruition by year-end 2011. LightSquared, which had purchased the satellite licenses, broke ground on a fourth generation ("4G") high-speed wireless broadband network using long-term evolution technology ("LTE"), expending some $4 billion in

[1] MICHAEL HELLER, THE GRIDLOCK ECONOMY 91 (2008).) [hereinafter HELLER, GRIDLOCK ECONOMY].

[2] For the history of the proceeding, see FCC, Comments in Opposition of Lightsquared Inc., In the Matter of LightSquared Technical Working Group Report, 27 F.C.C. Rcd. 2203 (2012).

capital.[3] The system would begin service in mid-2012 and, on completion by 2015, would cost a projected total of $14 billion.[4] The network would potentially serve tens of millions of wireless subscribers in competition with mobile carriers such as Verizon Wireless and AT&T Mobility.

The Commission lauded this competitive addition to the broadband marketplace. It included the 40 MHz of L Band frequencies as a featured component of the National Broadband Plan, issued March 2010, which committed the agency to adding 300 MHz of spectrum for mobile wireless services, in total, by 2015.[5]

But on February 14, 2012 the U.S. Department of Commerce posted a nasty valentine. Acting on complaints from the Department of Defense, the Federal Aviation Administration, and other parties following 2011 radio receiver tests, the Department of Commerce sent the FCC a letter stating that the emerging 4G network would interfere with GPS (global positioning satellite) receivers, which use frequencies adjacent to the L Band.[6] Ironically, the complaint was not that LTE emissions would spill into the GPS band, but that GPS receivers, long made to "listen in" to lightly-used neighboring frequencies, would suffer diminished performance due to the increasing L Band traffic.[7]

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[3] Tiffany Kary & Michael Bathon, *LightSquared Files Bankruptcy After Network Blocked*, BLOOMBERG (May 15, 2012, 12:12 AM ET), http://www.bloomberg.com/news/2012-05-14/lightsquared-failed-wireless-venture-files-for-bankruptcy.html.

[4] Scott Moritz & Olga Kharif, *LightSquared Blow Gives Falcone Few Options to Salvage Value*, BLOOMBERGBUSINESSWEEK (Feb. 21, 2012), http://www.businessweek.com/news/2012-02-21/lightsquared-blow-gives-falcone-few-options-to-salvage-value.html.

[5] FCC, National Broadband Plan 87 (2010), *available at* http://download.broadband.gov/plan/national-broadband-plan-chapter-5-spectrum.pdf [hereinafter NATIONAL BROADBAND PLAN].

[6] Letter to Julius Genachowski, Chairman, Fed. Commc'ns Comm'n, from Lawrence E. Strickling, Assistant Sec'y for Commc'ns & Info., U.S. Dep't of Commerce, at 2 (Feb. 14, 2012), *available at* http://www.ntia.doc.gov/files/ntia/publications/lightsquared_letter_to_chairman_genachowski__feb_14_2012.pdf [hereinafter NTIA Letter]. The letter's language is quoted from Letter from Ashton B. Carter, EXCOM Co-Chair, Deputy Sec'y of Def. & John D. Porcari, EXCOM Co-Chair, Deputy Sec'y of Transp., to Lawrence E. Strickling, Assistant Sec'y for Commc'ns and Info. (Jan. 13, 2012) (on file with authors). EXCOM is the Executive Steering Group of the Interagency National Executive Committee for Spaced-Based Positioning, Navigation, and Timing. *See also* Petition for Reconsideration of the U.S. GPS Industry Council, ET Docket No. 10-142, June 30, 2011 (for reconsideration on the *2011 MSS ATC R&O* on the Radionavigation-Satellite Service ("RNSS") and commercial GPS).

[7] This type of interference is called "overload." Complaints regarding this type of overload interference asserted, inter alia, that LightSquared's planned LTE network

Immediately, the FCC stated that it was suspending LightSquared's ATC authorization, and that it would revoke the agency's 2004 ruling creating it.[8] Three months later LightSquared declared bankruptcy.[9] In 2014, at the time of this writing, the firm remains mired in financial restructuring efforts and all work to construct a new LTE network is halted. The smoldering wreckage of the scuttled nationwide network provides a thematic logo for the process of spectrum rights definition at the FCC.

Even senior FCC officials were stunned by the sudden regulatory reversal.[10] The LightSquared LTE network promised to deliver at least an order of magnitude more economic value than would be lost by resulting interference to GPS. A well-ordered rights assignment in the GPS band could not only fully protect GPS users, including mission-critical tasks using GPS devices, but also improve wireless services available to those parties. In other words, whatever gains were achieved by the GPS interests lobbying against LightSquared's ATC venture came at a price that turned the great majority of GPS users into net losers.

This "non-market failure" resulted from the manner in which legal rights to spectrum use were defined and assigned. In Garret Hardin's terminology, it is a "tragedy of the commons."[11] When many parties use a

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would violate the FCC's requirements for "ancillary" use of the ATC. *See, e.g.*, LightSquared Subsidiary LLC Request for Modification of its Authority for an Ancillary Terrestrial Component, 26 F.C.C. Rcd. 566, 576–77, 585–87 (2011) (SAT-MOD-20101118-00239) (order and authorization) [hereinafter Authority Modification Request]. LightSquared responded by correcting complainants' overestimates of L Band use by the proposed LTE network, and by offering to slowly expand LTE network use of L Band frequencies while spending up to $50 million replacing government GPS units. *See* discussion *infra* Part II.A.

[8] Press Release, FCC, Statement from FCC Spokesperson Tammy Sun on Letter From NTIA Addressing Harmful Interference Testing Conclusions Pertaining to LightSquared and Global Positioning Systems (Feb. 14, 2012), *available at* http://hraunfoss.fcc.gov/edocs_public/attachmatch/DOC-312479A1.pdf.

[9] Kary & Bathon, *supra* note 3.

[10] Blair Levin, chair of the National Broadband Task Force (2009-2010) at the FCC, summarized the regulatory outcome this way:

> Something extraordinary happened last week. Our country reallocated 40 MHz of commercial spectrum. No Notice of Proposed Rulemaking from the FCC. No notice and comment period. No economic analysis. Not even a legal decision stating that that is what we are doing.

Blair Levin, Remarks to the Minority Media & Telecom Council (Mar. 8, 2012), *available at* http://broadbandandsocialjustice.org/2012/03/when-an-roi-500-times-better-than-goldman-isn't-enough-reallocating-our-focus-on-reallocating-spectrum.

[11] Garrett Hardin, *The Tragedy of the Commons*, 162 SCIENCE 1243 (1968).

resource, but none exercise effective control, a commons is said to exist.[12] Michael Heller refined the concept, in this context, to a "tragedy of the anti-commons."[13] Lee Anne Fennell, providing a synthesis, shows the problem to be a generic "common interest tragedy."[14] In this paper, we elect to add further to terminology creep by dubbing the situation a *tragedy of the regulatory commons*.

The primary alternative account frames the "LightSquared debacle"[15] as an arcane dispute over highly technical measures of radio interference.[16] It is that complexity, the nature of the beast in busy wireless markets deploying advanced technologies, that is said to cause the frustrating, anti-social outcome. In particular, some spectrum experts suggest that, because the engineering requirements for radio equipment ——specifically, GPS receivers—are not sufficiently defined by regulators,

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[12] This is in fact loose terminology, in the sense that, were a group of owners actually vested with "common" ownership rights, they would have incentives to organize their efforts so as to protect against resource dissipation. A corporation, a classic commonly owned resource, does this through governance institutions. It should also be noted that Hardin's "tragedy of the commons" portrayed, in fact, the breakdown of an "open access" situation where no ownership rights, common or private, were in effect.

[13] Michael A. Heller, *The Tragedy of the Anticommons: Property in the Transition from Marx to Markets*, 111 HARV. L. REV. 621 (1998) [hereinafter Heller, *Tragedy of the Anticommons*]; HELLER, GRIDLOCK ECONOMY, *supra* note 1.

[14] Lee Anne Fennell, *Common Interest Tragedies*, 98 NW. L. REV. 907 (2004).

[15] Cecilia Kang, *FCC T*reading *L*ightly *A*fter *LightSquared D*ebacle, WASH. POST (Feb. 15, 2012), http://articles.washingtonpost.com/2012-02-15/business/35445855_1_falcone-fcc-decision-fcc-officials.

[16] *See, e.g.* J. Pierre De Vries, *Optimizing Receiver Performance Using Harm Claim Thresholds*, 37 TELECOMM. POL. 9 (2013) ("The monetary scale of the problem is difficult to quantify, [but] it is large," with the FAA estimating consumer value from LightSquared's plan to be "at least $70 billion" while LightSquared estimated the value at $120 billion; Vries states next that "these numbers are not strictly comparable, and [they] both can be questioned as being self-interested."); Jon Brodkin, *Why LightSquared Failed: It Was Science, Not Politics*, ARS TECHNICA (Feb. 19, 2012, 9:00pm EST), http://arstechnica.com/tech-policy/2012/02/why-lightsquared-failed ("In the end, though, it was not politics, but the results of repeated tests which the FCC could not ignore, that thus doomed LightSquared."); David Schneider, *LightSquared's GPS-Interference Controversy Comes to a Boil*, IEEE SPECTRUM (Jan. 27 2012, 17:58 GMT), http://spectrum.ieee.org/telecom/wireless/lightsquareds-gpsinterference-controversy-comes-to-a-boil ("But more levelheaded engineers have also scrutinized the problem in detail, and the technical issues appear to be understood well enough to suggest possible work-arounds.").

the border between the L Band and the GPS Band was murky.[17] They point to this lack of technical specificity as the heart of the problem, the solution lying in greater diligence by regulators to define precisely what constitutes "harmful interference."[18] Proposals are being made, for instance, to begin more careful government regulation of GPS receivers, prohibiting the production and sale of cheaper models that are susceptible to quality diminution from traffic in neighboring frequencies.[19] The idea is that, by forcing the market to produce better-performing, if more expensive, radios, regulators will face less pressure to protect existing users from transmissions generated by entrants within—or across—allocated bands.[20]

The simple answer to this proffered solution is that FCC regulators already have authority to set receiver standards, but yet continually move to protect "sub-standard" radios when politically prompted to do so. The deeper answer is that regulators, even with perfectly reliable enforcement, do not know the value produced by emerging services or the costs imposed on existing ones. The trade-off between better, higher-cost receivers and more intensive sharing of spectrum between services is not evident. The receiver rules regulators issue are ill-informed guesses at the socially optimal result.

The real lesson learned from the LightSquared debacle is contained in the simple logic of "tragedy of the anti-commons," laid out elegantly in law professor Michael Heller's work,[21] in the economics of Nobel Laureate James Buchanan and Yong Yoon,[22] and elsewhere.[23] Those asserting the LightSquared-GPS dispute is a narrow technical matter miss the forest for

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[17] *See* Stephen Lawson, *LightSquared vs. GPS Raises Big Spectrum Issues*, PC WORLD (July 25, 2011, 2:30 PM), www.pcworld.com/article/236501 (citing experts discussing the receiver issues).

[18] LightSquared opponents pointed to the ATC licenses' provisions prohibiting "harmful interference," provisions common to all FCC wireless licenses, as cause for revoking the ATC licenses. *See infra* text accompanying note 70. In so doing, they ignored the even more prohibitive language that the FCC has used to describe the use of unlicensed devices, including GPS receivers. Such radios cannot cause interference and "interference must be accepted that may be caused by the operation of an authorized radio station." 47 C.F.R. § 15.5(b) (2010); 47 C.F.R. § 25.131 (2013). As a licensed service, LightSquared would have transmitted via such "authorized radio station[s]."

[19] *See* NTIA Letter, *supra* note 6, at 6–7 (planning new work that would serve "as the basis for standards for the development and procurement of GPS receivers").

[20] De Vries, *supra* note 16.

[21] Heller, *Tragedy of the Anticommons*, *supra* note 13; HELLER, GRIDLOCK ECONOMY, *supra* note 1.

[22] James M. Buchanan & Yong J. Yoon, *Symmetric Tragedies, Commons and Anticommons*, 43 J.L. & ECON. 1 (2000).

[23] Lee Anne Fennell, *Common Interest Tragedies*, 98 NW. U.L. REV. 907 (2004).

the trees. What appears to be a technical conflict is actually an economic conflict that is difficult to resolve and virtually impossible to solve efficiently, because of the legal rules in place. Different rules made to advance rather than hinder economic bargains could have enabled welfare-improving cooperation and avoided the costly collapse of a mobile competitor. Moving wireless markets forward to grasp the enormously robust opportunities for wireless technologies in the 21st Century requires an understanding of the anti-commons paradigm, its application to current regulatory quagmires, its solution via observed regulatory successes, and strategies for reform. Although tragedy occurred in the LightSquared debacle, it is possible to transition administrative spectrum use rules towards effective, economically nimble rights, which would allow consumers, carriers, investors, technologists, and entrepreneurs to cooperate for mutual advantage in creating and operating advanced wireless networks. Such positive outcomes are observable in other "interference" disputes, making it essential to understand how these contrasting results are achieved by policy makers.

In this article we explore the LightSquared-GPS conflict and identify the circumstances creating the regulatory commons. Given that interference effects are symmetric in nature, we explain why a focus on technology specifications is misplaced and why proper rights definition will do more to maximize production from spectrum assets. We show that, because LightSquared and its L Band neighbors had expanded rights and the ability to bargain, the firm overcame serious interference with immediately adjacent rivals—parties with more intense "technical" interference issues to overcome than those separated across bands. We then describe how terrestrial mobile license (called commercial mobile radio services, or "CMRS") are liberally defined to approximate private property, and how these de facto spectrum ownership rights facilitate cooperative resolution of interference disputes. In LightSquared's dealings with satellite (and L Band) licensee Inmarsat, as with CMRS licensees' transactions, legal rights are defined so as to accommodate market reallocations. These examples suggest a policy framework that would optimize wireless market productivity, and avoid LightSquared- type debacles in the future.

I. LIGHTSQUARED, LTE, AND GPS RECEIVERS

Under the Radio Act of 1927, government manages frequency access, restricting specific wireless deployments so as to pre-empt "harmful interference."[24] However, as Ronald Coase pointed out long ago, the

[24] *See* Thomas W. Hazlett, *The Rationality of U.S. Regulation of the Broadcast Spectrum*, 33 J.L. & ECON. 133 (1990); Thomas W. Hazlett, *The Wireless Craze, the Unlimited Bandwidth Myth, the Spectrum Auction Faux Pas, and the Punchline*

interference problem is not one-way, but is symmetric.[25] The excluded activities also have value, and suppressing them to protect other activities carries a cost to society. Put differently, rules to mitigate "harmful interference" simultaneously create "harmful interference" through lost output.

The social optimum is achieved via the mix of services that entail the highest total output (equivalently, the smallest "interference loss"). Regulators, however, do not internalize the costs or benefits associated with the relevant options. Moreover, they have strong incentives to remedy conflicts by avoiding political backlash, typically by placating influential incumbents. The general result is widely observed, with the vast majority of spectrum resources being overly restricted and under-utilized. Meanwhile, productive wireless services, more valuable by orders of magnitude than the services "protected," are pre-empted. Regulators themselves admit this unfortunate outcome, expressing frustration over the system's inability to shift bandwidth from under-used employments to emerging wireless applications of far greater social significance.[26]

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to Ronald Coase's 'Big Joke': An Essay on Airwave Allocation Policy, 15 HARV. J.L. & TECH. 335 (2001); Thomas W. Hazlett & Sarah Oh, *Exactitude v. Economics: Radio Spectrum and the 'Harmful Interference' Conundrum,* 28 BERKELEY TECH. L.J. 227 (2013).

[25] R. H. Coase, *The Federal Communications Commission*, 2 J.L. & ECON. 1 (1959).

[26] For example, in the FCC's National Broadband Plan issued March 2010:

> The current spectrum policy framework sometimes impedes the free flow of spectrum to its most highly valued uses . . . . In several instances, [the NTIA and FCC] assign large quantities of spectrum to specific uses, sometimes tied to specific technologies. . . . [B]ecause mission needs and technologies evolve, there must be a public review process to ensure that decisions about federal and non-federal use that may have worked in the past can be revisited over time. . . . In the case of commercial spectrum, the failure to revisit historical allocations can leave spectrum handcuffed to particular use cases and outmoded services, and less valuable and less transferable to innovators who seek to use it for new services.

NATIONAL BROADBAND PLAN, *supra* note 5, at 78–79; *see also* PRESIDENT'S COUNCIL OF ADVISORS ON SCI. & TECH., REPORT TO THE PRESIDENT: REALIZING THE FULL POTENTIAL OF GOVERNMENT-HELD SPECTRUM TO SPUR ECONOMIC GROWTH 16 (2012), *available at* http://www.whitehouse.gov/sites/default/files/microsites/ostp/pcast_spectrum_report_final_july_20_2012.pdf (2012) ("[W]e have created a fragmented partitioning of spectrum that has led to artificial scarcity and constraints on future uses. Because of this history, legacy spectrum assignments remain overly restrictive . . . .").

A regulatory commons occurs here because of the nature of the rights granted to, or withheld from, licensees. By authorizing the use of millions of GPS devices in the spectrum adjacent to the L Band, authorizations that lack the coordinating guidance of agents other than regulators, the FCC virtually ensured that future attempts to reallocate spectrum in this frequency neighborhood would prove contentious and difficult.

A. Conflict on the L Band-GPS Band Border

The dispute over the new LightSquared 4G network was not triggered by LTE emissions that would spill into the GPS band, but by the simple fact that the quiet L Band—hosting virtually no traffic, for very few subscribers, under satellite-only rules—would become much noisier when busy serving millions of terrestrial mobile voice and broadband data subscribers. Many GPS receivers have been built to analyze not just signals emitted in the authorized GPS band but signals traveling through the adjacent L Band. As Julius Knapp, chief of the FCC Office of Engineering and Technology, stated in congressional testimony, "In effect, we discovered that some GPS legacy equipment effectively treats the GPS spectrum and the L-Band spectrum as one band."[27] These emissions are an informational bonus that GPS radios use to fine-tune their locational estimates for objects or addresses. With greatly increased traffic in the L Band, as per the deployment of LightSquared's LTE network, this bonus would be lost and the service supplied by certain GPS receivers diminished.

The GPS market can be broadly grouped into two categories. In the mass market GPS receiver segment there exist tens of millions of GPS receivers in smartphones, automobiles, and GPS radios (produced by companies like Garmin or Tom Tom). These applications are not terribly sensitive to small changes in accuracy; a left turn will not be missed due to a six-inch mapping difference.[28] Thus, the cost of "L Band interference"

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[27] *The LightSquared Network: An Investigation of the FCC's Role: Hearing Before the Subcomm. on Oversight & Investigations of the H. Comm. On Energy & Commerce*, 112th Cong. (2012) [hereinafter *LightSquared Hearing*] (joint written statement of Julius P. Knapp, Chief of FCC Office of Eng'g & Tech., & Mindel De La Torre, Chief of FCC Int'l Bureau) *available at* democrats.energycommerce.house.gov/sites/default/files/image_uploads/Knapp.De%20La%20Torre.Testimony.pdf.

[28] Consumer GPS devices are typically accurate to within 10 to 50 feet. *How Accurate is GPS?*, GPS BASICS, http://www.gps-basics.com/faq/q0116.shtml (last visited April 8, 2014); *see also* Kevin Fitchard, *Analysis: Sorting Out the LightSquared GPS Interference Mess*, CONNECTED PLANET (July, 18, 2011, 8:55 PM), http://connectedplanetonline.com/3g4g/news/analysis-sorting-out-the-lightsquared-gps-interference-mess-0718 [hereinafter Fitchard, *Sorting*]. The NTIA

would not likely be significant even absent mitigation techniques. In addition, there are approaches available to reduce device impacts to an imperceptible level. For instance, LightSquared offered to use only the lower half of the L Band, those frequencies located furthest (in frequency space) from the GPS Band, for several years.[29] Then, as the LTE network scaled up in size, the additional 20 MHz closest to the GPS band would be deployed. This temporal lag would allow a new generation of GPS radios to be deployed, and these radios would include inexpensive filters that eliminate noise from the L Band. In general, the small cost to GPS users would be more than compensated by the availability of an additional nationwide broadband network delivering benefits to GPS users, via increased market competition and enhanced bandwidth for mobile high-speed data service.

The second category consists of high-precision GPS devices. Parties selling or depending on such receivers were the primary source of political opposition to L Band LTE. This category involves a far smaller number of receivers, but includes those installed in mission-critical crash-avoidance systems on passenger airliners and self-guided steering mechanisms on tractors and other farm equipment that are accurate to the millimeter.[30] LightSquared estimated that there were 500,000 such devices[31]; the Coalition to Save GPS[32] argued that there exist 750,000 to one million.[33]

To alleviate the most pressing concerns, LightSquared offered to replace government GPS units, spending up to $50 million.[34] The GPS parties claimed that that was insufficient to mitigate the potential damage.

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was ambiguous about whether using the lower 10 MHz would affect consumer GPS devices. *See* NTIA Letter, *supra* note 6.

[29] NTIA Letter, *supra* note 6.

[30] Fitchard, *Sorting*, *supra* note 28.

[31] Kevin Fitchard, *LightSquared, GPS Industry Spar Over Proposed Interference Fix*, CONNECTED PLANET (Oct. 14, 2011, 5:22 PM), http://connectedplanetonline.com/3g4g/news/lightsquared-gps-industry-spar-over-proposed-interference-fix-1014 [hereinafter Fitchard, *Spar*].

[32] Over 70 companies or trade associations are listed as members on the Coalition's website. *Coalition Members*, COALITION TO SAVE OUR GPS, http://saveourgps.org/coalition-members.aspx (last visited April 7, 2014). They include UPS, Tom Tom, Southwest Airlines, FEMA, Garmin, John Deere & Co., Caterpillar, the National Association of Manufacturers, Delta, Fed Ex, Aircraft Owners and Pilots Association, and the American Rental Car Association. *Id.*

[33] Fitchard, *Spar*, *supra* note 31.

[34] Press Release, LightSquared, Statement by Jeff Carlisle, Exec. Vice President for Regulatory Affairs & Pub. Policy at LightSquared (Oct. 27, 2011), *available at* http://www.lightsquared.com/press-room/press-releases/statement-by-jeff-carlisle-executive-vice-president-for-regulatory-affairs-and-public-policy-at-lightsquared.

The Federal Aviation Administration (FAA) released a study in 2011 that estimated the FAA's retrofit costs alone to be drastically higher—about $6 billion.[35] In addition, the FAA also estimated that adjusting its forthcoming NextGen air traffic control system[36] for L Band LTE conflicts would lead to 800 deaths over ten years and raise NextGen costs by $60 billion.[37]

Opponents of the LTE network included not only the FAA, but also the U.S. Department of Defense and a wide array of other parties with investments, products or operations in the GPS Band.[38] The Coalition to Save Our GPS was not bashful about stating its expected cost of mitigating interference from LTE use of the L Band. The organization estimated the costs—just to government agencies—of an astounding $245 billion.[39]

This estimate massively overstates the social cost of L Band LTE network interference. In the political arena, interested parties have strong incentives to emphasize the negative consequences of policies they oppose. The FAA's cost estimate for the NextGen delay, for example, implausibly exceeds the market capitalization of the entire U.S. passenger airline service industry.[40] We also know these estimates are excessive because when the

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[35] FED. AVIATION ADMIN., LIGHTSQUARED AVIATION IMPACTS 6 (2011), *available at* http://www.insidegnss.com/pdf/07122011_FAA_-_LightSquared_Aviation_Impacts.pdf [hereinafter FAA REP].

[36] NextGen is a multibillion dollar upgrade to navigation systems on airlines, largely replacing radar-based systems with more precise GPS-based systems. Ashley Halsey III, *FAA to Equip Some JetBlue Planes With NextGen GPS Technology*, WASH. POST, Feb. 3, 2011, at A1. The FAA cost estimates arise from re-planning the GPS systems and infrastructure investments, which total $17 billion. It is not clear to the authors, in the FAA's letter to the FCC, where the remaining $42 billion in costs arise. *See* FAA REP, *supra* note 35, at 6.

[37] FAA REP, *supra* note 35, at 6.

[38] *See, e.g.* Authority Modification Request, *supra* note 7, at 576-77, 585-87.

[39] Press Release, Coalition to Save Our GPS, Sampling of Dep'ts and Agencies Shows $245 Billion Potential LightSquared Impacts on GPS in Fed. Gov't Uses Alone (Oct. 27, 2011), *available at* http://www.saveourgps.org/pdf/government_cost_estimates.pdf.

[40] As of early 2013, the estimated market cap of the industry was around $50 billion. *See generally* GOOGLE FINANCE, http://www.google.com/finance (last accessed on Feb. 21, 2013) (providing values for certain airlines, including Delta-Northwest Air Lines at $11.66 billion, Southwest-AirTran Airlines at $8.55 billion, United-Continental Air Lines at $8.79 billion, American Airlines at $8.00 billion, US Airways at $2.20 billion, JetBlue Airways at $1.72 billion, Alaska Airlines at $3.57 billion, Spirit Airlines at $1.40 billion, and SkyWest-ExpressJet at $0.71 billion); YAHOO! FINANCE, http://finance.yahoo.com/ (last accessed on Feb. 21, 2013) (providing similar values). These airlines represent nearly 90% of market share (domestic revenue passenger miles). *See generally* RESEARCH & INNOVATIVE TECH. ADMIN., BUREAU OF TRANSP. STATISTICS, http://www.transtats.bts.gov/. (last viewed Apr. 7, 2014)

Coalition to Save Our GPS opposed the LightSquared's grant of ATC authority, they cited an estimate that the new licenses permitting LightSquared to provide LTE were worth $10 billion in total.[41]

Simple Coasian analysis establishes this valuation as a cap on costs to GPS users. In his famous 1960 essay, "The Problem of Social Cost,"[42] Ronald Coase explained that the cost of any "harmful effect" is the loss in output it incurs. That loss, in turn, is bounded by the most efficient (least costly) mitigation technology. In this instance, the Coalition defines the upper limit of the cost of LTE interference to GPS as $10 billion. Were the costs of LTE interference above that amount, the mobile licenses could be purchased by affected GPS parties and the spectrum held vacant, eliminating the burden.

Of course, the Coalition to Save GPS did not present its estimate of the ATC licenses as bounding the costs of interference, but to support its assertion that liberalization of LightSquared's satellite licenses extended an unjustifiable windfall:

> All in all, LightSquared's proposal represents a new low in financial engineering at the expense of the U.S. taxpayer. Never before has a single company tried to gain so much from our national spectrum resources and pay so little for the collateral damage caused by its plans.[43]

The outraged assertion is ironic. The GPS Coalition was aiming to have a $10 billion windfall not extinguished, say by auction to the highest bidder, but transferred to GPS interests in the form of an FCC license cancellation. That transfer is what they claimed would best protect their economic interests. In the event, regulators obliged them, leading one to muse that "never before has a single [industry] tried to gain so much from our national spectrum resources and pay so little for the collateral damage caused by its plans." The policy action created no more than $10 billion in social gain, and yet caused easily more than $100 billion in collateral damage.[44] The losses so exceed the gains that it is likely that the welfare of most

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[41] Press Release, Coalition to Save Our GPS, LightSquared Did Not Pay For and Does Not Have a "Legal Right" to Build a Nationwide Terrestrial Network in the MSS Band (Oct. 27, 2011), *available at* http://www.saveourgps.org/pdf/History_Windfall_112611.pdf ("If allowed to go forward, LightSquared gets to pocket the $10 billion increase in spectrum value that would result.") (citing a Brattle Group study of spectrum valuation).

[42] R. H. Coase, *The Problem of Social Cost*, 3 J.L. & ECON. 1 (1960).

[43] Kevin Fitchard, *LightSquared is Jilting Taxpayers Out of Billions, GPS Industry Claims*, CONNECTED PLANET (Oct. 27, 2011, 2:56 PM), http://connectedplanetonline.com/3g4g/news/lightsquared-is-jilting-taxpayers-out-of-billions-gps-industry-claims-1027.

[44] *See* discussion *infra* Part II.B.

constituent members of the Coalition to Save Our GPS was adversely impacted. The gains from additional cellphone rivalry and mobile data network capacity would have reduced prices and expanded opportunities for wireless applications. Excluding this beneficial outcome outweighed any plausible gains from reduced interference costs for the vast bulk of GPS users.

B. The Nature of a Regulatory Commons

One way to protect GPS is to simply banish L Band LTE. Existing satellite phone services use very little of the total capacity of the L Band, which is why LightSquared attempted to exploit this unused capacity and why, without LightSquared's LTE network, the L Band would continue to be quiet and unassuming. With so little satellite phone usage, GPS receivers may continue to listen in the L Band to marginally improve their satellite reception.

The relative quiet is the status quo, and it signals the generation of little social value. The satellite telephone market has proven an economic graveyard, with numerous carriers —such as Irridium,[45] Teledesic,[46] and Globalstar[47] declaring bankruptcy. So long as the L Band is regulated under rules not allowing for popular, profitable services, it will continue to be an excellent buffer for GPS, much like living next door to a vacant lot affords a home owner extra parking. But the L Band is one exceptionally expensive parking lot.

The alternative framing of the issue—one where LightSquared is interfering with GPS devices, and the government must act to stop that interference—commits precisely the error that Ronald Coase exposed in 1959. This framing fails to understand "interference" as a two-way problem, something that should be particularly easy to see in the instance of the LightSquared-GPS conflict given that the GPS claim was that LightSquared created interference by using the spectrum allocated not to GPS but to a neighboring band.

To illustrate the problem, Mindel De La Torre, chief of the FCC's International Bureau, in a candid internal email, analogized GPS users to drivers using the wrong lane in traffic. GPS users, she said, have "been

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[45] Arik Hesseldahl, *The Return of Iridium*, FORBES (Nov. 30, 2011, 10:00 AM), http://www.forbes.com/2001/11/30/1130tentech.html.

[46] Sharon Pian Chan, *The Birth and Demise of an Idea: Teledesic's 'Internet in the Sky'*, SEATTLE TIMES (Oct. 7, 2002), http://community.seattletimes.nwsource.com/archive/?date=20021007&slug=teledesic070.

[47] Barnaby J. Feder, *Globalstar, Bankrupt Satellite Company, to Be Sold for $55 Million*, N.Y. TIMES (Jan. 16, 2003), http://www.nytimes.com/2003/01/16/business/globalstar-bankrupt-satellite-company-to-be-sold-for-55-million.html.

driving in the left lane [LightSquared's allocated L Band] with impunity, but now it looks like the left lane might actually have traffic in it, the GPS community is yelling bloody murder."[48] GPS users were able to use the adjacent "lane" without conflict when it was lightly used by satellite services. The pro-GPS argument essentially is one of detrimental reliance, since the rules explicitly state that GPS devices must tolerate interference from other licensees. In any event, the end result is *mutual interference*, but the legal fight that followed may have been prevented had the FCC allocated spectrum licenses in a sensible way that avoided the tragedy of the anti-commons.

In choosing to resolve the border dispute between LightSquared (and its future customers) and GPS users by killing LightSquared's LTE network, the Commission "interfered" with one set of wireless opportunities in order to protect another. It is impossible to exactly quantify the costs and benefits in such a situation. This is the crux of the problem in central planning of spectrum (or other) markets. Resource prices (here for spectrum) are not readily available and the offers from willing partners in market transactions are replaced by bureaucratic edicts, obfuscating demand and supply information that would be available from the observation of standard economic exchanges.

The best publicly available information, however, supports the claim that the decision to block the LTE network was—by at least an order of magnitude—a net loser for society. LightSquared estimated that its network using 40 MHz L Band would generate about $120 billion (present value) in consumer surplus.[49] These projections could be biased upwards, however independent valuations of mobile radio spectrum in the U.S. yield even higher forecasts—about $200 billion in social welfare (consumer and producer surplus).[50] These benefits from permitting LTE vastly outweigh

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[48] *LightSquared Hearing*, *supra* note 27, at 32 (questions of Chairman Cliff Stearns, Sr.), *available at* http://democrats.energycommerce.house.gov/sites/default/files/documents/Final-Transcript-OI-LightSquared-Network-FCC-Investigation-2012-9-21.pdf.

[49] *See* Daniel Fisher, *What's Falcone's $4 Billion Gamble on LightSquared Worth Now?*, FORBES (May 1, 2012, 8:11AM), http://www.forbes.com/sites/danielfisher/2012/05/01/whats-falcones-3-billion-gamble-on-lightsquared-worth-now/ (citing an economist's estimate that the LightSquared spectrum was worth approximately $12 billion and the consumer value around $120 billion).

[50] This is based on analogizing the 40 MHz of L Band spectrum to 30 MHz of generic mobile spectrum, estimated to produce annual social welfare gains of over $10 billion. The annual flow is discounted as a perpetuity at a real discount rate equal to five percent to produce a present value. This employs a model calibrated on international mobile market data to value the impact of additional bandwidth on prices and voice minutes (using U.S. data for the year 2003). *See* Thomas W.

the cost of fixing whatever problems were alleged to occur with GPS receivers, which were only estimated at about $10 billion by the opponents themselves.

An objection may be raised: that the GPS interests—which are numerous, use unlicensed radios, and have non-exclusive rights[51]—are unable, in practice, to make a serious offer to acquire the L Band licenses. Suppose, as a thought experiment, that Delta, Fed Ex, and UPS (three members of the anti-LightSquared lobby) were highly motivated to protect their GPS receivers from degradation and managed to raise the capital to buy the licenses for $10 billion. These parties could then leave the band as is, excluding terrestrial mobile traffic. This is the acquisition the FCC provided, but without charge to the Coalition.

This objection reveals part of the fundamental issue. The barrier to purchasing the adjacent spectrum for protection is the "free rider problem." The investment by the three firms would silence the source of interference for all the users of the GPS band, not just Delta, Fed Ex and UPS. The benefits constitute a non-excludable public good. Hence, it is not likely that the three partners would finance such a purchase. The capital actually invested would produce less than the optimal level of protection.

Switching from thought experiment to real-world conditions, we see the character of the regulatory commons. A cooperative venture to buy "interference protection" via L Band ATC licenses is a transactional nightmare. GPS interests are permitted to use the GPS band—and, implicitly, the L Band next door—not by the grant of ownership rights but via specific use rights.[52] The "unlicensed spectrum" is governed by technical and behavioral rules (including power limits) established by regulators; usage rights are non-exclusive and distributed to millions of disparate parties. Moreover, the GPS Band is widely allocated for uses by government agencies. These institutions are prohibited from reassigning rights in secondary market transactions.[53]

The regulatory commons results in the pre-emption of Coasian bargaining. This outcome is often referenced as "market failure," where

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Hazlett & Roberto E. Muñoz, *A Welfare Analysis of Spectrum Allocation Policies*, 40 RAND J. ECON. 424, 435-36 (2009).

[51] *See* 47 C.F.R. § 15.5(b) (subjecting all such radio use to two conditions: "that no harmful interference is caused," and "that interference must be accepted that may be caused by the operation of an authorized radio station, by another intentional or unintentional radiator, by industrial, scientific and medical (ISM) equipment, or by an incidental radiator"); *id.* at § 25.131 (2010) (offering limited non-exclusive rights).

[52] *Id.*

[53] *Id.*

positive-sum deals cannot be realized due to prohibitive transaction costs. But this outcome is conditional on the legal regime. Specifically, the creation and distribution of fragmented, incomplete, and non-exclusive GPS Band use rights by the FCC prevented bargaining—a "non-market failure."

In distributing fragmented usage rights for spectrum so widely in GPS assignments, FCC regulators made market transactions impossible. If $1 in damage is inflicted on current users from new services, with the new services yielding $1 million in consumer benefits, an intensely productive deal still may not be executed, because trade-offs and decisions are in the domain of the regulator. If the interests losing the $1 scream loudly, or are located very close to the policy maker's ear, the social welfare-enhancing advance will be thwarted.

Such sad outcomes do not come to fruition, however, when a carrier decides to upgrade its mobile network, say, from analog to digital. Under an alternative regulatory scheme, wherein wireless operators enjoy de facto spectrum ownership, millions of spectrum users (network subscribers) will find that the new devices "interfere" with their radios and, at some point in the transition, will render them useless. But social coordination remedies this situation. The operator who owns the necessary spectrum rights can gently reallocate spectrum from the old service to the new, matching supplies with demands, and can distribute new digital phones (marketed as "free, with a contract!") to old customers, allowing them to enjoy "interference protection" via an equipment change-out. Countless such conflicts are managed under the constraints of competitive markets, and supported by property rights of a workable kind.

It is noteworthy that the dispute between LightSquared and GPS interests was not caused by insufficient specificity in interference contours despite that common theme in much of the spectrum policy literature.[54] The rules were actually clear that LightSquared's LTE network was not to distribute out-of-band emissions above specified levels, and that the unlicensed devices in the GPS Band would have to accept whatever interference licensed devices in adjacent bands might inflict.[55] The FCC

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[54] *See, e.g.* De Vries, *supra* note 16, at 757 (2013); Philip J. Weiser & Dale Hatfield, *Spectrum Policy Reform and the Next Frontier of Property Rights*, 15 GEO. MASON L. REV. 549 (2008).

[55] *See* 47 C.F.R. §§ 15.5(b), 25.131 (2010). Garmin, for instance, stated the rule clearly in a 2006 technical document: "[Garmin GPS devices] must accept any interference received, including interference that may cause undesired operation." GARMIN, GPS 15XH/15XL TECHNICAL SPECIFICATIONS 1 (2006), *available at* http://static.garmincdn.com/pumac/GPS15xH_15xL_TechnicalSpecifications.pdf. TomTom, likewise, declared its GPS devices to be in conformity with 47 C.F.R. Part 15., TOMTOM INT'L BV, DECLARATION OF CONFORMITY (Sept. 11, 2009), *available at* http://www.tomtom.com/lib/doc/FCC%20DoC%20-%20START.pdf.

simply chose to overrule these regulations on "public interest" grounds, which the Communications Act of 1934 generally allows it to do.[56]

Moreover, the remedy imposed by regulators to the border dispute did not add technical sophistication to emission rules, but simply proscribed terrestrial mobile services in the L Band. While implementing the fix requested by GPS lobbyists, the FCC extinguished an arguable border incursion by slamming a blunt object against the spectrum allocation table, removing no more than a $10 billion problem by eliminating a more than $100 billion gain. This did not remedy the "interference," but greatly expanded it.

The rights assigned to GPS users also made for a poor resolution process. The administrative procedures were opaque. The relevant questions concerning harmful interference were not presented side by side, and no objective quantification of the appropriate alternatives was put forward by spectrum allocators. This accommodated a decision in which policy makers—regulators at the FCC, as well as powerful members in Congress and the Executive Branch—could exercise political discretion.

This non-transparency derives from the endemic externality problem embedded in administrative allocation of a key resource such as radio spectrum. Economic choices—in this case, resolving the conflict over how best to use the L Band—are made by administrators who do not internalize the costs or benefits of their rulings. The lack of simple accounting is highly illustrative of the nature of the system. Decision-makers prefer not to make the alternatives explicit, as that would yield information for legal or political challenges, constraining their degrees of freedom.

As Blair Levin, formerly a top FCC policy official who headed the National Broadband Task Force in 2009-10, said:

> Through a complicated process—mostly out of the public eye—of K St. machinations, inter-agency battles, and congressional pressure, we as a country came to the unstated but clear conclusion that the GPS industry has a primary right to use the spectrum in the band owned by LightSquared.[57]

The passage is perfectly worded, except for the reference to "the band owned by LightSquared." As vividly demonstrated, the L Band was not owned by LightSquared, which owns only licenses authorizing particular activities. The FCC may extend or revoke such usage rights, according to "public interest, convenience or necessity." The owners of bankrupt LightSquared may have standing to challenge the administrative process in

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[56] 47 U.S.C. § 309(a) (2012).
[57] Levin, *supra* note 10.

which its use rights were revoked as "arbitrary and capricious," but it has no claim for a violation of its property rights in radio spectrum.[58]

The protection of incumbent GPS interests was achieved with violent policy shifts that opened markets, and then closed them, creating an entrepreneurial foray and then crushing it. Moreover, the policy framework took the view that virtually any interference to existing wireless operations was to be prohibited, even if the gain from the prohibition was tiny and the loss—in blocking, "interfering" with, the new opportunity—was vast. A regime that is subject to wild perturbations, as per political influence, dangerously threatens those equities and undermines the socially constructive incentives they yield. The message to new entrants following the LightSquared debacle is, "Do not invest to create additional wireless opportunities, the barriers are too high and, alas, the rulemakers cannot be trusted."

The blame for the LightSquared debacle does not belong to the malfeasance of current FCC personnel. Neither does the blame belong to the villainy attributed to LightSquared's owners (including the political entrepreneur and private equity maven, Phil Falcone.[59]) There are no villains or heroes in the LightSquared debacle, only another instance of a recurring tragedy of social disorganization. The essential source of misallocation is the creation of a regulatory commons. With spectrum use rights defined in small, fragmentary, non-exclusive slices, economic reorganization, responding to new opportunities, is impossible due to prohibitive transaction costs.

II. THE BENEFICIAL ROLE OF SECONDARY MARKETS IN THE L BAND

Determining which party "caused" the interference is not a question competently pursued by government, and the "technical" metrics used to inform the question do not answer it. Indeed, the problems generated are symmetric and economic in nature. Consider this description of the LightSquared-GPS dispute:

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[58] 47 U.S.C. § 301 ("It is the purpose of this chapter, among other things, to maintain the control of the United States over all the channels of radio transmission; and to provide the use of such channels, but not the ownership thereof . . . ."). Licensees must waive "any claim to the use of any particular frequency or of the electromagnetic spectrum . . . because of previous use of the same." § 304.

[59] Matt Levine, *Phil Falcone's Alleged Piggish Behavior Made Him Some Enemies*, DEALBREAKER (June 27, 2012, 4:30 PM), http://dealbreaker.com/2012/06/phil-falcones-alleged-piggish-behavior-made-him-some-enemies; Azam Ahmed, *S.E.C. Files Civil Charges Against Falcone*, DEALBOOK (June 27, 2012, 2:47 PM), http://dealbook.nytimes.com/2012/06/27/s-e-c-files-civil-charges-against-falcone.

> Given that LightSquared is coloring within the lines, it claims that the GPS industry should be afforded no legal protection.
>
> Technically LightSquared is right, though interference was never a problem until LightSquared tried to rezone its L-band spectrum from satellite to terrestrial use. Even if the FCC were to agree, the commission is still in a tough spot since allowing LightSquared's network to go forward could jeopardize consumer, commercial and government navigation and location devices across the country.[60]

Yes, the regulatory choice is perfectly understandable. That is what makes the LightSquared debacle *classic*, not *curious*. Some parties will have to adjust, with costly actions, to accommodate the new neighbors. But these costs cannot be avoided, and excluding the entrant does not minimize the expense. LightSquared's investors have already lost $4 *billion*; consumers in aggregate stand to lose orders of magnitude more. On the other hand, an expenditure of less than just $400 *million* would fix potential problems associated with the operation of its (now deterred) LTE network,[61] according to LightSquared's estimates.

LightSquared may be high or low, but the basic problem is not their math. It is that there is no GPS band owner, de jure or de facto, to bargain with. It lacks a responsible party—one that can be paid to cooperate—with which to trade. It has only a regulator, one pressured by both LightSquared and its GPS opponents. Two of the three sets of parties in this conflict resolution process, GPS interests and the regulatory authority, fail to internalize the costs and benefits resulting from the decision reached.[62] It

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[60] Kevin Fitchard, *LightSquared to FCC: You Owe Us Spectrum*, GIGAOM (Mar. 16, 2012, 12:37 PM), http://gigaom.com/2012/03/16/lightsquared-to-fcc-you-owe-us-spectrum.

[61] There is reason to take LightSquared's estimates seriously. The firm sank large investments in a network that depended on GPS interference issues being resolved; it is clear that LightSquared believed that they could be resolved at reasonable cost. The $400 million estimate is calculated by adding filters to 500,000 "precision" GPS units at a cost of $800 each. This assumes the high-end, for each filter, of the stated price range ($300 to $800 each). Moreover, LightSquared's technology partner, Patron America, designed a filter that cost just $6. LightSquared committed to providing up to $50 million of such upgrades, at its expense, to protect government GPS devices from interference. Roger Cheng, *LightSquared's GPS Fix Could Cost Industry $400M*, CNET (Oct. 12, 2011, 4:15 PM PDT), www.cnet.com/news/lightsquareds-gps-fix-could-cost-industry-400m.

[62] Charles Wolf, Jr. elaborates on problems generated by regulatory outcomes produced by decision-makers who do not internalize the costs and benefits of the choices made:

> Which failure is the greater, nonmarket or market, depends on whether the supply distortions created by internalities in nonmarket output are larger

may be hugely expensive to block the LightSquared 4G network, but the expense is not felt by the policy makers who chose to block it. This made their obstinacy free to indulge. Deterring large social gains for mobile wireless users presents no opportunity cost to organized GPS interests or the FCC, as they are not in a position to capture gains from trade.

It is not a technical problem that has deterred LightSquared but the nature of the property rights held by market participants. To see this, consider that LightSquared had initially encountered severe *in-band interference* problems. Other licensees in the L Band—notably, satellite service provider Inmarsat—supply important public safety, aviation, and national security applications.[63] The L Band channels allocated to these licenses were originally "interleaved" with those used by LightSquared (also supplying satellite services), creating potentially fatal interference challenges were a terrestrial mobile system to be deployed using the existing band plan.[64]

Indeed, under the FCC's original L Band allocation licensed satellite carriers could not provide LTE or other non-satellite services, even if license restrictions were dropped, because the tiny bands between "interleaved" borders crowded mobile traffic into uneconomically narrow lanes. To overcome this situation, LightSquared offered deals to its fellow L Band users. Licenses were swapped and contiguous spectrum bands were created under the control of one company or another, LightSquared paying its neighbors to cooperate.[65] Border disputes were eliminated by eliminating borders.

> or smaller than the demand distortions created by externalities in market output.

Charles Wolf, Jr., *The Theory of Non-Market Failure: Framework for Implementation Analysis*, 22 J.L. & ECON. 107, 117-18 (1979); *see also* CHARLES WOLF JR., MARKETS OR GOVERNMENTS: CHOOSING BETWEEN IMPERFECT ALTERNATIVES (2d ed. 1993).

[63] In 2004, before providing ATC services, Inmarsat had approximately 300,000 terminals deployed worldwide and delivered voice, fax, intranet, and Internet to land-based and maritime users. *Inmarsat to Seek ATC License*, PR NEWSWIRE (Feb. 15, 2006), http://www.prnewswire.co.uk/news-releases/inmarsat-to-seek-atc-licence-154031705.html; *see also* Jonathan Norris, *Inmarsat Super-Charges its Mobile Satellite Services Business*, APEX EDITOR'S BLOG (June 23, 2012), http://blog.apex.aero/ife/inmarsat-supercharges-mobile-satellite-services-mss-business (describing Inmarsat's MSS applications).

[64] Mobile Satellite Ventures Subsidiary LLC, 20 FCC Rcd. 9752, 9765-66 (2005) (order and authorization).

[65] Sarah Young & Paul Sandle, *Inmarsat's LightSquared Deal Activated*, REUTERS UK (Aug. 18, 2010, 4:02PM BST), http://uk.reuters.com/article/2010/08/18/uk-inmarsat-idUKTRE67H2W820100818 ("[Inmarsat] said the agreement would

A regulatory commons was avoided. With exclusive rights held by a small number of licensees, secondary trading led to a spectrum reorganization in 2007.[66] According to the FCC, this process was critical. "Next generation broadband systems require large, contiguous blocks of spectrum . . . . [M]uch of the L-band spectrum will not be suitable for broadband without such coordination."[67] Yet, as it played out, "harmful interference" that blocked the emergence of an LTE network was remedied by Coasian bargains. By early 2012, the payments from LightSquared to Inmarsat had grown to $490 million.[68] These purchases put Humpty Dumpty back together again:

> LightSquared is making significant efforts to rationalize narrow, interleaved bands of L-band spectrum, held by several international operators, into contiguous blocks that will support next-generation broadband technologies for both mobile satellite and terrestrial use . . . The Commission has recognized that these types of operator to operator arrangements, especially in the L-band, should be encouraged and are preferable to "regulations based largely on hypothetical cases."[69]

In truth, the private agreements also deal with "hypothetical cases." Their real distinction is that they incorporate superior information and benefit from improved incentives for decision-makers. The FCC implicitly recognizes that the private ordering – where parties are rewarded for making better estimates and executing more efficient deals – outperforms rules developed by those with no financial stake in the outcome.

With the licensees in the L Band, the FCC did not test radios, seek more clarity as to the nature of the "harmful interference," or determine what reliability level Inmarsat's customers would receive due to potential "harmful interference" from LightSquared's operations. They trusted the parties to make efficient choices with respect to these concerns. It worked.

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enable the companies to carve up their satellite spectrum over North America more efficiently," citing a pay schedule of $81.25 million as an initial payment, with $337.5 million over three years, and $115 million per year in phase two, with the initial agreement signed in 2007 but activated in 2010).

[66] Press Release, LightSquared Inc., LightSquared Delivers Notice To Inmarsat Triggering Re-Banding Of L-Band Radio Spectrum In N. Am. (Aug. 18, 2010), *available at* http://www.lightsquared.com/press-room/press-releases/lightsquared-delivers-notice-to-inmarsat-triggering-re-banding-of-l-band-radio-spectrum-in-north-america.

[67] Authority Modification Request, *supra* note 7, at 569.

[68] Comments in Opposition of LightSquared Inc. at 8, Authority Modification Request, 26 F.C.C. Rcd. 566 (SAT-MOD-20101118-00239), *available at* http://hraunfoss.fcc.gov/edocs_public/attachmatch/DA-11-133A1.pdf.

[69] Authority Modification Request, *supra* note 7, at 581 (footnote omitted).

Not so happy a conclusion obtained, however, with the rights distributed in the GPS Band. The parties alleging LightSquared's deleterious impact on GPS service are numerous, do not possess exclusive rights, and are often non-profit enterprises (including government agencies). Delaying or deterring productive wireless applications supplied by others is not an opportunity cost to these rights-holders. The resulting tragedy owes not to issues that can be decided on the basis of engineering data. As the LightSquared tragedy played out, an insightful news report summarized the technical information gleaned from government-conducted "harmful interference" tests:

> For a purportedly 'scientific' report, the technical working group's interference study is extremely self-contradictory. LightSquared and the GPS industry reached entirely different conclusions in many of the report's focus areas even though both sides were relying on the exact same data and the exact same methodology.
>
> 'It was clear there were very different interpretations of the data from the GPS group and from LightSquared,' Spirent's Butler said. 'What it came down to was the definition of harmful interference. The test methodology was pretty well worked out. We got good data. But without a meaningful common definition for interference, both sides reached different conclusions.'[70]

Indeed, technological information will not answer whether 1dB (decibel) loss in the signal to noise ratio (C/N_0) is the correct standard to use—or 6dB. The former allows for more radiated energy to impact a radio receiver under a "no harm, no foul" assumption, the latter less. The choice between the different standards constituted perhaps the key determination in the entire matter. The NTIA choose 1dB as the standard, despite vigorous protestation from LightSquared that a 1dB loss had "little impact" and that "it is well understood that 1dB loss of C/N_0 is a very small fraction of the link margin that GPS receivers carry."[71] The "correct" amount of signal to noise is not a technical matter but an economic choice: how much is a tighter protective shield is worth, relative to its cost? The government's choice was the loss of a nationwide wireless network.

III. LIBERAL RIGHTS ASSIGNMENTS MITIGATE THE REGULATORY COMMONS FOR CMRS LICENSEES

The conventional wisdom has built up in the U.S. that spectrum is very difficult to define and that interference conflicts are endemic.[72] But

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[70] Fitchard, *Sorting*, *supra* note 28. Spirent is a firm that designs and tests wireless equipment.

[71] Comments in Opposition of LightSquared Inc., *supra* note 68, at A-41.

[72] Weiser & Hatfield, *supra* note 54.

this view is highly misleading, a product of the manner in which certain conflicts are funneled through a political process. When appropriate spectrum use rights are in place, the contentiousness of border disputes typically dissolves. Hence, incentive structures created by FCC spectrum rights regimes support—or sabotage—efficient market reconfigurations. What we learn is that it is neither possible nor necessary to fully define spectrum contours ex ante, that some spillovers are efficient, and that optimal interference levels are quickly identified when incentives are properly aligned.[73]

LightSquared's successful rationalization inside the L Band is not unique. We have seen similar processes in several other markets, most notably with respect to CMRS allocations. When spectrum use rights have been distributed to responsible economic agents in the market, conflicts tend to be resolved—just as LightSquared was able to "clean up" the L Band through private contract. LightSquared's plans faltered in a cross-border dispute where it faced holders of non-exclusive rights, including public agencies unable to participate in secondary markets.

CMRS markets exhibit organizational efficiencies that arise when licensees are awarded broad, flexible rights to exclusively control a defined radio spectrum space. Operators are awarded CMRS licenses, a regulatory category that subsumes cellular, PCS (Personal Communications Services), AWS (Advanced Wireless Services), SMR (Specialized Mobile Radio), and 700 MHz allocations. In such licenses, the FCC delegates decision-making over services, technologies, business models and network architecture to licensees, effectively permitting market allocation of the bandwidth.

Communications scholars Dale Hatfield and Phil Weiser concede the economic success realized in the operation of these wireless markets. But they argue that the de facto property rights held by mobile operators are not the basis of this success. Instead, they cite "the technical characteristics of PCS services" as uniquely favorable for limiting "harmful interference" claims. Mobile operators serve "large geographic areas" and are

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[73] Charla M. Rath, *Defining Radio Rights: Theory and Practice* 3, *in* J. Pierre De Vries &Kaleb A. Seth, *The Unfinished Radio Revolution: Eight Perspectives on Wireless Interference*, 9 J. ON TELECOMM. & HIGH TECH. L. 501, 528-530 (2011), *available at* http://www.silicon-flatirons.org/documents/conferences/2010.11.12-862/Rath.pdf.

> Licensees also deal with thousands of instances of interference from unauthorized operations each year. Again, licensees' efforts to resolve these issues are very much local and generally do not involve the FCC. If we can locate the source of harmful interference, we can often work with the owner of the property or transmitter to address the problem . . .

Id. at 530.

"cellularized," an architecture that generally lowers emission levels (say, compared to television broadcasting), making it easier to limit cross-border spillovers. Additionally, markets are served by "stable 'repeat players'" with "considerable incentives for cooperative behavior."[74] Engineering professor Charles Jackson agrees, adding that PCS operators also enjoy greater autonomy over airwaves because they control both receivers and transmitters in the frequencies they use.[75]

These factors do help explain how CMRS licenses work, but inexorably lead to the conclusion that the nature of the liberal rights granted responsible economic agents—not special circumstances determined exogenously—are key to producing the favorable outcomes seen.

We begin with the latter point by Jackson. The nature of the CMRS authorization is to cede choices over spectrum use in a given band to a given licensee. The licensee is then free to share access to the allocated bandwidth with others; indeed, this is the basic business model that makes CMRS licenses worth billions of dollars in the U.S. But how is this best done? With FCC allocations, exclusive rights are sometimes awarded; in other cases non-exclusive, overlapping use rights are authorized, as with unlicensed bands.

The incentive yielded by the broad scope of the CMRS rights is that the licensee optimizes the total value of services using the underlying spectrum. This creation of valuable services forms the pool of benefits from which the carrier obtains payment. In particular, the licensee constructs and operates networks, retaining control over receivers and transmitters. This vertical integration is dictated by efficiency concerns,[76]

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[74] DALE HATFIELD & PHIL WEISER, CATO INST. POL. ANALYSIS, NO. 575, TOWARD PROPERTY RIGHTS IN SPECTRUM: THE DIFFICULT POLICY CHOICES AHEAD 17 (Aug. 17. 2006), *available at* http://www.cato.org/sites/cato.org/files/pubs/pdf/pa575.pdf.

[75] *See* Linda Doyle & Tim Forde, *Towards a Fluid Spectrum Market for Exclusive Usage Rights*, *in* 2010 IEEE INTERNATIONAL SYMPOSIUM ON NEW FRONTIERS IN DYNAMIC SPECTRUM 620, 628 (April 2007), *available at* http://www.tara.tcd.ie/bitstream/2262/23959/1/TowardsAFluidSpectrumMarket.pdf (describing comments by Jackson).

[76] Licensees like Verizon or AT&T rely on markets to supply much of the mobile ecosystem, of course. The technology and infrastructure are developed by such firms as Qualcomm, Nokia, or Alcatel-Lucent; handsets by Apple, Samsung, Blackberry or Sony-Ericsson; application platforms by the Apple App Store, Google Play or Windows Store; and a virtually limitless array of edge providers—from Wikipedia to Ancestry.com to Twitter—supply content. That ownership of CMRS licenses is inevitably integrated with the ownership of the mobile network departs from this decentralized structure. In general, the carrier sinks considerable capital to construct and operate a mobile platform upon which an ecosystem may evolve, retaining control over both spectrum and core physical network infrastructure. Rival service providers and subscribers share these assets, but by

flowing from the licensee's incentive to optimize spectrum access and so maximize resource value. In CMRS networks, thousands or even millions of mobile devices are emitting and receiving signals—why such networks are built in the first place. Such traffic creates endemic compatibility issues and potential interference. The emissions or downloads of any one user can negatively impact the cellphone performance of many others.

CMRS operators respond to such challenges in systematic ways, even as competitive innovations are continually introduced in the rivalry between platforms. First, carriers assiduously avoid splitting control over spectrum and network resources. Indeed, it is seen that, as Jackson says, "handsets are part of the network."[77] This drives not only integrated control of spectrum and infrastructure, but strong carrier coordination of what devices are permitted to use the network (setting standards, testing and certifying devices). In short, that there is unified coordination of networks and end user devices is a product of the property rights regime. Second, carriers employ prices to protect high-valued applications by excluding low-valued access. "Bandwidth hogs" are free to use networks, but they must pay for the privilege. With both equipment authorizations and pricing menus, carriers maximize by effectively coordinating access across all "transmitters" and "receivers."[78]

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purchasing bundled services (spectrum access plus network access) rather than "naked" spectrum or network elements. This structure allows the carrier to coordinate highly complementary inputs, mitigating transaction costs and strategic hold-up. *See* Benjamin Klein, Robert G. Crawford & Armen A. Alchian, *Vertical Integration, Appropriable Rents, and the Competitive Contracting Process*, 21 J.L. & ECON. 297 (1978); Thomas W. Hazlett, David Teece & Leonard Waverman, *Walled Garden Rivalry: The Creation of Mobile Network Ecosystems*, GEO. MASON U. L. & ECON. RES. PAPER SERIES NO. 11-50 (2011).

[77] Charles L. Jackson, Wireless Handsets Are Part of the Network, *in* Skype Commc'ns S.A.R.L., Opposition Brief of CTIA – The Wireless Association, Fed. Commc'ns Comm'n Doc. No. RM-11361 app. C (April 30, 2007), *available at* http://files.ctia.org/pdf/Comments_CTIA_Skype_Opposition_Complete_43007.pdf.

[78] Howard A. Shelanski & Peter W. Huber, *Administrative Creation of Property Rights to Radio Spectrum*, 41 J.L. & ECON 581 (1998).

> We have already suggested that 'spectrum' consists of a licensee's right to send signals from a transmitter to a receiver at a specified power and frequency. A 'complete' bundle of property rights in spectrum must include the ability to close off the output end of that conduit, not just to control the input end. The owners of the TransAlaska Pipeline, for example, would not be said to enjoy full property rights if they were free to pump oil in at the Prudhoe Bay head-end but not to control who takes oil out at the Valdez terminus. It would similarly be of little service for a DBS operator to carry a subscription programmer's material if parties

Third, mobile operators invest continually to upgrade technologies, expanding network functions and capacities. Cellular networks in the U.S. have advanced from 1G to 2G to 3G to 4G since the mid-1990s without any government mandates to do so. Along the way, mobile carriers (also without mandate or directive) introduced whole new services such as texting, push email, and broadband access, hundreds of new devices (netbooks, tablets, and smartphones), and hundreds of thousands of mobile applications.[79] Each network upgrade involves a delicate balancing act, protecting existing services and subscribers, while accommodating new, *potentially interfering* uses.

These improvements would, if directed by the FCC, constitute "spectrum reallocations." The fact that airwaves can be deployed in new networks or used to support innovative services is a product of the liberal use rights extended in the CMRS license. Markets—or, "secondary markets," since the initial FCC assignments are being rearranged by transactions between private firms—are thus able to create new ownership structures. The outcome of this trading process *could be* extreme fragmentation resulting in the costly border disputes seen in so many wireless markets. But the for-profit firms holding liberal licenses avoid such wealth-dissipating tragedies. The observed market structures reflect this strategic interest in maintaining an optimal level of control—far from total, as seen in the robust nature of the evolving, decentralized marketplace (see Figure 1), but designed to be sufficient to keep spectrum resources from being squandered.

> other than the paying subscriber were free to demodulate the signal. The right to exclude is accordingly recognized by courts as 'one of the most essential sticks in the bundle of rights that are commonly characterized as property.'

Id. at 601. (citation omitted); *see also* Doyle & Forde, *supra* note 75.

[79] Alternatively, in broadcast television, where TV licensees do not control spectrum and TV receiver sets are unlicensed devices regulated by the FCC, vertical disintegration is mandated. Television networks, despite benefiting when their viewers receive clearer signals and improved content, have no pragmatic means—apart from government mandates—of upgrading technology. The digital TV transition officially took over two decades (1987-2009) and—most importantly—kept spectrum bottled up in an outmoded delivery platform, terrestrial broadcasting, that costs society far more than it delivers in economic gain. Thomas W. Hazlett, Unleashing the DTV Band: A Proposal for an Overlay Auction, *Comment to the FCC*, *in* NBP Public Notice No. 26, Comment to the Fed. Commc'ns Comm'n., GN Docket No. 09-47, 09-51 & 09-137 (Dec. 18, 2009), *available at* http://mason.gmu.edu/~thazlett/pubs/NBP_PublicNotice26_DTV Band.pdf.

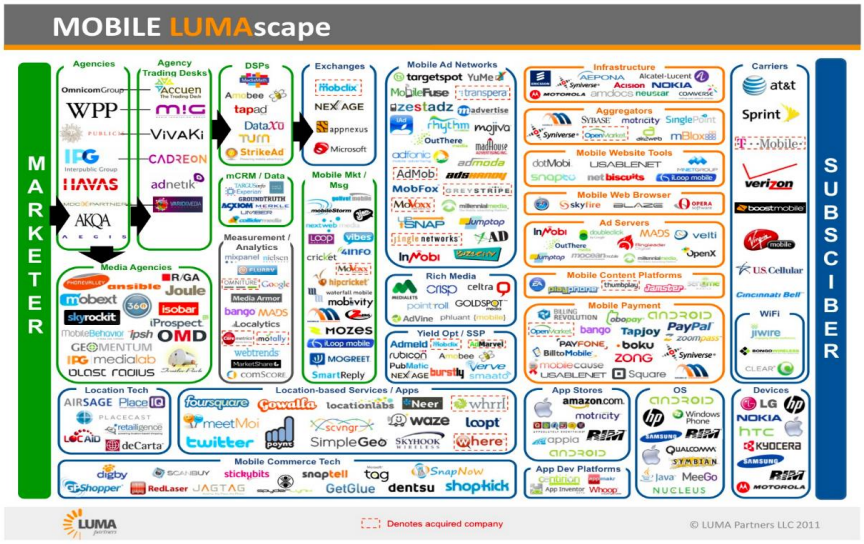

Fig. 1. Stylized Structure of the Mobile Ecosystem[80]

Hence, the large degree of integration observed in mobile markets is an endogenous outcome of the liberal spectrum rights regime. Rather than being dictated by the cellular technology, it is the result of rational choices made by properly incentivized economic agents. Indeed, this ownership structure is so central to the success of the market that it appears to be inseparable from the cellular technology itself. The "large geographic areas" for CMRS coverage areas that Hatfield and Weiser cite as special circumstances, for example, are a product of license consolidation by bidders in FCC auctions as well as secondary market transactions, not regulatory fiat. U.S. regulators notoriously fragmented rights, in fact.[81] The total number of mobile licenses issued by the Federal Communications Commission exceeds 50,000.[82] These rights have created four or five

[80] This rendition was created by Luma Partners, a U.S. investment banking firm. *Mobile LUMAscape*, LUMA PARTNERS LLC, http://www.lumapartners.com/lumascapes/mobile-lumascape (last accessed April 14, 2014).

[81] Whereas countries in the European Union, for example, routinely award national licenses, the FCC divvies America into 734 local franchise areas (for Cellular Market Areas, or CMAs) and 174 Economic Areas (EAs) for the primary license maps used. Together with the even more fragmented license rights issued in Specialized Mobile Radio (SMR) and then brought into the cellular market as per a 1990 liberalization.

[82] In July 2003, a count of mobile licenses totaled 51,597. Thomas W. Hazlett, *Is Federal Preemption Efficient in Cellular Phone Regulation?*, 56 FED. COMM. L. J. 155, 193 (2003). Since that time the FCC has held auctions for AWS, in which

national wireless networks—depending on how one counts—through merger.

This aggregation process deserves special attention. The creation of thousands of CMRS licenses by U.S. regulators imposed substantial costs on the market due to the importance of economies of scale and scope in mobile networks.[83] In simple terms, 734 small cell-phone systems using a given swath of spectrum, but with different coverage areas,[84] have costs substantially higher than one cellular system using the same spectrum but with nationwide coverage. In economic terms, the adjacent networks are highly complementary assets, and combining them into common ownership better coordinates production, generating large efficiencies. Or, from the opposite perspective: to the extent that the regulatory license map is not adjusted by secondary market transactions, there would exist massive and pervasive "interference" between licensees, each of whom is blocking the scale economies that are possible to exploit.

This economic interference from excessive fragmentation translates directly into radio interference. When allocations are intentionally de-concentrated by policy makers, extra borders are created in spectrum space. It is over the rules governing these borders that interference disputes are waged. A significant portion of the economies of scale that accrue from secondary market transactions of CMRS licenses, then, owe to the elimination of such spillovers. When firms sharing a contentious border combine, integrating assets under one owner, spillovers are eliminated; the new firm maximizes the total value of the combined spectrum.[85] But this useful process of rights aggregation via secondary market transactions can

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1,087 licenses were sold (in 2006), and 700 MHz, in which 1,090 licenses were sold (in 2008). *See* Auction 66 Advanced Wireless Services (AWS-1), FED. COMMC'NS COMM'N, http://wireless.fcc.gov/auctions/default.htm (follow "66: AWS-1" from drop-down menu under "Go to an Auction:" at upper-right corner of page) (last reviewed/updated on Dec. 1, 2010); Auction 73 700 MHz Band, *id.* (follow "73: 700 MHz Band" from drop-down menu under "Go to an Auction:" at upper-right corner of page) (last reviewed/updated on June 19, 2012).

[83] Brokerage fees in cellular license transactions in just one year (1991) were estimated by the FCC to total about $190 million. WIRELESS TELECOMMS. BUREAU, FED. COMMC'NS COMM'N, THE FCC REPORT TO CONGRESS ON SPECTRUM AUCTIONS 8 (1997) *available at* http://wireless.fcc.gov/auctions/data/papersAndStudies/fc970353.pdf.

[84] Two cellular licenses were issued (by lottery) in each of 734 local license areas in the 1980s. See Federal Communications Commission website: http://www.fcc.gov/encyclopedia/cellular-service.

[85] Harold Demsetz made this important point for externalities. Harold Demsetz, *Ownership and the Externality Problem*, *in* PROPERTY RIGHTS: COOPERATION, CONFLICT, AND LAW 282 (Terry L. Anderson & Fred S. McChesney eds., 2003).

only occur when regulators have defined ownership sufficiently to support such activity.

Cellularization, another supposedly unique cause of harmony in CMRS cited by Hatfield and Weiser, is an architectural choice made by owners of liberal licenses. One advantage of the approach is to allow lower power levels to be used in handsets, which need to send signals only to nearby base stations, enabling networks to re-use channels from cell to cell. To the degree that cellularization reduces spillovers, its adoption is again endogenous to the incentives yielded by the liberal license, not an artifact of the technology.

Indeed, where liberal licenses are lacking cellular systems have been involved in some of the bitterest and most intractable FCC interference disputes in history—for example, the LightSquared debacle. LightSquared's ill-fated LTE network was cellular and its emissions well-behaved, conforming to border limits as set by the FCC. Another example involving low-power cellular emissions was the years-long Nextel-public safety dispute over the use of 800 MHz frequencies. This episode has been singled out by Hatfield and Weiser as illustrative of the failure of markets in handling spillover problems.[86]

First, this directly contradicts the claim that cellular technology yields harmony, as the Nextel system accused of causing interference was a cellular network. Second, the dispute was a direct product of the fact that the public safety agencies complaining about radio interference were governmental entities unable to participate in secondary market transactions.

Third, the solution to the interference dispute which the FCC implemented mimicked secondary market mergers. The Commission enacted a "spectrum swap" wherein Nextel traded cash ($4.8 billion) plus its licenses to access spectrum adjacent to police and fire department bands, in exchange for a CMRS license using bandwidth removed from its neighbors. The reason that such a transaction had to be imposed as a "spectrum swap" by regulators was that the parties Nextel had to transact with—public safety organizations—were barred by law from buying or

[86] "[C]oordination and possible relocation costs—or other transaction costs (such as developing clear legal entitlements)—may be too formidable to be addressed through private market arrangements." Weiser & Hatfield, *supra* note 54, at 573. For a recent case where the FCC stepped in to coordinate a relocation of a set of incumbent licensees to avoid adjacent channel interference, see Improving Public Safety in the 800 MHz Band, 19 FCC Rcd. 21818 (2004) (report and order).

selling licenses. It took the FCC a decade to create a facsimile of this market process.[87]

Finally, consider cross-border disputes that remain, even after mergers have aggregated the vast majority of licenses and eliminating all but a handful of borders. As Weiser and Hatfield note, the interference between mobile operators is not an issue of regulatory concern, given that the "stable, repeat players" prefer to settle these issues privately. But "stable, repeat players" could not themselves avoid the Nextel and public safety conflict. Between CMRS licensees, in contrast, interference mitigation is pro forma. As Charla Rath, an executive with Verizon Wireless, describes it,

> Under current rules, licensees negotiate to extend rights into each others' licensed spectrum on a daily basis. These are not massive, onetime negotiations between companies, but involve hundreds of individual negotiations between companies' engineers who are tasked with the day-to-day operations of the network.[88]

The policy key to the observed harmony: "under current rules." These rules give (a) exclusive domain to profit-maximizing carriers over spectrum use, yielding incentives for optimization; and (b) yield flexibility to those licensees, allowing them to adjust operations so as to mitigate border incursions without seeking administrative waivers or otherwise engaging regulatory agents. In this environment, gains from trade are regularly effectuated, with efficient solutions to conflicts serving the interests of all. More to the point, running to regulators, which would replace such bargaining with FCC rulings, is seen as expensive, time-consuming, and inefficient relative to the alternatives.

In a specific instance relayed to one of the authors by an engineering consultant, Nextel complained to Verizon, circa 2002, about interference it was receiving from the latter's base stations using 800 MHz (cellular) bands next door to frequencies allocated to Nextel's SMR licenses. While Verizon was complying with FCC rules, not technically creating impermissible "harmful interference," it nonetheless agreed to install new filters on its base stations. Nextel paid for the filters, and may have provided additional compensation.[89] Such settlements avoid

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[87] *See* Hazlett & Oh, *supra* note 24.

[88] *See* Rath, *supra* note 73, at 529 (citing 47 C.F.R. § 24.236 (2008) (permitting field strength agreements in PCS, AWS and 700 MHz), 27.55(a) (permitting private agreements in AWS 1 and 700 MHz), and *id.* at § 22.912 (permitting cellular licensees to agree on service area boundary extensions)).

[89] This episode was relayed to Thomas Hazlett by an RF engineer who had, during this period, served as a consultant to Nextel and, at other times, has worked at the FCC.

regulatory overhead and are common within the wireless industry.[90] This is a product not of CMRS technologies, but of the assignment of efficient rights bundles to responsible economic agents who internalize the costs and benefits of engaging in contentious dispute resolution—or avoiding it—at the FCC.[91]

CMRS is exceptional, not because of any given technical or economic aspect of the service, but due to the expansive, flexible nature of the use rights awarded the licensee. These rights are distinct from the narrowly-specified use permits authorized in a traditional FCC wireless license, and—like LightSquared was able to do in the L Band ——enable profit-seeking enterprises to merge, trade, partner, or otherwise create financial structures that bring the incentives of rival parties into alignment.

CONCLUSION

LightSquared faced two challenges in turning virtually worthless "satellite spectrum" into highly valued "LTE spectrum." The first was that the satellite licenses they owned were allocated "interleaved" channels, mixed in with channels licensed to other satellite operators in the L Band. These narrow channels made the provision of mass market mobile services quite impossible, because modern cellular systems use much larger channels for efficient operation. Although the total bandwidth available in the designated "satellite" L Band was sufficient to support such operations, regulators had prevented it through a band plan imposed years earlier.

LightSquared (and its predecessors) straightforwardly dealt with this problem. LightSquared negotiated bargains with the other licensees, most importantly Inmarsat, and rationalized ownership rights. Putting the Humpty Dumpty L Band back into continuous spectrum blocks was expensive but necessary in order to deploy a competitive terrestrial mobile network. Through license trades and monetary payments LightSquared successfully reconfigured L Band spectrum into contiguous blocks, one of

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[90] Rath, *supra* note 73, at 529.

[91] Cellular systems are themselves subject to tragedy of the regulatory commons when rights are held by regulators rather than responsible economic agents. The "harmful interference" problems associated with cellular systems turned into years-long logjams at the FCC. The first cellular allocation, in fact, took somewhere between 11 and 43 years, depending on how one establishes the end points. Cellular technology was developed at Bell Labs in 1946. In 1968 the FCC opened a formal proceeding to allocate spectrum for the service. In 1984-89 the Commission issued about 1,468 licenses, mostly by lottery, for each of the two systems it authorized across 734 CMAs. The FCC's National Broadband Plan summarized the regulatory delay as lasting from 1970 to 1981, or 11 years. *See* NATIONAL BROADBAND PLAN, *supra* note 5, at 79.

which they controlled. With the FCC's liberalization of usage rights via an ATC, LightSquared undertook to construct a modern 4G network.

However, an issue of cross-border interference then arose. The highly fragmented and incomplete rights that GPS users had been awarded created a regulatory commons. In technical terms it was far less prohibitive than the issue of L Band interference, because LightSquared's LTE operations would not transmit over the ostensibly established border. The conflict arose because radios in the neighboring GPS band "listened in" to the L Band and would be potentially confused by rising noise levels there. Whatever the damage to the GPS services from LTE in-band interference, the dollar cost was outweighed by the benefits to mobile wireless customers enjoying the benefits of an additional nationwide broadband network.

Regardless of the modest scale of the actual radio conflict, the political conflict proved intractable. Users of the GPS band possess non-exclusive use rights, using radios approved by the FCC under unlicensed device rules. Powerful interests with significant operations in the band, including the Federal Aviation Administration and the Department of Defense, are public agencies. The organizations are unable to participate in secondary market transactions, and their executives would not financially benefit from such activities even if they were. Bargaining broke down.

The GPS "commons" is protected by regulators, agents incentivized to craft rules that reflect political concerns. The resulting equilibria, as seen throughout the history of FCC regulation, disproportionately favor incumbents and may impose large net costs on society. With the regulatory commons, under-allocation of spectrum, squandering valuable wireless services, is the norm.

Conversely, with flexible, exclusive spectrum rights assigned to responsible economic agents, markets can efficiently structure and re-configure ownership rights. Border disputes are largely mitigated via merger (eliminating the borders themselves), pre-empted by the vertical coordination of networks and the devices that use them, or via network adjustments arranged by profit-maximizing agents. The performance of this system, seen primarily by CMRS licensees but also in LightSquared's L Band rationalization, is so strikingly superior to the failures endemic in the regulatory commons that it is surprising that its policy implications are so widely misunderstood.

Using regulatory forms already implemented, policy makers can strategically avoid meltdowns such as the LightSquared debacle by avoiding the impractical rights distributions that create them. While much damage has already been done over the past 85 years of allocation under a top-down administrative planning model, substantial improvements have been demonstrated, particularly in CMRS allocations, and can be more fully

employed in other allocations, leading to dramatic improvements in consumer welfare.

Consider emergency radio services. Instead of giving thousands of public safety agencies (there are more than 100,000 wireless licenses awarded to local fire, police and EMT departments[92]) control over the use of specific frequency spaces, taking such spectrum out of any possible secondary market restructuring, such agencies can be funded to purchase radio services from commercial providers.[93] These contracts with providers could build in redundancy across networks and technologies. Handsets that shift from terrestrial mobile base stations to back-up satellite service when a natural disaster knocks out local communications, have long been available but have been under-provided to public safety organizations pre-occupied with building their own radio networks.

Important efficiencies are achieved by sharing, running emergency applications over commercial networks supported by millions of private subscribers. Agencies, with no comparative advantage in owning or operating communications networks, would then be able to focus on purchasing the best price-quality package in the market. Presumably, contracts would contain terms for prioritizing traffic; in emergency situations, public safety users would have first claim on bandwidth. The present alternative locks in a given amount of spectrum and then directs agencies to construct their own network from there. It makes no more sense than shipping police departments specified quantities of auto parts, mandating that they use this much—no more, no less—for the construction of police cars.

Spectrum is an input into an output. It is that output, mobile communication, that the government agency needs to consume. It is difficult to know, objectively and from outside an actual situation, how much of each ingredient is the right amount to use. It is impossible to know what will be the right amount (or type of spectrum) in the future. Better to let markets configure the inputs, and governments to buy the outputs. This will not cost taxpayers more, but less. And service will improve. Not only will the receipts from the sale (auction) of liberal licenses be substantial when less bandwidth is requisitioned for public safety, government purchases will be more transparent and efficient.

Consider, next, the allocation of unlicensed bandwidth. Such bands, like GPS, are managed by regulators, who establish rules of access.

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[92] U.S. GEN. ACCOUNTING OFFICE, Telecommunications: Actions Needed for Better Management of Public Safety Spectrum 2, GAO/RCED-88-173 (1988), *available at* http://www.gao.gov/assets/150/146642.pdf.

[93] Funds could come from general revenues and those generated by wireless licensed auctions.

But regulators do not know how much an unlicensed band is worth to society relative to the alternative—the same bandwidth allocated to liberal licenses, auctioned to the highest bidders. The information gleaned in the market, where resources go to those who value them most highly, is truncated when the FCC sets aside spectrum for unlicensed use. The decision to do so invariably turns into a battle between warring corporate factions, those who believe their business models will best prosper with one type of allocation or the other. Regulators materially benefit by being the locus of such tug-o-wars; they get to exercise their preferences, while mingling with those industry executives that they might like to work with during post-agency employment, enhancing their human capital. But the economic way to resolve such allocation questions is to let the opposing parties bid for bands and deploy them using business models of their choosing. FCC experts elucidate:

> Some special administrative provisions for low-powered devices may be efficient in a market system. However, in making decisions about the amount of spectrum allocated to unlicensed use, the government should face the opportunity cost of limiting or foreclosing other use . . . . Future expansion of dedicated spectrum for unlicensed use could be obtained through . . . a licensee . . . charg[ing] manufacturers a fee for the right to produce and market devices to operate in that band.[94]

The government, the public, and competing interests jockeying for policy should know what opportunity costs are associated with rival choices. Just as land is distributed to decentralized property owners, with governments then acquiring resources to supply public parks, spectrum allocated for unlicensed operations can be markedly improved by the use of market prices. When choices are made to use given frequencies in one manner versus another, the prices made to secure that outcome reveal the value of the alternatives sacrificed. This crucial accounting is what is sacrificed in top-down allocations that effectively force bureaucrats to make trade-offs uninformed by market data and heavily influenced by political pressure. Exhibit A: the LightSquared debacle.

Unlicensed bands are often, in fact, analogized to public parks[95] by advocates arguing for more such allocations. But the implications of the analogy are the reverse. Land resources are not bottled up in case-by-case allocations with the state choosing between parks or other real estate deployments. Instead, resources are generally made available to the market via private ownership rights. Trading then takes place, prices are revealed,

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[94] Evan Kwerel & John Williams, OFFICE OF PLANS & POLICY, FED. COMMC'NS COMM'N, *A Proposal for a Rapid Transition to Market Allocation of Spectrum* 7, 31, OPP Working Paper No. 38 (2002).

[95] SPECTRUM EFFICIENCY WORKING GRP., FED. COMMC'NS COMM'N, REPORT OF THE SPECTRUM EFFICIENCY WORKING GRP. 36 (Nov. 15, 2002).

and transactions divert resources into their most highly valued employments. These can and do include public parks, with taxpayers, voters, interest groups and policy makers forced to confront the associated opportunity costs. This not only improves initial allocations, and speeds resources into productive use, but removes the hidden costs of lock-in via regulatory commons.

Such costs are routinely ignored in the spectrum allocation process, which continues to create legal regimes—such as the TV White Spaces proceeding, ongoing since 2002 and still mired in rulemakings and trials[96] —that force the government to make allocation choices without the benefit of competitive spectrum valuations. Policy makers believe that certain business models, such as local area networks commonly supported in the use of unlicensed spectrum (as with WiFi, cordless phones, or baby monitors) cannot be accommodated without government issuing non-exclusive spectrum use rights. They are mistaken. Not only can liberal licenses support local networks (where devices come "plug 'n' play" from the electronics vendor, no wide area network carrier needed), as suggested by FCC analysts themselves, the FCC has previously authorized band managers to help coordinate unlicensed users.[97]

Without the property rights necessary to utilize secondary markets, future opportunities for enhanced wireless communications will have less chance for success. When regulators consider alternative legal regimes in initial spectrum allocations, this is a vital, if overlooked, factor. The extraordinarily high social costs of just one tragedy of the regulatory commons, as demonstrated by the elimination of LightSquared's 4G network, reveal the magnitude of the error made when the costs of rights fragmentation are ignored by policy makers.

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[96] Bill Ray, *'Google Maps' of US White Space Spectrum Goes LIVE*, THE REGISTER (Mar. 4, 2013), http://www.theregister.co.uk/2013/03/04/google_white_spaces.

[97] As in the creation of a trade association, UTAM, to coordinate collective action by unlicensed device users in the unlicensed PCS band. Kenneth R. Carter, *Policy Lessons from Personal Communications Services: Licensed vs. Unlicensed Spectrum Needs*, 15 COMMLAW CONSPECTUS 93, 107 (2007).