Looking to Spectrum for Network Utopia

Dewayne Hendricks

What We Want

In network utopia, everyone will be connected across the digital divides of economics and geography. In network utopia, everyone will be connected with enough "bandwidth"—enough bits—that there will no longer be any impediment to innovation. Reaching network utopia may be possible by looking at where the most bits are: radio spectrum. Although spectrum has been treated like a scarce resource for almost one hundred years, today's emerging technologies are changing this situation. There is actually an abundance of spectrum—more than enough for everyone.

Where We Are

Today's communications technology is moving toward a world of all-digital transmitters and receivers. These advances in technology, combined with the swift evolution of mesh-based transmission and switching protocols, are opening up a new set of possibilities for unique new services utilizing intelligent wireless networks. These networks will contain smart transmitters, receivers, and switches. The Federal Communications Commission (FCC) has recently coined a term to describe these types of wireless devices: cognitive radios (CRs). Today's Internet is perhaps the best example of a self-regulating structure that embodies these new technological approaches to communications in the networking domain. However, to date, many of these innovations have not moved into the wireless networking arena.

Wireless networks of the future will likely involve a mixture of links and switches, of different ownership, that terminate at the end-user in the first mile via relatively short-distance links. What will then be required is a built-in, distributed, self-governing set of protocols to cause the network to make more efficient use of a limited, common shared resource—the radio spectrum. Creating such a self-regulating structure for the optimal sharing of spectrum will require much effort. A major problem that stands in the way of these new approaches today is the current FCC regulatory environment and the manner in which spectrum is managed and allocated under its rules.

One of the major hurdles encountered by a wireless entrepreneur who wants to develop innovative new communications products involving radio is access to the requisite amount of spectrum. Obtaining spectrum mandates the involvement of the wireless entrepreneur with the government, which immediately puts the entrepreneur at a disadvantage when compared with entrepreneurs in the computer sector, where government involvement is minimal. As a result, wireless innovation has occurred at a much slower pace, since the use of technologies such as spread spectrum (which is used in one of the Wi-Fi standards) requires more spectrum, not less, in order for their advantages to become apparent when used for high-speed data transmission.

The current regulatory approach to radio is based on the technology that was in use at the time the Communications Act of 1934 (the bill that created the FCC) was framed. Basically, this technology was what we would call today "dumb transmitters speaking to dumb receivers." The technology of that time reserved bandwidths to be set aside for each licensed service so that spectrum would be available when needed. Given this regulatory approach, many new applications cannot be accommodated because there is no available unallocated spectrum in which to "park" new services. However, given the new set of tools available to the entrepreneur with the advent of digital technology, what once were dumb transmitters and receivers can now be smart devices capable of exercising greater judgment in the effective use and sharing of spectrum. The more flexible the tools that we incorporate in these devices, the greater will be the number of uses that can be accommodated in a fixed amount of shared spectrum.

One of the most promising regulatory actions by the FCC in the last twenty-five years was its move in 1981 to permit the use of spread-spectrum technology in unlicensed devices. This proposal eventually resulted in a new type of wireless device that operates under the unlicensed Part 15 regulations and is deployed in what are called the industrial, scientific, medical (ISM) bands. More important, these devices are forbidden to operate at power levels greater than one watt, and their transmissions must be spread a minimum amount across the assigned spectrum.

Those restraints notwithstanding, the Part 15 regulations and later additions and changes to those rules have spawned the development, manufacture, and marketing of a wide range of "no license required" products. Because mass manufacturing has now started to occur, spread-spectrum products for data transmission from the several thousand current vendors no longer carry the premium price tags that had limited the technology mainly to large organizations, such as businesses, schools, and libraries. Today a radio that can handle Ethernet traffic (100 Mbps, suitable for high-speed computer communications) up to a distance of about 40 kilometers (25 miles) costs about $4,000. Devices with lower capability—with operation at T1 speeds (1.5 Mbps) to a range of 25 kilometers or so—cost less than $500. For very short ranges, such as for communications within a building, wireless local-area network (LAN) cards for PCs are priced as low as $50.

There is every reason to believe that these prices will drop further as manufacturing volumes increase to meet the growing market demand for higher bandwidth and secure wireless connections from PCs to the Internet. In the future, people may, for example, routinely rely on wireless transmission to reach a central system that would then connect to a traditional network of ground-based lines. Reliable, secure unlicensed data radios operating at T3 or higher speed to a range of more than 30 kilometers could soon cost less than $500 each. The current buzzword for the most prevalent of these new unlicensed devices is Wi-Fi, a shorthand for the various IEEE 802.11x standards. These devices can support communication at speeds of 2 to 100 Mbps, over distances from 50 feet to 30 miles. For example, in early January Apple introduced an 802.11g Wi-Fi base station that operates at 54 Mbps, supports up to fifty-five users, and costs $199.

Where We Can Go

The creation of a decentralized structure for the optimal sharing of the radio spectrum will require a substantial effort by a combination of telecommunications experts and entrepreneurs working with the various regulatory bodies around the world. The deployment and growth of such a system is achievable through increasingly "smart" wireless electronics with a built-in set of self-governing protocols. The early stages of this growth can be seen today as Wi-Fi device deployment is becoming more widespread.

This future is not from the realm of science fiction. The FCC is attempting to grapple with these issues in order to determine the regulations and policies that will affect the governance and use of spectrum for the balance of this century. In 2002 the FCC created a special task force on spectrum policy; the task force produced a report with recommendations on new approaches for spectrum policy and management, and the report has been released for comments from the general public. The comments that are submitted to the FCC on this report can play a significant role in guiding the hand of the FCC as it crafts a set of rules to implement the findings of the report.

Higher education has an important role to play as this process moves forward. Right now, in and around campuses across the country, these new wireless devices are being deployed in ever growing numbers—a trend that will only increase as the prices continue to drop. Already they are changing the way that students and faculty interact with one another. For instance, some schools are now considering banning the use of wireless networks in the classroom because they are often considered to be disruptive to the learning process. At other schools, these wireless devices are being debated as replacements for the wired telephone infrastructure currently being used, with the possibility of major cost savings.

As this regulatory process plays out, the higher education community needs to acquaint both the FCC and Congress with the uses to which these new wireless devices are being put and the benefits that can be realized as a result. Higher education will be on the "front lines" with many of these new wireless technologies. For this reason, as advanced radios are deployed, higher education can be in a position to best help the government tackle the crucial issues of incorporating both positive and negative incentives within the network infrastructure itself to make the best use of a shared common resource—the radio spectrum—and to move toward network utopia.

Dewayne Hendricks is CEO of the Dandin Group, located in Fremont, California. For the past four years he has been a member of the FCC's Technological Advisory Council.