Jesse Sunenblick

Into the Great Wide Open

New technology could radically transform broadcasting. The dreamers and players are already debating how far to go.

In 1940, the Austrian-born actress Hedy Lamarr, considered by some the most beautiful woman in Hollywood, approached her neighbor there, the avant-garde composer George Antheil, and asked him a question about glands. Antheil, known for his propulsive film scores for multiple player pianos, had broad interests: In addition to his music he wrote a syndicated advice-to-the-lovelorn column and had even published a medical book, *Every Man His Own Detective: A Study of Glandular Endocrinology*. As the story goes, Lamarr—whose acting exploits (which include the first big-screen nude scene) and marriages (there were six husbands, most notably Fritz Mandl, an Austrian arms dealer with ties to Hitler and Mussolini) are too varied to discuss here except to say that she was a woman far ahead of her time—wanted to know how she might enlarge her breasts. Somehow, though, they ended up talking about radio-controlled torpedoes, and the future of communications was changed.

After years of living with Mandl, Lamarr was familiar

with the problem of sending control signals to a torpedo after it was launched from a ship, especially radio signals, which the enemy could easily detect and jam. She had a notion of a radio transmission that, by changing its frequency many times a second, could allow an observation plane to covertly guide a torpedo over long distances. Combining Lamarr's knowledge of radio control with the model Antheil had used to coordinate 16 pianos in his *BalletMécanique,* the pair invented the idea of "frequency hopping" and obtained a patent for a Secret Communications System. This was the first example of a single radio transmission using multiple frequencies across the radio spectrum—the range of electromagnetic frequencies that are useful for sending broadcast signals—without bumping into other transmissions and causing interference. Sixty-plus years later, frequency hopping has evolved into a technology, called "spread spectrum," that proponents claim could put an end to most forms of radio interference, presaging a time when the airwaves (TV signals travel over the same spectrum), one of our most heavily regulated resources, could be opened up.

The implications of this idea are far reaching for human communication, including journalism. If there is no longer a reason to tightly regulate the broadcast spectrum, then just about anyone would be allowed to broadcast. As technology continues its march toward miniaturization and higher speeds, we might soon have devices that fit in our pockets capable of sending voice, video, and other data over long distances. And if we could use such devices without causing interference, then today's bloggers, for example, confined by laptops, short-range wireless connections, and slow video feeds, could be tomorrow's roving band of telejournalists. Imagine lone-wolf Christiane Amanpours showing up on site, unencumbered by the demands and the strictures of our

modern media monopolies, beaming reports live to whoever might care to watch, not just on television but on a computer, on a cell phone, on the dashboard of a car.

As in the earliest days, broadcast pioneers are once again talking and dreaming about broadcast's potential to connect all corners of the earth. Of course, in the world of broadcasting what is possible is often undone by what is profitable—or politically expedient. The advent of spread spectrum has spawned a subterranean debate about how to manage the radio spectrum that has broadcasters arguing with technologists, economists arguing with media critics, and everybody arguing with the FCC about a radio revolution.

When you connect to the Internet at Starbucks, when you talk on your cell phone, or when you use many of the other radio technologies that constitute our current wireless craze, you are using spread spectrum. Spread spectrum works by contradicting the traditional rules of radio communication, in which a single signal is sent over a single frequency in the electromagnetic spectrum for which it has a license from the FCC. With spread spectrum, a transmission is disassembled and sent out over a variety of frequencies, without causing interference to whatever else might be operating within those frequencies, and is reassembled on the other end by a "smart" receiver. Licenses aren't necessary for spread-spectrum transmissions, but the devices currently aren't allowed to operate at more than a few watts of power. And since the early 1990s, when they were first available for use by consumers, they have been relegated to that portion of the radio spectrum known as the "junk band"—the uppermost usable frequencies that are home to gadgets like cordless phones, microwave ovens, and baby monitors and which, because of shorter wavelengths, have trouble cutting through bad weather and obstacles like trees and buildings.

The FCC has issued licenses for frequencies since it was established in 1927, and the impetus to do so was an outgrowth of a decade of ethereal chaos in the 1920s, when the airwaves were overloaded with so many new broadcasters on so few available frequencies that it was impossible in many urban areas to receive a steady signal. Media critics like to point out how this licensing system has contributed to an oligarchy of the air, in which the Viacoms and Clear Channels of the world control access to most radio communication. But by 1990 it had contributed to something else: a dearth of available frequencies left to license. The spectrum, like an oil reserve, was nearly depleted.

Spread spectrum offers a far more efficient way of using the radio spectrum, and throughout the 1990s the FCC opened up license-free slivers for devices that employ spread-spectrum technology—first for gadgets like garage door openers and home alarm systems and later for WiFi, which has blossomed into a multibillion-dollar industry. WiFi not only allows city dwellers to hook up to the Internet at Starbucks but is pushing the Internet into rural locales not served by cable or DSL and making possible public-safety networks for police and fire departments.

Now the FCC is considering a series of rule changes that would open up much more of the spectrum for unlicensed radio. The timetable on any commission decision on such rule changes is fluid and depends, in part, on who replaces Michael Powell, a strong proponent of unlicensed radio technology, as FCC chairman. The most significant of the rule changes would allow unlicensed radio to operate with more power, over longer distances, and in portions of the spectrum currently occupied by heavyweight incumbents such as the television networks; they would also clear the path for the manufacture of smart radios, which can transmit selectively through little-trafficked frequencies, essen-

tially dodging interference. The big broadcasters are engaged in a rigorous lobbying effort to discredit the science of spread spectrum, which they believe could undercut their competitive edge by allowing thousands of individuals to establish their own television or radio programming or to offer wireless Internet service on the cheap. To public-interest groups, however, the advent of unlicensed radio represents an opportunity for greater citizen access to the airwaves and the possibility of a network of community radio or TV stations in every town in America.

"The rule changes represent the most important communications decision the FCC will face in the next 10 years," says Harold Feld, associate director of the Media Access Project, a nonprofit, public-interest telecommunications law firm that hopes the FCC will expand the role of unlicensed radio. "If the commission can stand up to the most powerful industry lobbies in Washington and create new rules that reflect new technologies, the American people will see nothing short of miracles."

In my conversations with Feld, he kept repeating the phrase "cheap, ubiquitous Internet access"—which, in his opinion, is the crux of the debate—and emphasizing the importance of getting these spread-spectrum devices deployed with sufficient power and with access to the lower frequency, "beachfront" sections of the radio spectrum dominated by the big broadcasters. That, he says, would create a plethora of journalistic opportunities for media big and small. In addition to creating a nation of broadcasters, network news companies could bolster their Web offerings with live-action video feeds, using a one-person news crew, from anywhere with a WiFi connection. A WiFi media reader, meanwhile, could replace the bundle of newspapers and magazines that you carry to work or home every day. And ubiquitous mobile Internet connections would mean

that reporters, who would have constant access to research tools, could improve the content of their stories. (Of course, someone would have to pay for all these technological goodies.)

Everyone, it seems, has a dog in this fight. Venture capitalists who stand to make a buck off more powerful versions of WiFi. Technologists who want an arena for their futuristic ideas. Media activists who envision an unlimited radio dial with thousands, if not millions, of noncommercial stations. Wireless Internet service providers who want to extend their reach. Economists who think that the best way to make use of new radio technology is to privatize the radio spectrum and let the instincts of capitalism take over. And of course lobbyists for powerful incumbents who want to preserve their exclusive licenses.

Out of this fray has come a distinctive vision of the spectrum as a public commons, in which an unlimited number of users share unlicensed portions of the radio spectrum, and—subject, of course, to power and usage restrictions—do with it what they want. The movement gained steam throughout the 1990s, as advancing spread-spectrum technologies called the FCC's licensing system into question. One of the movement's philosophical pillars is that unlicensed radio technology has the ability to democratize the media, much the same way that the Internet did through blogging, although on a profoundly grander scale. Eben Moglen, a Columbia University law professor and one of open spectrum's biggest supporters, has an idea about how open spectrum might accomplish this.

For the last 11 years, Moglen has served as general counsel (pro bono, of course) to the Free Software Foundation, a group that promotes the creation and distribution of, well, free software. He is also an unabashed Marxist. In his office, I told Moglen I was having trouble understanding how an

"open" spectrum would differ from a "closed" spectrum and could he please offer an analogy from the real world that would bring the otherworldliness of the radio spectrum into context.

He leaned back in his chair and spread his arms out wide, as though everything around us were part of the analogy he was about to give. Which was true. "Take the island of Manhattan," Moglen said. "The level of anonymity in Manhattan is subject to social regulation, like the radio spectrum is subject to political regulation. And it's variable: Sometimes you go places where you have to identify yourself, sometimes not. And as the city imposes restrictions on movement, zoning, and behavior, the federal government places restrictions upon the radio spectrum.

"However," he went on, "the difference is in the number of restrictions. The essence of life in Manhattan is openness. It's all free, it's all here, you can get to it. You can walk from the West Side to the East Side, from Harlem to Chinatown. Or take a cab. But what would Manhattan look like if its social policies were on par with the current government policies concerning use of the radio spectrum? It would be unendurable. You'd have David Rockefeller owning Rockefeller Center. Rupert Murdoch would have a dominant say in everything that happens between the Battery and 23rd Street. Worse, you'd be sitting in Starbucks, having a conversation, and somebody would say, 'You, stop talking! You, talk about the weather!' You're allowed to have person-to-person conversations, but for the privilege of doing so in my neighborhood you have to pay six dollars a minute. And, because there's nothing resembling a Central Park on the radio spectrum, if you want to gather people and talk about the war in Iraq, tough luck! We need a Central Park for radio!"

If the government tried to license newspapers, Moglen says, the courts would block it on the ground that it violated the First Amendment. "The technological reason that we have given in the past for why a system of licensing—one that would be completely unconstitutional with respect to print—is constitutional in the spectrum no longer exists! And when the broadcasting licensing system falls, as it inevitably must, American society will be transformed. Mr. Murdoch, Mr. Eisner, Mr. Gates—Will. Be. Poorer. We. Will. Be. Richer. And there will again be news in this society, which at the moment, there almost isn't."

Many media critics accuse the FCC, under Chairman Powell, of perpetuating communications policies that favor forces of media consolidation and the status quo. Yet interestingly, in the case of unlicensed wireless communication, Powell has been on the other side of the barricades from big media. To Powell, WiFi is the prototype for the role that unlicensed radio will play in the future, an example of what he has described, in various speeches, as "the great Digital Migration" or "the Age of Personal Communications"—optimistic assessments of what he sees as a new information paradigm that lies just over the horizon. In terms of convenience, at least, we are certainly on the cusp of profound changes: We will soon talk over the Internet the way we talk today over telephones, but for less money, because Internet voice is a computer application, not a government-regulated telecom, and because providers don't need to build a multibillion-dollar infrastructure to offer it. This is likely to give rise to an Internet of things, a state of überconnectivity. "The visionary sermons of technology futurists seem to have materialized," Powell said in a January 2004 speech at the National Press Club in Washington, an assessment of the transition from the world of analog to digital. "No longer

the stuff of science fiction novels, crystal balls, and academic conferences, it is real. Technology is bringing more power to the people."

But a running theme in Powell's Washington speech is that the "Digital Migration" means far more to Americans than convenience—that the ubiquity of the Internet, combined with the miniaturization and higher power of radio technology, will empower individuals, rather than large institutions, to become central in the creation and dissemination of ideas. "Governments are almost always about geography, jurisdiction, and centralized control," Powell said in his Washington speech. "The Internet is unhindered by geography, dismissive of jurisdiction, and decentralizes control." The implication here is that technology, if given the chance, will level the playing field. Toward the end of his Washington speech the chairman laid out a multipronged strategy for accomplishing the "migration," much of it dependent on reforming the radio spectrum to allow the next generation of unlicensed radio to operate with more power and bandwidth—so that a wireless Internet network that can now reach a distance of 200 feet, for example, might some day spread across 200 miles or perhaps the entire planet. Whoever gets Powell's job is unlikely to share his passion for unlicensed radio, but the debate isn't going away.

Dave Hughes, a retired colonel from Colorado Springs, knows better than most what a network like the one Powell described might look like. It was Hughes who told me the story of Hedy Lamarr, because it was Hughes who had resurrected her name from the dustbin of technological afterthoughts when he nominated her for an achievement award (which she ultimately won) from the Electronic Frontier Foundation, a watchdog for digital civil liberties, in 1997, when Lamarr, who died in 2000, was old and forgotten and

living in Florida. ("It's about time," Lamarr is rumored to have said upon hearing of the award.) Colonel Hughes has been a lot of things in life—a hero of the wars in Korea and Vietnam, a professor of English at West Point, an inventor of America's first online computer bulletin board, and a pioneer of rural computer networking—but what he is most is a vociferous advocate of radio and in particular of spread spectrum.

"My humble goal," Hughes likes to say, "is to see all 6 billion minds on the planet connected in all the ways our brains and ears and mouths and eyes can communicate. At least when you can communicate, you can reduce the areas of disagreement to real substance."

In 1991, Hughes bought two of the earliest spread-spectrum radios to hit the marketplace, units that produced a single watt of power. He connected them between his Internet-equipped office building and an early IBM version of a Web site on his home computer. The wireless link of that connection between the two radios cost him nothing; had U.S. West provided the connection, it would have cost $600 a month. Hughes thought: If it works between buildings, why not rural towns? In the mountains of southwest Colorado, Hughes perched a pair of spread-spectrum radios in such a way that a school district in the town of San Luis was connected wirelessly to an early version of the Internet, for a one-time cost of $3,000, as opposed to the $2,000 a month that U.S. West was asking at the time to run a 40-mile cable to Alamosa, where the closest Internet provider was. Then he thought, if we can connect towns here, why not in the most remote places on Earth? He went to Mongolia with spread-spectrum radios, and now Ulan Bator is the third world's most wirelessly connected city.

In 2003, Hughes used three WiFi radios in his most ambitious project yet: constructing the world's highest

Internet café at the base camp of Mount Everest. From his home in Colorado, Hughes collaborated with Tsering Gyaltsen, the grandson of the only surviving Sherpa to have accompanied Sir Edmund Hillary on his first ascent of the mountain, and designed a network in which WiFi radios in the Café Tent beneath the Khumbu Ice Fall are linked to a satellite dish 1,500 feet away that sends data, via satellite, to an Internet service provider in Israel. Then, last year, Hughes helped another Nepalese entrepreneur add computers and a wireless link to his cybercafé in the Namche Bazaar, the trading center of the Everest region. He used three antenna relays (one hanging off the side of a monastery at 14,000 feet) to extend the network to a school in the nearby town of Thame, where 10 Sherpa children are now taking English and computer classes over the Internet from a Nepalese-born, English-speaking Sherpa computer programmer who lives in Pittsburgh.

The computers the Nepalese children use rely on a free software program called Free World Dial Up, which allows them to speak to their teacher over computers, for a flat rate, the way most people do over telephones. To Hughes, when Nepalese children are talking to their teacher in Pittsburgh and handing in their lessons by computer, giving them, as he says, "half a fighting chance to succeed in this world," that represents more than a demonstration of the possibilities of technology. It is a paradigm shift, a revolution. "You have to understand the disruptive nature of this technology," he often says. "Who's getting robbed? Because of the technology, it's AT&T that's getting robbed. The technology is way out in front of the regulatory, legal, and economic communications systems of this country. There's going to be titanic battles. But ask yourself, What happens to the incumbents? Well, what happened to the horse and buggy? What happened to the printing press?" Of course, the revolution

Hughes envisions can always be interrupted by the real world. On February 1, Nepal's king Gyanendra dissolved the government and shut down all telephone and Internet connections in the country. A WiFi network—even a global one—could not stop a power grab in Nepal.

It is easy to be nostalgic for the earliest days of radio, when, before a licensing regime was put in place, tens of thousands of amateur operators shared the still-mysterious airwaves in a raw, often free-form haze of chatter, music, and news, much like the Internet today. There was something supernatural about radio then, and one line of thinking saw the medium as a force of social connectivity. An article from *Collier's Magazine* in 1922 entitled "Radio Dreams That Can Come True" talks about radio "spreading mutual understanding to all the sections of the country, unifying our thoughts, ideas and purposes, making us a strong and well-knit people." There is an obvious utopian quality to such declarations, common in all periods of significant technological change. While one could certainly argue that first radio, and then television, did achieve the task of uniting us, it did not happen in a way that the *Collier's* writer could have imagined, and it did not happen in a way that had all that much to do with making us strong and well knit.

By the mid-1920s radio was controlled by two national networks—NBC and CBS—and the coming years would witness the invention of advertising and the fine-tuning of capitalism on the radio dial. Does the same fate await spread spectrum and smart radios? In the mainstream press, technoenthusiast feature stories appear regularly, touting the cutting edge of unlicensed wireless communications like WiMax, which is essentially a pumped-up version of WiFi, with a networking reach of 30 miles; Zigbee, a tiny wireless sensor that can be placed on crops to track heat, moisture,

and nutrients in the soil; and Ultrawideband, an emerging technology that can move huge amounts of data over short distances. The attendant prophecies sound transformative. "These technologies will usher in a new era for the wireless Web," *Business Week* declared last April. "They'll work with each other and with traditional telephone networks to let people and machines communicate like never before." Lost in such assumptions is a legitimate chance that even if unlicensed devices like smart radios become available to the public, regulators would compromise the potential of such equipment by, for example, imposing strict power limitations to avoid even the slightest chance of interference.

And then there are the economic realities. One of the groups fighting the hardest to open up the radio spectrum to unlicensed radios is the New America Foundation, a public-policy think tank in Washington. On its Web site, New America offers a minitreatise on solutions to our current spectrum woes and comes across as a voice of the people, advocating, among other things, "greater shared citizen access to the airwaves." Yet unlike many supporters of unlicensed radio, New America's vision contains a seed of economic prudence. Jim Snider, a research fellow there who specializes in spectrum issues, was quick to point out not only the "open" and "unmediated" nature of unlicensed radio but also the rising tide of interest from the venture capital community, which over the last two years has produced over 20 well-financed startups and a variety of new products.

Snider advised me to visit the offices of Shared Spectrum Company, a venture capital firm in Virginia that builds prototype frequency-agile radio transmitters (which hop from channel to channel across wide swaths of the radio spectrum, looking for quiet places to transmit) and whose efforts New America endorses. And so, on a stultifying day

in late July, I took a ride on the Metro out to Tyson's Corner, Virginia, the East Coast's consummate "edge city"—those hybrid constellations of retail, office, and residential developments near highway interchanges and an older, central city that are paragons of the new economy.

Shared Spectrum rented an office on the second floor of a building with tinted windows, across the hall from a travel agency called Vacation Station. When I arrived, its founder, Mark McHenry, accompanied by his lawyer, suggested we go to the roof so that he could show me what a vast, empty wasteland the supposedly crowded spectrum really is. On the roof, a young employee had set up an antenna and an expensive machine called a spectrum analyzer, a boxy device that sweeps through every radio frequency and displays, on a screen, how much signal strength, which McHenry referred to as "energy," is operating at each frequency. The four of us got down on hands and knees to watch the machine work. Zipping through swaths of spectrum, it immediately made clear why McHenry had such confidence in smart radios and why the prospect of building them had enticed him to leave a cushy job as a program manager at the Defense Advanced Research Projects Agency, or DARPA, the furtive technology arm of the Pentagon widely credited with having invented the Internet.

We zoomed in on the aviation band, where there was little activity. Then the TV band, where there were gaps all over the place. The military band, eerily dead. "There's basically nothing here," McHenry said. He beamed. "Once you accept the idea of frequency-agile radios, anything becomes possible."

Back inside, I asked if he (like Michael Powell, Dave Hughes, and Eben Moglen) thought that smart radios would empower people to become active participants in the creation of knowledge. I had assumed that McHenry, like

the folks at the New America Foundation, would see these gadgets as an egalitarian force. But his response—a slight shake of the head and a bewildered look—made me feel silly for asking.

Back in New York, I thought of something McHenry had told me about the U.S. military's plans to use spread-spectrum technology in warfare. I remembered his saying the word *robots,* and so I did some research and found what seemed like a good window into the nexus between technology and corporate and military power. DARPA, the outfit McHenry used to work for, is in the process of developing what it calls Next Generation, or XG, technology—the mother of all spectrum-sharing protocols—that will enable every unit on the battlefield to communicate by radio, over longer distances and with more ease of use than is currently possible. Using smart technology, XG radios will store the spectrum conditions for every country on Earth on a microchip and automatically conform to the conditions of the environment, avoiding the hassle of manually assigning frequencies to military radios during combat. Shared Spectrum is getting paid millions of dollars to help DARPA develop algorithms for XG radios. As I clicked further into the bowels of various military Web sites, I came across another organization, the Artificial Intelligence Center, which has a hand in several army projects, including TEAMBOTICA—radio-controlled robots that the army plans to use in reconnaissance and surveillance missions.

As I looked at pictures of the TEAMBOTICA robot on my computer, the words of Mark McHenry echoed in my ears: "Once you accept the idea of frequency-agile radios, anything becomes possible." Indeed. Eben Moglen and Dave Hughes had said essentially the same thing. With the exception of heavyweight spectrum incumbents like the broadcasters, who are unable or unwilling to concede the

end of interference, most everyone who talks about unlicensed radio uses the same vocabulary, although to radically different ends. For Moglen it is about democracy. For Hughes it is about connectivity. And for McHenry it is about money. His frequency-agile radios have already entered the military-industrial complex; someday soon, this technology will likely enter the civilian realm and forge a path not unlike the Internet, making a few people very rich, producing devices that we might come to see as indispensable but that in the end may or may not have much to do with freedom, personal or otherwise.