The Return of the Broadcast War

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ABSTRACT

The requirement that a radio user obtain the government's permission to transmit has been a foundational feature of communications regulation for about eighty years. However, the recent regulatory expansion of "open" regimes for managing the electromagnetic spectrum such as the increase in license-exempt and "light" licensed frequencies in several countries may change all of that, and this prospect has created a lot of excitement among observers of wireless telecommunications and communication law. Garage door openers, cordless phones and baby monitors, it is hoped, were just the first kinds of "radio stations" one could have without a license. Under open regimes, more people will have more wireless devices in their hands than ever before, and they will be able to use them in new ways. Proponents hope that more use, more efficient use, and more application innovation will result. However, the fate of services in these bands and of the open spectrum model itself now rests with user behavior. As of this writing, no one is sure of the answers to basic questions such as when (or if) these open bands of the electromagnetic spectrum will become congested with too many users, if they will fail due to congestion, or more generally, what it is exactly that people will do with these new wireless freedoms.

This paper employs a theoretical framework from Moore's (1978) process theory of law to present the oral histories of Wireless Internet Service Providers (WISPs) using license-exempt bands in 2003-2004 to provide Internet service in six countries (US, Canada, UK, Ireland, Australia, New Zealand). It finds differences of engineering opinion as to whether a portion of unlicensed spectrum is empty or full, the emergence of formal and informal negotiation about spectrum use, spectrum extortion, jamming of license-exempt frequencies, and equipment certification violations—in short, it finds remarkable similarities to user behavior during the "Wavelength Wars" c. 1922-1926 in the US. It concludes that new developments in the configurability of radio are returning the ability to jump channels and increase power levels to small numbers of semi-skilled users. However, in final analysis it may be that the remaining extralegal means to secure order in the electromagnetic have been operating all along, and will continue to—that is, they do not foretell the failure of open spectrum regimes, but describe the complicated conditions within any system of order.

KEYWORDS: license-exempt, unlicensed, wireless internet, law as process, legal anthropology, socio-legal studies

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The requirement that a radio user obtain the government's permission to transmit has been a foundational feature of communications regulation for about eighty years. However, the recent regulatory expansion of "open" regimes for managing the electromagnetic spectrum such as the increase in license-exempt and "light" licensed frequencies in several countries may change all of that, and this prospect has created a lot of excitement among observers of wireless telecommunications and communication law. Garage door openers, cordless phones and baby monitors, it is hoped, were just the first kinds of "radio stations" one could have without a license. Under open regimes, more people will have more wireless devices in their hands than ever before, and they will be able to use them in new ways. Proponents hope that more use, more efficient use, and more application innovation will result. However, the fate of services in these bands and of the open spectrum model itself now rests with user behavior. As of this writing, no one is sure of the answers to basic questions such as when (or if) these open bands of the electromagnetic spectrum will become congested with too many users, if they will fail due to congestion, or more generally, what it is exactly that people will do with these new wireless freedoms.

In effect, license-exempt bands are a partial return to the "state of nature" for communication policy—what will people do without government? (or more properly, when the role of government is changed, and the requirement for prior permission to transmit is removed.) Using two case studies drawn from a larger project across six countries, this essay considers the case of Wireless Internet Service Providers (WISPs)

trying to use "open" spectrum, and chronicles their successes and failures. It shows that perhaps unsurprisingly, when the federal law is removed, users make their own order bound by their own wildly differing standards of fairness and propriety. This topic could be identified by the keyword *shared* spectrum, but in what follows sharing sits alongside selfishness, coexistence with extortion, formal law with kinship and neighborhood custom.

First, this paper will outline this theoretical approach embodied by these observations, an approach grounded in the anthropology of law and derived from Moore's process theory of law (1978): here somewhat glibly labeled "telecommunications policy from below." Second, it will introduce Wireless Internet Service Providers (WISPs) and this project's methods in studying them. Next, it will present two detailed, recent (2003-2004) case studies—an entrepreneurial project in a small city that never quite got off the ground because the spectrum never quite looked empty enough, and a broadcast war between two competing WISPs that evokes the world before any radio regulation (the "Wild West" of radio, as some have called it). Finally it will conclude by drawing conclusions about the future of open spectrum regimes, and the utility of studying the administrative law processes of telecommunications with a process theory of law.

Telecommunications Policy From Below: The Theory of Law as Process

If one is interested in the study of telecommunications policy, it is almost always assumed that the "action" can be found in elite bodies we would identify as "policymaking" (legislatures and regulators), and the appropriate object of study is a law or ruling—or more expansively, an elite debate about one. Certainly the world

outside these fora is crucial to this kind of research, but the world makes its entry via logical arguments in legal analysis, in descriptions of technological changes, in ideal hypothetical cases, via secondary reporting of market research, and in economic simulations of reason. Research on telecommunications policy is in this way dominated by a philosophically conservative approach to law—an approach encouraged structurally by the political economy of the policymaking process (e.g., Streeter, 1996, ch. 4).

If inherent in all of these diverse approaches is an overarching philosophy of law, the closest philosophy may be legal formalism. A policy researcher never need mention that "the law" of interest is the law as it exists written on a page (or written on an FCC MO&O [Federal Communications Commission Memorandum Opinion and Order]) or that the appropriate focus of a research project should be a patriciate debate over a present or future policy. The analyst's goal is to decide how a current or proposed law (on a page) is right or wrong. Research in this tradition has produced useful and even brilliant work. However, although the experts toiling to do it are more savvy than any layman about the intrigues and interpretations that surround every line of "formal" law, these intrigues rarely appear in mainstream analyses of telecommunications policy and they are almost never the focus of it (if they do, the scholarship is sometimes called "critical," even though all good scholarship should be so).

In contrast, this paper takes a methodological approach derived from the anthropology of law, specifically Moore's theory of law as process (Moore, 1978). This approach is can be contrasted with most other research in telecommunications policy by two critical differences: First, it considers the law as it appears in the lives of people who are not policymakers. These lives occasionally appear in telecommunication "user

studies," but it is significant that what is *used* in other studies is the communication technology (as in "telephone users," "Internet users") and not the law.[1] Telephone users are studied so that the right law can be written down to shape the context within which these telephone users use. "[A]lthough everyone acknowledges that the enforceable rules stated and restated in legal institutions, in legislatures, courts and administrative agencies also have a place in ordinary social life (Bohannan 1965), that normal locus is where they are least studied" (Moore, 2000, p. 55). That is, these telephone users, and others, are also users of the law. To care about this is not just to go looking for the same law in a different place, but instead it is looking for a different law. Instead of the words of law on a page, in everyday life law is what you can get away with. This is to discard legal formalism and state that the law on a page might not even be that useful to understand the legal dimensions of what people often do. It is well-known that only a rare few will ever encounter formal legal proceedings, and even outside of these—as anthropologist of law Sally Falk Moore has noted—law in life often only becomes operative when a certain kind of person is there who claims to know about it and to press for its enforcement (Moore, 1978). This paper's second departure from the most common approaches to telecommunications policy is then that it takes as its object the intrigues and interpretations that surround law. Indeed, without formalist law as an object, this approach asserts that the "surrounding" impermanent perceptions are in fact the substance of the law. The rules are whatever we believe the rules are, no matter what the books say.

Many precedents for this approach exist. Although the theory of law as process has not been employed in this manner in the past, excellent previous scholarship in

[1] "User studies" is often a programmatic division at research conferences in this area.

communication policy has focused critically on the culture surrounding law (e.g., Horwitz, 1989), and approaches derived from political economy (Mosco, 1996) also commonly consider culture—although it is typically the culture surrounding "policymakers." Perhaps most memorably, some scholars have considered administrative agencies like the US FCC as an interpretive community, and analyzed communication policy symbolically rather than institutionally (Streeter, 1996). There have also been approaches to law that are methodologically similar to this one via oral history (Horwitz, 1997). Previous scholars have rejected legal formalism by turning to the critical legal studies movement (Streeter, 1990), buy here we will instead turn to socio-legal studies (Galligan, 1995) a pluralistic scheme for studying the law that is inclusive of legal anthropology (for a review, see Just, 1992; Moore, 2001).

To do all of this is also to examine the administrative law of telecommunications in a manner more familiar to more mainstream legal discussion of topics like crime, in that notions like enforcement, deterrence, compliance (and even recidivism) seem newly relevant in the communication policy literature where they never otherwise appear. That is, it is obvious that changing the penal code's sanction for or definition of assault will not eliminate assault. Similarly, radio laws will always have radio pirates. Scholarship has highlighted a few exciting cases of these, but the point here is that anyone who has used telecommunications equipment has used law.

Returning Wireless to its "State of Nature"

This essay considers the promise and viability of open spectrum regimes by investigating how a few interlocutors make and unmake order in the electromagnetic spectrum. The process theory of law would hold that invoking law in a social situation is

a way to symbolically communicate, establish, maintain, or undermine order against a background assumption of absolute indeterminacy. This way of thinking about law may have seemed unnecessary to discussion of the electromagnetic spectrum until quite recently. After all, it seems that order among users of the spectrum has been achieved by government regulation of the time, power output, location, and frequency to be used by radio transmissions. Users of the spectrum may have seemed like only second- or third-hand users of the law, as their awareness of national spectrum allocation rules might be limited to the concept of a "channel" when turning the knob on an old television set.

But as alluded to in the introduction, spectrum users are now being expected to interact with each other and the spectrum in novel ways. Unlicensed spectrum "parks" like the US allocation of 2.4-2.4835 GHz (commonly used for "Wi-Fi" wireless data networking and cordless phones) confine all users to a narrow slice of spectrum and dictate that they must accept whatever interference results. Some scholars have advanced the prospect that the liberalization of spectrum should continue such that most or all of the spectrum is open (for a review and proposal, see Benkler, 2002).

The closest historical analog to this situation may be radio broadcasting c. 1920 in the US. At this time, although there was something called a "license," there was no governmental enforcement authority. All users had a limited choice of frequencies (all stations were at 360 meters or, after 1922, at either 360 or 400 meters), power limits, and all users had to accept any interference that resulted. At first, within the overall framework of shared licenses, stations that encountered interference made "simple agreements" and "handshake pacts" with each other to reduce interference (Douglas, 1987: 92-93). Specifically, within the conditions for transmission specified by the

government, individual stations haggled over the control that they had left, creating new norms, formal, and informal agreements at the local level to interact with the federal. Stations arranged to manipulate the times they transmitted (e.g., making voluntary frequency sharing schedules), the locations of their transmitters (dividing up the transmission area amongst themselves), their power within the limits specified by the government, and their frequencies within what the government allowed. The US Department of Commerce sponsored conferences to encourage this kind of self-regulation from 1922-1925. However, before long "owners of stations who believed themselves to be interfered with took matters in their own hands," leading eventually to "a warlike atmosphere" (93) and, ultimately the breakdown of order into chaos.

Although it is difficult to clearly see such a distant past, a common interpretation among radio historians is that at some point, after the local arrangements began to fail, all systems of order failed. Stations "jumped without restraint to new wave lengths…[and] also jumped their power" (Caldwell, 1927: 10-11) even beyond federal limits. "By the end of 1926 it was impossible in most geographical areas to receive a consistent broadcast signal" due to interference between stations (Douglas, 1987: 95). This crisis is the genesis story of modern telecommunications regulatory agencies, which are often described as born to bring order from this chaos. The solution by 1934 was a much more rigid allocation of the electromagnetic spectrum that largely eliminated shared use of bands except among radio amateurs—centralizing the administration of the spectrum and creating the US FCC and its counterparts.

Today's unlicensed electronic consumer devices might appear to be nothing like the radios of the 1920s. However, the recent experience of users of shared frequencies (now called "open spectrum" regimes) show the striking parallels between 1927 and

today. Chiefly, the experience so far shows the widespread reappearance of multiple, interlocking, overlapping systems of rules derived from a wide variety of sources of authority—federal administrative law, municipal authorities, private mediators, bilateral contracts, friendships, rivalries, family ties, and neighborhood norms. These multiple fields of rule-making have always existed, but their operation is now more salient.[2] As federal policy has thrown the spectrum open to "individual" firms and actors, it is clearer than usual that this is the stuff individual action is knit from.

To the Trenches of License-Exempt Spectrum

One of the largest recent changes in the use of license-exempt spectrum is the emergence of a wireless Internet service provider (WISP) industry—the FCC has estimated that there are 3,000 commercial WISPs in the US alone. Sophisticated users of the electromagnetic spectrum from this industry are in an interesting position. They are frequently well-educated, technically trained engineers within an established white-collar profession. If it is possible to speak so broadly about the engineer's disposition toward the law, it could be said that a person from this background is likely to be exceedingly conscientious about following it, even though when the rules about radiocommunication are strict, the engineer's own skills of are the ample means to bend or break them.

As an introduction to this industry's experience of the law, consider Tim Pozar, an engineer and founding member of the Bay Area Wireless Users Group of San Francisco, California. In 2002, Tim wrote the definitive legal guide for the emerging community of Wi-Fi engineers, and he began it with the sentence, "I am not a lawyer."

[2] In some contexts, the words "fields" automatically evokes Foucault, the connection intended here is legal anthropology's semi autonomous social field (see Moore, 1973).

The guide, titled "Regulations Affecting 802.11 Deployment," started as a presentation transcript posted to Pozar's personal Web site and then became so well-known that it was eventually included in a popular wireless reference book as an appendix (Flickenger, 2003, appendix A). A point worthy of note about Pozar's presentation is that he approached radio regulation like a quest: the law in this area was a distant thing that an engineer would be unlikely to know but quite likely to violate. In response, Pozar conscientiously interviewed telecommunications lawyers and read law books until he could produce a very comprehensive list of both of the relevant sources of authority at different levels and agencies of government and also their specific rules. His presentation includes explanations of limits on the height of towers, rules against swapping antennas between different equipment manufacturers, a discussion of the risk of wireless networks interfering with aircraft RADAR, the limit of a wireless worker's maximum exposure to electromagnetic fields, and much more. He concludes by recommending "coordination with other users" (p. 17) in unlicensed bands and it is to this coordination that this paper will now turn.

The case studies that appear below arose from a comparative cross-national study of these providers in six countries: the US, Canada, Ireland, Great Britain, New Zealand, and Australia. For the larger project, 63 groups were chosen that identified themselves as WISPs in 2003 that were affiliated with the "open wireless," "community wireless," "municipal wireless" or similar movements (or these groups were referenced on Web pages about those terms). This includes groups that call themselves commercial, noncommercial, and governmental and these groups range from the quite formal to the quite informal. To be included, the group had to have a significant Web presence in 2003. Extensive, ongoing participant observation was conducted with two

of these groups (one in the US, one in the UK), while members of an additional 16 groups have so far been visited at least once by researchers who interviewed participants in an open-ended format methodologically akin to oral history. Researchers also attended meetings (if possible) and received a tour or demonstration of the network (if relevant). All groups (including the remaining 45) were analyzed by quantitative and qualitative content analysis of online material about them (including often extensive mailing list archives). This larger project is ongoing, and the case studies presented below represent early results from the visits to 16 groups that are worthy of considerable attention on their own. Names of the people, places, and organizations involved in the following case studies have been changed.

Methodologically, this approach could be characterized as an oral history of users of the electromagnetic spectrum, or more formally, what Yin (2003) would term a holistic, multiple case study research design organized around literal replication.[3]

Case I: MonroeMesh's Failed Transition to Sharing

Monroe is a small city of about 210,000 people in the Midwestern US, and a county seat.[4] Known for its local university and very high levels of education, the main industries are white-collar services (notably health, finance, and insurance), retail trade, government, and education. These are slowly displacing a historical focus on light manufacturing in a period of economic growth that has been continuing for over ten years. Monroe is set among very slight hills. At the time the group we will meet was founded, high-speed broadband Internet service was already widely available and

[3] In Yin's terms, both case studies presented here represent failures of order (literal replication) that were arrived at in different ways.

[4] In the 2000 US Census, per capita income in 1999 dollars was about $23,000. There are 3000 people per square mile. 7.6% of the population has no secondary school diploma.

prices were falling. This case study is based on interviews with Terry and Dave in 2003 and 2004. Terry and Dave are both white, well-educated men in their twenties who decided to found a WISP in Monroe—optimistically named MonroeMesh.[5]

Terry is a local engineer with a passion for tinkering with wireless equipment. Before founding MonroeMesh, Terry gained previous experience with a rare, proprietary unlicensed wireless data technology called RARLAN.[6] In the late 1990s, using 12 radios scavenged form a friend's failed electronic coupon printing business, Terry built a RARLAN network in a small town near Monroe as a hobby. The network wirelessly connected his friends to the Internet (via an ISDN line) and to a shared file server. The connection served most anywhere within an area of about 15 square miles. "We had an old Sparc 2 sitting at [a friend's] house with a 22-gig SCSI hanging off it—that was our central depository. We had mp3s, video, whatever we want," said Terry. "It was pretty kick ass."

This earlier technology, RARLAN, used shared spectrum, but the other users were encountered rarely enough that the fact of spectrum sharing was not especially obvious, and the high power of the RARLAN radios gave an extra feeling of security: "RARLAN was so powerful that, if you were close enough, it would overload the front end on whatever tuner you had…it was a very robust, very good solution." When it ever became noticeable that other users did exist and there was a technological skirmish between systems, the skirmish was fine with Terry because his radios always won. Once, in the manner of a confidential aside, he mentioned, "We walked over the analog

[5] The network did not use what is commonly called "mesh" technology, but Terry and Dave hoped to.
[6] RARLAN operated at 900MHz. The company was purchased by Cisco and is now defunct.

cell phones. You heard a clicking sound in your earpiece if you were using a cell phone anywhere in town." He paused, then continued, "I thought that was pretty cool."

The introduction of the first cheap "Wi-Fi" wireless Internet consumer products in 1999 spurred new wireless networking projects across the world (see Sandvig, 2004; Bar & Galperin, 2004).[7] At the same time that Tim Pozar was getting excited about Wi-Fi in San Francisco, Terry and Dave met in Monroe and formed a working group that included four other technically-inclined people interested in the capitalizing on the new possibilities of even cheaper unlicensed use of the spectrum. The initial goals of the hobbyist were carried over from the earlier RARLAN network, "I wanted to be able to drink beer and have my PDA get me alerts from work," explained Terry. Dave added, "I wanted Internet access out at the lake."

They soon conceived of a city-wide transport network that a variety of local service providers could connect to and jointly pay for. For instance, the local radio station could join, then use MonroeMesh's transport network to link remote broadcasts (such as DJs or live music events) with the studio. This was already being done with 900MHz ISM band equipment, but the radio station reported that there were so many other users on that band in town that "that first leg was horrible—they could rarely get more than voice grade communication." Dave and Terry saw the possibility for higher-quality digital sound broadcasts if they moved over to Wi-Fi. Additionally, a local Internet service provider (ISP) agreed to connect to the network and provide a connection to the Internet with an authentication scheme—the MonroeMesh city-wide

[7] "Wi-Fi" is short for "wireless fidelity" and it is an industry consortium's name for interoperating radios that comply with the IEEE 802.11 standards.

network would then be a way to connect to the local ISP from a laptop while outside (and without dialing in or using any wires).

As a beginning, using their own money the group built three nodes on tall buildings in Monroe (including one at the radio station), and the limited network worked just as it was intended to. But as they planned for the network's expansion, Terry and Dave had more and more misgivings. Terry explains,

> We did some surveying. In one instance, we were on top of [a particular] building, just looking around, and we found 10, 15 networks. All just hammering away. All just blasting away, making noise. And in the same area! That's an issue.

Later along the widespread adoption of Wi-Fi these numbers (10, 15) would not be a concern, but in 2002 they were. The Wi-Fi equipment in question (an access point) usually sends out a digital signal called a "beacon" even when it has no traffic. This "hammering away" almost surely consisted of beacons detected by the site survey software Terry and Dave were using. Packet data traffic like Wi-Fi (and all Internet traffic) is notoriously "bursty," and seeing a few other users on the same band wouldn't mean the band was full of traffic, simply that others had set their equipment to use that frequency if and when they did have something to transmit. Both Dave and Terry were well aware of the technical details of the communication protocol, nonetheless the electromagnetic spectrum felt full to them.

As another way to facilitate the sharing of spectrum, the Wi-Fi communication standard calls for the band to be further divided into overlapping channels in a way similar to older cordless phones—if a cordless phone user heard static on one channel

they could move a switch on the phone to switch to a different frequency—the same held true for Wi-Fi.[8] But Terry explained that regardless of the number of channels there were, someone else might still be using them:

> If I were to use any of the channels that are available to me, 1-11 let's say. No matter what I've picked, I'm asking for loss. There's no technical way I can avoid loss with the gear that I'm given. Or I can get. Anything that can find is going to fall down at some point. And even though these [other] networks are not necessarily very active, they're still producing traffic.

The notion of overlapping channels itself has been problematic for the engineering community, as traffic on adjacent or even nearby channels implies some (though not complete) degradation in service quality. One trade press article that appeared around this time stated forcefully: "The 802.11b standard gives us 14 channels to work with, right? Wrong! Sorry, it's really only three useful ones."[9]

The MonroeMesh hesitation in this case does not seem to be about responding to interference, but sharing: only sharing without the possibility of any degradation at all was acceptable. Dave explains at a later session:

> You're sitting at a table with two network engineers that would rather build nothing than to build something that doesn't work the way it should. Because the user expects the network to be a utility. When they turn on the light switch, the lights come on. When they call 911, the ambulance is at their door. It's the same thing.

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[8] For instance, the IEEE 802.11b standard defines 14 channels, 1-11 are used in the US, 1-13 in most of Europe, and 14 in Japan.

[9] From: http://www.wi-fiplanet.com/tutorials/article.php/972261&ei=0wgiQ-_yDpiuiAGRm-j7AQ e.g., channel 1, 6, or 11 in the USA. The channels in 802.11b center on frequencies in 5MHz steps, but a transmission is 22MHz wide, meaning that transmissions on adjacent channels overlap significantly.

After the initial burst of activity, MonroeMesh experienced several frustrations trying to negotiate for tower placement, then Terry and Dave were astonished by the effect of the Midwestern weather on their gear and equipment, then they become disappointed at the limited reach and few features of the Wi-Fi equipment when compared to Terry's more powerful RARLAN radios of the past. MonroeMesh ran out of steam and the group dissolved in 2004, with 3 stations and 20 users, and without formally incorporating or taking in any money. "Maybe 20 users wasn't enough to legitimate me donating gear and doing all this work," said Terry. "I'm sorry for being so cynical." Still, both Dave and Terry listed Wi-Fi experience on their resumes, and both quickly moved on to higher-paid jobs working on wireless systems, Terry with an out-of-state telephone company[10] looking to move into wireless, Dave in the I.T. department of a large organization.

The Engineer's Perception of Congestion and Beauty

The MonroeMesh case reinforces an important lesson about technology—the need to pay due attention to the way things look as well as the way they work. Dave and Terry's experience of the electromagnetic spectrum came to them from the user interface of their mapping software (for a discussion of mapping, see Sandvig 2004). The popular software *Netstumbler*, for example, presents the user with a list of detected networks where each new station identified is added to the list. No measure of the amount of utilization is given. The experience of running *Netstumbler* when 15 other networks were nearby but transmitting nothing might be one of seeing the spectrum as though it were "full" because 15 networks are listed on the screen rather than none.

[10] Actually, a competitive local exchange carrier (CLEC).

While national spectrum regulators and the Wi-Fi protocol designers would see that spectrum as empty, they were looking at it from a different perspective, through a different portal.

More significantly, when we look at the MonroeMesh case in order to understand the system of rules governing Terry and Dave's behavior, it is clear that their professionalization as engineers is the controlling complex of obligations. While this may not be so for Terry, for other engineers who are now coming to wireless systems with a background in computer software rather than in radio, the uncertainties of the radio environment are traumatic. They didn't want MonroeMesh to work as much as they wanted it to be beautiful to engineers, and this couldn't be accomplished within their other constraints.

Case II: The Planetree Forest Spectrum War

The next case study includes threats of litigation and (at the time of interview) an ongoing government investigation. To permit the parties involved to speak at all about these events (especially because the radiocommunication enforcement community is so small even across six countries), this essay will not reveal which country of the six (US, Canada, UK, Ireland, Australia, New Zealand) is the home of "Planetree Forest." While the culture and law of the six nations varies, the actual national law in this case makes surprisingly little difference to what happens in Planetree Forest, as the reader will see.

This case study concerns the relationship between two WISPs, here called TownNet and SATNet. The materials for this case study come from interviews with the two co-founders of TownNet (Alan and Philip), a private mediator working at a not-for-profit organization who was called in to adjudicate the following dispute, and two

government officials from the national communication regulator who were in a position to be familiar with the regulations relevant to the dispute.[11] The lack of SATNet interviews make the picture of events unfortunately somewhat one-sided, but the two available parties (a SATNet employee and the SATNet founder) both declined requests for interview—perhaps for reasons that will become clearer below. Public information about the dispute was also consulted. All descriptions here refer to the time of the interviews: the middle of 2004. As most of the information comes from TownNet interviews, the dispute will be told from the perspective of Alan and Philip.

Planetree Forest has a lower unemployment rate than surrounding areas and higher levels of education.[12] The main industries are farming and the light manufacture of furniture, precision machinery, and clothing, and the landscape is marked by farms, river valleys, and 54 small towns (the population of the largest is 3,000) where at the time the two groups described here began operations, only dial-up Internet access was available.

TownNet was a not-for-profit organization founded by Philip, a former telecommunications engineer, and Alan, a manager, who lived in Planetree Forest. They gathered about six other local professionals (two accountants, a marketing manager, a property developer, someone from the municipal government's I.T. department, and a telecommunications market researcher) who were dissatisfied that no broadband Internet service was available and wrote a business plan that projected that they could build a sustainable (break-even) service using the latest wireless technology with about

[11] To protect the confidentiality of the TownNet founders, the government officials were not told that the interviews were in reference to the specific dispute.
[12] The area ranks in the 89th percentile for per capita income when ranked against other areas in the country. There are 348 people per square mile. 21.9% of the population has no secondary school diploma.

USD $50,000 for ten towns. At the time, large telecommunications carriers had publicly claimed that it was not profitable enough to deploy broadband service in Planetree Forest. In response to a national policy to accelerate the deployment of broadband in rural areas, government subsidies were available from several agencies at different levels of government. Alan and Philip of TownNet received a zero-interest loan of about USD $5,000 and quit their jobs. They subsequently received an additional $50,000 in the form of regionally-administered development grant and expanded the network to include 16 towns. But TownNet was not the only group interested in using new wireless technology to bring high-speed Internet to Planetree Forest.

SATNet and the Informal Spectrum Negotiation

SATNet was a for-profit company run from a town outside Planetree Forest whose founder had previous experience in information technology. Both SATNet and TownNet offered very roughly comparable wireless Internet service,[13] and both designed their network to use license-exempt bands for many necessary links (although both also used other bands). Note the neighborhood relationships involved in their first contact, about potential interference, described here by Alan:

> What [SATNet] basically said to us was, "could you change the channel please?" But they didn't ask us, they told their customer who happened to be our customer's landlord. Who then told his brother-in-law, who was our customer. It was the brother-in-law who finally introduced both parties.

[13] SATNet provided a speed of 512kpbs for about USD $24.99 per month, and served 8 towns in Planetree Forest. TownNet offered comparable service to 16 towns (including TownNet's 8), with a speed of 512kpbs for about USD $29.99/month and 1 Mbps for $82.99/month.

Somewhat surprisingly, it turned out that SATNet was also receiving substantial government subsidy to provide service to Planetree Forest in competition with TownNet. SATNet may have received as much as about USD $30,000 from a different agency at a different level of government, from a fund for the promotion of commerce. To reconcile this competing use of public funds, the municipal government asked both parties to come in for a voluntary meeting. Alan reflects on it that:

> at first they tried to sell us equipment, a client device they had built. [We didn't buy.] We initially signed a [non-disclosure agreement] with them. We were going to work together. We came up with this idea of sharing the spectrum. We said we'd use only a given channel. We came up with a reasonable plan and they seemed happy at the meeting.

An official from the agency that gave TownNet the bulk of their funding asked for a second meeting, intended to be a "technical meeting" between the engineering staff of both groups. The second meeting goes badly, as Alan explains:

> [SATNet] said, "We were here first, tough." Their stated objective was to close the space down so that no one else could move in. Part of the agreement was that they'd provide us with a list of where we could use what channel and we would provide a list of what areas we had covered. That agreement has sat in abeyance. They [didn't] do anything and we haven't changed anything.

Worried, Alan of TownNet then posted to a mailing list for coordination between WISPs. His post read in part:

> I think we're going to have a problem with spectrum issues. Does anybody have any advice on arbitration over use of channels? These people won't negotiate -- it's likely to end up in court.

SATNet forwarded Alan's post to TownNet's funding agency with the addendum: "This guy's a troublemaker."

From Negotiation to Jamming

By this point TownNet and SATNet have an antagonistic relationship, to be sure, but some antagonism may be acceptable. They are competitors and in order to compete they both need to share the same resource (in this case part of the 2.4 GHz band) that they both see as finite. Next, according to Philip, SATNet's strategy for winning changed to enforcement of a first-come, first-served model of the band, and the instrument used changed from negotiation to technology. Philip elaborates,

> When we moved one [TownNet] link to 300 yards and crossed two of their long links we found that we couldn't do anything. We stick up an antenna and do *Netstumbler* and get a long list of [SATNet] out there. [Before], we were picking channels that were well separated, the noise floor appeared nice and quiet, and [now] at a matter of a few hundred yards with line of sight we couldn't see a thing. There was no signal, nothing….Then customers started to complain that their own [indoor] home networks stopped working….So [the regulator] in the end started some sort of investigation.

This mysterious failure of all of the open spectrum to be open happened just after a number of alarming developments in the Wi-Fi engineering community.

First, widespread publicity appeared about wireless Internet's newly discovered susceptibility to "logical jamming." Briefly, digital wireless systems use a "listen before talking" procedure to reduce the chance that a transmission will collide with one from

another station. For example, the equipment used by TownNet and SATNet employ Carrier Sense Multiple Access with Collision Avoidance (CSMA/CA) that includes a process called "clear channel assessment." When a wireless card performs a clear channel assessment as a prelude to "talking," if another station is transmitting the card will wait a "backoff" interval and then perform the assessment again. Wullems et al (2004) noticed that directing a wireless card to transmit a continuous pattern of bits will cause all other devices within range to always conclude that the channel is busy, and wait indefinitely (see also US-CERT, 2004). Similarly, simple scripts appeared on the World Wide Web at this time that allowed a wireless device to "use" all of its available capacity by transmitting nonsense. Rumors were flying in the wireless community about new equipment proposed by manufacturers (like the *Sony AirBoard*) that would increase the speed of data transmission by using all of the available channels simultaneously across multiple bands, using multiple radio chipsets at the same time.[14] Finally, online discussion boards reported that commercial telecommunication carriers had begun to raise the transmission power on their equipment to nearer the legal maximum (Foust 2004a, 2004b), presumably to drown out competing signals. It is not clear what happened to the open spectrum in Planetree Forest in 2004, but Alan is convinced:

> They were over power. [SATNet] was using amplifiers. There are a number of technologies that cause denial of service that are actually very difficult to pinpoint and I'm…convinced that they were using something. They really didn't like competing with anybody. [They thought,] "The more channels I grab means the less competition."

[14] e.g., see: http://www.akibalive.com/archives/000514.html

From Jamming to Extortion

At this point, the municipal government asked TownNet and SATNet to return for a third of what Alan called (with a chuckle) "these arbitration--confrontation meetings." This time they also invited an outside mediator, and Alan said the SATNet tactic moved from jamming to extortion:

> We agreed that [SATNet] would let us use channel one and they'd use the rest. He went away with this agreement but he had this list of [other] demands still in place. He wanted us to pay for reconfiguring their network. [He said] we were going to pay them [thousands of dollars] to implement the changes that were necessary.

Even after the agreement, nothing changed immediately, until a few days later "on the day the regulator knocked on their door, that all stopped and suddenly our customer['s equipment] burst into life." Alan and Philip explained that *both* SATNet and TownNet were found to be using Taiwanese equipment that was not certified for operation in the country, and had secondary harmonics in a licensed band (thereby violating certification laws and causing harmful interference by the legal definition). While charges of jamming, especially by denial of service using random or nonsense traffic would be almost impossible to prove, luckily the fact that they both bought very cheap uncertified equipment over the Internet allowed a national regulatory official the reason to inspect the premises, and all interference disappeared. Both TownNet and SATNet have continued to compete but with no interference.

Lessons learned?

Local ties interconnect all aspects of TownNet's story. A local government employee was one of their founding group, they were able to secure free access to

antenna locations and some development money (at least the initial zero-interest loan) in part through existing relationships in the community where they lived. But one relationship is essential to understanding this story, and that is the one between the TownNet founders and the official who worked for the national communication regulator. The official also lived in Planetree Forest and wanted broadband in his community; after meeting the founders at an early public organizing meeting about broadband, they became friendly.

"He's very professional. But he does keep us informed," notes Alan.

Philip seconds, "He has access to spectrum analyzers and all those kinds of things, we used to regularly bring him in because getting a hold of that stuff is expensive."

In another context, Alan explains that "He compartmentalizes his advice as well. Sometimes it was a formal warning."

Philip says, "He still gives us quite a lot of technical help." Let us close the case study with Philip's observation about the overall experience of the broadcast war, which he pins, surprisingly, on telecommunications regulators (who can never win, even when they win broadcast wars). Philip says,

> Part of the problem with a lot of regulators is that they're too heavy with the regulation. If you're being a bad neighbor someone needs to officially remind you that you're being bad. No more than that.

Conclusion

Although it may seem elementary, it is worth remembering that "new laws are thrust upon going social arrangements in which there are complexes of binding

obligations already in existence….The social arrangements are often effectively stronger than the new laws" (Moore, 1978, p. 58). In these cases we have seen that the engineer's allegiance to principles of engineering as a profession can be far stronger than any allegiance to communications regulation, and that even as engineers they have an allegiance to *their* system that is much stronger than any to *the* system. Similarly, from a variety of perspectives it could be obvious that TownNet was the injured party in the Planetree Forest broadcast war, but there is no doubt that their relationship with members of their own community and a national regulatory official were critical in bringing the war to a resolution.

The Future of The Approach "From Below"

2005 may be a historical moment when the study of telecommunication policy critically needs attention to the law "as it is lived." Unlike some other domains of law, communication policymakers and researchers have often assumed that the law is never particularly "operative" (Moore's term) in the lives of everyday people. Arcane communications rules are written for a small audience of industry insiders. In a recent magazine parody, a political writer noted that this culture in the US was so insular it should be called "FCC World," and that it has "perhaps five thousand denizens" (Lemann, 2002). In the Spring of 2003 this sort of thinking was radically destabilized by a US FCC vote on the relaxation of media ownership caps. While that topic is usually considered arcane, a record-breaking two million e-mails, telephone calls, and FAXes poured into the FCC about it. The surprise for many analysts was that it was possible for two million people to even become aware that administrative regulation on media ownership existed in the first place. This trend of a more active public has combined

with recent consumer protection efforts and liberalization of the electromagnetic spectrum in reinforcing ways. For instance, consider the new availability wireless devices that do not require licenses in many countries, the new regime of low power FM licenses from the US FCC, the use of a non-exclusive "light-license" of £1 per year for some wireless broadband services (with a simple online form) by the UK Office of Communications, and the creation of an online "National Do Not Call Registry" (http://www.donotcall.gov/) by the US Federal Trade Commission.[15] While these are examples of many things, they are also examples in which much larger numbers of people are now expected to be aware of and interact with an administrative regulator in fairly unprecedented ways.

To close with one final return to Monroe and Planetree Forest, while these case studies describe fundamentally different events, it should be clear by now that there are many things wireless engineers will always agree on. When asked to describe the biggest obstacle to inexpensive wireless data service by MonroeMesh, Dave sighed, "If only we got another tall building." In Planetree Forest, the reply was also quick: "It's the trees."

[15] For fixed stations in 5GHz Band C (5725 to 5850 MHz).

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