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THE EDITORIAL VIEW

Smartphone Spectrum Disorder

By Tom R. Halfhill {4/30/10-01}

Broadcast television in America, once described as a vast wasteland, now looks more like prime real estate. Or rather, the radio-frequency spectrum that broadcast TV occupies is the suddenly valuable property. So valuable that some people in the telecommunications industry want to seize all that RF spectrum for wireless telephony and banish terrestrial TV broadcasting to the dustbin of history.

Is broadcast TV obsolete? In-Stat estimates that only about 12% of U.S. households still rely exclusively on free, over-the-air TV. Everyone else subscribes to cable or satellite service. (Excepting a few hardy souls who have forsworn TV altogether.) Some say this dwindling minority of the frugal is expendable. Naturally, some of the folks who say it are in the wireless telephone business.

However, the real issue isn't the alleged obsolescence of broadcast TV. It's the shortage of high-quality RF spectrum for wireless data services—in particular, wireless services for smartphones and tablets. The wireless telcos and handset vendors are painting a marvelous vision of the future in which everyone carries a wireless device that delivers a dazzling array of features and services, including broadband Internet access and mobile video. Unfortunately, there isn't enough spectrum available to make the vision come true. It's a pipe dream without the pipes.

Advanced data services require much more bandwidth than voice calls, emails, or text messages. Watching one YouTube video pumps more data through the network than all the plain-text messages a person might send and receive in a year. AT&T says that data traffic on its wireless network has soared 5,000% since 2006—thanks, largely, to the popularity of Apple's iPhone, which only works with AT&T.

Google, which owns YouTube, says that streaming video already makes up 40% of traffic on the Internet and will rise to 66% within four years. Although wired networks can deploy more copper and fiber to keep up with demand, RF spectrum is a scarce resource, limited by the laws of physics.

And not just any RF spectrum will do. Higher-frequency spectrum lacks the range and penetrating power to blanket a dense metropolitan region with reliable service. Lower-frequency spectrum has the desired propagation characteristics but was allocated for other purposes decades ago. Smack in the middle of that spectrum is the airspace occupied by terrestrial broadcast TV.

Fewer Channels Are Likely

TV broadcasters in the U.S. already surrendered a big chunk of their valuable spectrum in the recent transition from analog TV to digital TV. They lost UHF channels 52 to 69, which the Federal Communications Commission (FCC) has auctioned off for other uses. Each TV channel is 6MHz wide, so this historic reallocation freed up about 108MHz. The broadcasters think they've done their part and want the telcos to look elsewhere.

But the telcos want an *additional* 500MHz of spectrum for commercial wireless services. Some industry sources are calling for 700–800MHz. Finding that much high-quality airspace will almost certainly require sacrificing more TV channels. There aren't many good alternatives.

One proposal is to raid the TV broadcasters again and take away UHF channels 40 to 51, or even channels 20 to 51. Proponents say this plan would leave enough airspace for the shrinking number of hardy viewers who can live with a dozen or so TV channels. But the takeaway would free up less than half the additional spectrum the telcos say they need. And TV broadcasters don't like the idea of surrendering more of their valuable spectrum to create wireless services that, increasingly, compete with their own programming.

Another proposal is to reallocate the "white space" between TV channels—unused blocks of spectrum that keep the broadcast signals from interfering with each other. TV broadcasters are wary of this idea, too. It could degrade TV reception, especially in crowded urban areas, where buildings cause multipath reflections.

Amputating the Rabbit Ears

Yet another alternative is to replace today's powerful regional TV transmitters with numerous lower-power transmitters. Multiple TV stations could share the same channels in the same area. But this plan would require TV broadcasters to make another major investment in new technology, only a few years after their huge investments in DTV. And it would free up only 100–180MHz, not nearly enough spectrum to support future wireless data services.

The most radical proposal is to end terrestrial TV broadcasting altogether. Everyone would have to subscribe to cable or satellite service or stream video over the Internet (wired or wireless). Even this drastic action would free up only about half the spectrum we supposedly need.

A related issue is net neutrality. If the government requires network providers to treat all traffic equally, they won't be allowed to prioritize different kinds of traffic or charge variable rates for different traffic. An urgent phone call or text message might be delayed by someone watching a YouTube video of kittens playing piano. CNN's streaming video might stall or stutter if it's interrupted by packets from an online poker game.

The whole mess is shaping up as an epic battle at the FCC, which tries to manage the public resource of RF spectrum for the public good. On one side of this battle are TV broadcasters and millions of viewers who still depend on free airwaves. On the other side are the wireless telcos and smartphone vendors and their millions of customers. The futures of two industries hang in the balance.

Old-Style Broadcasting is Efficient

Wireless providers are the relatively new kids on the block. They glow with the aura of trendy technology. What could be more fashionable than whipping out an iPhone or iPad and streaming any TV show you want, on demand? Or placing a live-video call anywhere in the world, using a pocket-size device that makes AT&T's prototype videophones of the 1960s seem like clunky computer terminals?

Smartphones and tablets can deliver many other services, too: broadband Internet access, streaming audio, online videogames, GPS navigation, and augmented reality. (See *MPR 12/28/10-02*, "Augmented Reality—And Larrabee.")

In contrast, terrestrial TV broadcasting seems so...20th century. It conjures a mental image of black-and-white TVs sprouting rabbit ears. It seems so old-fashioned that it's not even trendy enough to be retro.

Put fashion aside for a moment. Technically, broadcast TV is the most efficient way of distributing video to large numbers of people. One transmitter can blanket a metropolitan region with a penetrating signal that carries high-definition video and high-fidelity audio to millions of affordable receivers.

Broadcast signals don't degrade or slow down as more people tune in. Indeed, a larger audience helps defray the fixed cost of broadcasting the signal by exposing advertisers to more potential customers. This advertising-supported, one-to-many model has thrived for decades because it reaches the most people using the least equipment over the least amount of spectrum.

Unicasting is More Flexible

Telcos are pushing the unicast or pointcast model: each person receives a unique video stream. Even if two people watch the same TV show at the same time, each viewer gets a dedicated datastream of digital video flowing from the server through the network to the receiver. Although this method permits greater flexibility, adding more viewers tends to worsen performance. Sometimes an overloaded server or network stops working altogether.

For now, mobile users are tolerating small screens, low-resolution video, inconsistent frame rates, and frequent dropouts. Eventually, users will demand higher quality, especially if Internet Protocol TV (IPTV) makes significant inroads against conventional TV in the home. To match the quality of broadcast TV, a video datastream needs approximately the same amount of bandwidth, because both methods use similar data-compression schemes. Those schemes approach the compression limits defined by Shannon's law, so there's little opportunity for improving efficiency in that regard.

Furthermore, the unicast model requires much more infrastructure than the broadcast model. Instead of a single transmission antenna beaming a pervasive signal throughout a metropolitan area, modern telecommunications networks use thousands of switches, thousands of routers, thousands of miles of cable, and thousands of cellular base stations to connect millions of servers with millions of handsets.

The backhaul portion of the telecommunications network—the wired portion—is almost infinitely expandable (at a cost, of course). However, the final leg is wireless and limited to the amount of RF spectrum allocated by the FCC. Plus, it's a two-way network. Every receiver is also a transmitter, adding more complexity. Although TV stations aren't cheap, they're much cheaper than building a modern telecommunications network capable of covering an equal amount of territory.

I Want My MTV

Microprocessor Report has tried to calculate the maximum number of users who can simultaneously watch a TV show delivered as streaming video over 6MHz of spectrum allocated to a cellular telephone network. We sought the assistance of our colleagues at In-Stat who cover the telecommunications industry. This seemingly simple question provoked a lively debate, because there are numerous variables. The answer, more or less, is that two or three dozen people might be able to view unique video streams using about 6MHz of wireless network bandwidth.

In contrast, a TV station using the same amount of bandwidth can broadcast high-definition video to *millions* of people. DTV also allows a station to divide a 6MHz channel into subchannels, multiplying the capacity of the airspace when compared with analog TV.

However, comparing broadcast TV with streaming video is not straightforward. These technologies use spectrum in very different ways. Low-power cellular transmitters distributed throughout a metro area can share the same spectrum without stepping on each other's signals. So a cellular network can reach millions of users, too, though not as cost-effectively as a strong TV signal covering an urban area. No matter how we slice the spectrum, 20th-century broadcasting still looks more efficient than 21st-century unicasting—for reaching a mass audience.

The catch is the mass audience. Everyone watching a channel of broadcast TV must watch the same program at the same time. (Video recording does allow time shifting, but it requires a bit more effort.) Unicasting allows each viewer to watch a different program at any time.

Ultimately, the difference between the broadcast "push" model and the unicast "pull" model could be crucial. The additional cost and complexity of unicasting may prove irrelevant when weighed against the craving for video-on-demand. Even with hundreds of channels of cable or satellite TV programming available, today's viewers don't appear to be fully satisfied. They want a virtually infinite number of "channels" available at their whim.

In Step With the Zeitgeist

Unicasting may be more in tune with what the Germans call *zeitgeist*—the spirit of the times. Nowadays, the shared experience of watching the same TV program at the same moment seems as quaint as families gathering around a TV set on Sunday night to watch *The Ed Sullivan Show*. Today's viewers have a different attitude: "I want to watch *anything* I want, and I want to watch it *now*." (Even if it's a 50-year-old rerun of *The Ed Sullivan Show*.)

Satisfying those wants will require huge investments in telecommunications infrastructure and—most likely—major reallocations of RF spectrum.

The fairest solution, perhaps, is a global network extended with millions of femtocell wireless routers. These small, short-range routers connect cellphones to the nearest wired node, much as Wi-Fi routers connect PCs to the same network. Every home and office can have its own femtocell. The routers can hand off the wireless connection to a conventional cell tower if the mobile device wanders out of range.

Also, femtocell routers may be exempted from net-neutrality regulations. Already, consumers are buying Wi-Fi routers that let them prioritize local traffic for certain bandwidth-intensive applications, such as online games. That kind of traffic management at the backbone level will likely be outlawed under net-neutrality rules.

The femtocell solution seems fair because it shifts the cost of expanding the wireless infrastructure directly to the users who want video-on-demand and other advanced services. Just as most people buy their own Wi-Fi router, most people may buy their own femtocell router, perhaps with a telco subsidy.

Consider it another twist on pay TV. With almost 90% of Americans subscribing to cable or satellite service, an overwhelming majority of the public has already voted against free TV. Maybe the advertising-supported broadcast model is indeed obsolete. (Incidentally, I'm one of the hardy holdouts.)

Of course, quantity doesn't guarantee quality. An unlimited variety of streaming video may amount to yet another vast wasteland, as FCC chairman Newton M. Minow famously described American TV in 1961. But viewers will be able to waste their time on the programs of their choice, whenever and wherever they want. Addictions are expensive. ◇

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