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Broadband Cowboy

As Beltway bureaucrats keep America in the wireless Dark Ages, a spectrum revolt is brewing in the heart of Indian country.

By Brent Hurtig

Dewayne Hendricks will go awfully far out of his way to prove a point. He has mounted transceivers on rooftops in Mongolia and traveled to the South Seas to build a broadband network for the island nation of Tonga. His quest: to demonstrate the power of wireless technology - and the way the US government stunts its potential.

Hendricks isn't a government official, a telco CEO, or an engineer. Rather, he's a professional gadfly, who runs the Dandin Group, a consulting firm. With few qualifications beyond vision, chutzpah, and a hands-on mastery of wireless technology, he sits on the FCC's Technological Advisory Council, alongside a who's who of tech executives from AT&T, Cisco, WorldCom, and Lucent. He prefers to operate beyond the reach of US authorities, but his goal is nothing less than a fundamental reengineering of the national wireless infrastructure.

There's no sensible reason why Americans shouldn't have inexpensive, ubiquitous, high-performance broadband access, Hendricks says. Using technologies that are already available or in fast-track development, everyone could enjoy reliable, fully symmetrical wireless at T1 speed or better. No more digital divide. No more last-mile problem. No more compromises. The only things standing in the way are the FCC, Congress, and "other people who just don't get it."

Sitting in his cluttered home office in the Fremont hills above the San Francisco Bay, Hendricks exudes the runaway ebullience of a true believer. "People yearn for the way they communicate on Star Trek," the youthful 52-year-old says. He leans toward a coffee table neatly laid out with Trekker props and grabs one. "I need a communications paradigm shift," he exclaims, waving a toy Communicator, "so that anywhere I go, any time, I can move bits around."

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In its zeal to keep transmissions from interfering with one another, Hendricks says, the government reserves the vast majority of frequencies for exclusive use by public agencies, corporations, and groups like ham radio enthusiasts. This leaves too little spectrum to support wireless broadband as he envisions it. Moreover, the government restricts technologies - like spread spectrum, ultrawideband, and software-defined radio - that could enable everyone to share frequencies, a practice known as spectrum overlay. Until the government makes spectrum overlay central to its policy, he contends, wireless will be stuck in the Dark Ages.

So Hendricks is striking a match to light the way - and start a fire, if he can. At Turtle Mountain Chippewa Reservation in North Dakota, he's installing a wireless network. In its initial form, the system will meet FCC requirements governing frequency, power, and transmission technology. But not for long. Hendricks' mission is to build the best system possible - even if it's illegal - and he intends to use every tool at his disposal. Should the FCC crack down, the tribal leaders will hoist the flag of Native American sovereignty, asserting that they can do whatever they want with the sky above their reservation.

The sovereignty argument might win in court. It might lose. The FCC might not take the bait. Congress might intervene. Any of these outcomes would serve Hendricks' larger purpose: to create public pressure that will force the FCC to loosen its grip. "People on the outside are going to feel like cavemen when they see the tribes with these amazing systems," he says. "If the reservations can have them, why can't everyone?"

The reason is that there's not enough spectrum available. What might work well for several thousand people amid the uncrowded airwaves surrounding Turtle Mountain - 125 miles from Minot, North Dakota, the nearest American city - would be a lot trickier to deploy for the same number of people in Chicago, and currently impossible to manage for the city's entire population. The only way to deliver high-performance broadband to everyone, everywhere, Hendricks says, is to give all transmitters access to the full spectrum, or at least a lot more of it.

While they don't necessarily approve of Hendricks' strategy, many observers within the telecom community support his goals. "There's a hunger out there for much more spectrum,"says Colonel Mike Cox of the Defense Department's Joint Tactical Radio System program, which is developing software-defined radios. "We can't manufacture it, so we've got to better utilize what we have."

Turtle Mountain, a 6- by 12-mile patch of rolling hills and deciduous forest near the Canadian border, is home to some 11,600 Chippewa. Ramshackle trailers and decrepit cars dot the landscape. "Nearly a third of these houses don't even have telephones," Hendricks says, lodged behind the wheel of a rented station wagon. "We can bring the tribe advanced telecommunications using voice-over-IP technology."

Hendricks conceives Turtle Mountain's network as a perpetual work in progress that will evolve as he experiments with new gear and devises high-performance techniques for hooking it up. To date, he and his team have connected the Turtle Mountain Community College and a handful of other buildings. The system's backbone - currently four Western Multiplex radios that ring the reservation, one tapped into the college's T1 line - communicates with several prototype Motorola Canopy nodes scattered around the reservation. Practical throughput at the nodes is better than double that of T1, though Net access speed is limited by the T1 gateway.

Hendricks drives up to an out-of-use casino that houses some of the tribal government's offices. He pulls his husky frame out of the car and lifts the wagon's hatch. Inside is a tangle of wires and toaster-sized Canopy nodes, each containing an antenna, transceiver circuitry, and a modem.

"These things are practically plug-and-play," he says. "Just mount one on a rooftop, plug in an Ethernet cable from a router or a computer, align the node with an access point until the LEDs light up, and you're connected."

Turtle Mountain's system operates in the spectral zones known as unlicensed bands, the realm of cordless phones, garage door openers, and baby monitors. Within these bands, anyone can transmit without a license, though only at very low power, as specified by the FCC's Part 15 rules. Given the commercial incentive to make the most of these tiny slices of spectrum, Part 15 has proven an incubator for spread spectrum technology, such as Bluetooth and Wi-Fi.

A spread spectrum radio encodes a signal and distributes its power over a range of frequencies. A receiver that knows the code can recognize the transmission and reassemble the original signal. To other receivers, the transmission can look like low-level noise, allowing spectrum overlay. Spread spectrum nodes will be the next addition to Turtle Mountain's arsenal.

The Canopy unit under his arm, Hendricks heads for the old casino's server room. A note on the locked door reads BACK AT 2 PM. It's half past 3. He tramps back to the car looking peeved.

He gets a warmer reception at the brand-new Turtle Mountain Community College. There, the school's president, Carty Monette, proudly shows off the reservation's jewels: eager students, freshly painted classrooms, computers. And now a network that one day, he hopes, will deliver courses in job skills, Native American languages, and general subjects to every home in the community.

Turtle Mountain is part of a $6 million project sponsored by the National Science Foundation and administered by a nonprofit association called Educause. Its aim is to demonstrate wireless systems in colleges at four reservations on the northern plains. Although breaking the law isn't part of the charter, a letter distributed to tribal colleges in July 2000 acknowledged the possibility of trouble with the FCC. "Wireless technology raises questions about who controls the spectrum on reservations," the letter says. "Campuses that are interested in participating in the project need to demonstrate awareness that there could be problems with the Federal Communications Commission, local telephone companies, and others."

"Find a country with less regulation and show the rest of us what can be done. We laughed, but sure enough, he did" - namely, Mongolia.

The reason for the caveat is straightforward, according to Educause project director David Staudt. The technology is new, and making it serve the reservation's needs may require bending the rules.

In fact, Jerry Vaughan, deputy chief of the FCC's Wireless Telecommunications Bureau and the agency's point man for Native American affairs, says the commission would consider waiving any regulations that impede Hendricks' broadband rollout. "I applaud anybody who's trying to get telecommunications onto reservations," he says. "That's not to say I agree with all of his methods."

But conflict is exactly what Hendricks is looking for. "We made a deal," he says. "In exchange for a state-of-the-art wireless network, the tribe is willing to go to the mat with the FCC to assert its sovereignty."

The US government already recognizes Native American tribes as sovereign nations. Whether sovereignty extends to the airwaves, though, is an open question. "Our reservation boundary goes into the ground and up to the sky," asserts Richard Monette, Turtle Mountain's tribal chair and Carty's brother.

Stanford law professor and tech activist Lawrence Lessig agrees. He's assembling a pro bono legal team to defend the tribe's rights. "As long as there's no real interference," he says, "the tribes have the absolute right to control how spectrum is used in their territories." Lessig's certainty isn't just blind optimism. In a June 2000 policy directive, the FCC promised to deal with tribes on a "government-to-government basis."

But that directive is often misinterpreted, Vaughan points out. "The problem with wireless is that it doesn't go to the border and stop," he explains. "That's why it's under control of the FCC."

The issue won't be resolved before Hendricks makes his move. Someday soon - he won't say when - he'll toss the first stone. He might open some Canopy nodes and boost their transmission power, or he might install an unapproved software-defined radio. It doesn't really matter. He's just hoping the FCC will react when his pebble hits its window. If not, he'll lob a bigger stone, and a bigger one, until he shatters the glass and forces the government into action. Then, he says, "We throw down the sovereignty card, and the endgame begins."

Dewayne Hendricks was 12 years old when a friend's father in his middle-class Detroit neighborhood showed him a ham radio. He watched the meters and listened to the static, and he was hooked. His own dad refused to pony up for a rig, so he launched a precocious end run: He built one out of discarded television sets and a surplus Army radio. "I earned my ham radio operator's license before I was 13," he says.

He received a BS in psychology from Detroit's Wayne State University in 1970, but he spent his spare time noodling with the school's IBM mainframes. Three years later, he became assistant director of the computer center at Southern Illinois University, where Buckminster Fuller was on the faculty. The celebrated technologist was working on his World Game, a competition designed to develop solutions to intractable real-world problems such as hunger and pollution. The World Game was played in regional workshops, and Hendricks saw a way to link them in real time. "Cost-effective landlines didn't exist," he explains, "so we used ham radios to send data around the world."

Ham-style datacasting became the focus of Tetherless Access Limited, a company Hendricks cofounded with partner Charlie Brown in 1990, after stints at Amdahl, IBM, and Apple. To make his products fly, Hendricks needed more spectrum than the unlicensed bands allowed. He joined the Wireless Information Networks Forum, a lobbying group.

WINForum gave Hendricks his first taste of the regulatory process. The organization began with the common goal of implementing long distance wireless networks. But soon, he recalls, it became "usurped by the big boys - telcos, radio manufacturers, and others - who pushed us aside to stick their snouts in the trough."

Dispirited, Hendricks turned to Henry Goldberg, WINForum's high-powered attorney. Sparring with heavyweights might be a waste of energy, the lawyer suggested. Instead, he proposed a strategy that Hendricks calls the Goldberg protocol.

"Advances in wireless technology are more likely to come from people like Dewayne than from the big companies," Goldberg explains. "So I said, Find a country where there's less regulation and show the rest of us what can be done. We laughed, but sure enough, he went out and found a country."

Namely Mongolia, where Communist rule was coming to an end. Seeking to promote democratic values - and spur overseas business for American manufacturers - the US State Department and the National Science Foundation had contracted wireless guru Dave Hughes to bring Internet access to the North Asian nation. Hughes recruited Hendricks, and in November 1996 the erstwhile lobbyist found himself in the capital city of Ulan Bator, scrambling to get five universities, the public library, and the US Embassy online before the snow fell. Within a month, Hughes recalls, "Kids were able to ride their ponies to the library and surf the Net."

In 1998, Crown Prince Tupouto'a of Tonga was looking for an enterprise worthy of a progressive-minded potentate. Eric Gullichsen, cofounder of Sense8 (a pioneering virtual reality shop) and Tonic (Tonga's .to domain-name registry), had heard of Hendricks' exploits and introduced the two men. The crown prince proposed a $13 million, four-year plan to bring wireless Internet, telephone, and video delivery to the South Pacific kingdom.

"Tonga was my ace in the hole," Hendricks says. "I could deploy anything I wanted." Word spread to Washington about this Indiana Jones of wireless, and in 1999 he was appointed to the FCC's Technological Advisory Council. With a free hand in Tonga and the government's attention, Hendricks was ready to wield the Goldberg protocol as an instrument of change.

Suddenly, in August 2000, the project fell apart for reasons neither side will discuss. As it happens, Hendricks had already scoped out his next Goldberg protocol test bed. "I learned about an FCC initiative to improve communications services on Indian reservations," Hendricks recalls, "and it dawned on me that 561 sovereign nations were close at hand." As his hopes for Tonga faded, Hendricks booked a flight for Turtle Mountain.

A spectrum "commons" will spur new technology and more efficient use of the airwaves. Over time, it would encompass much of the radio spectrum.

FCC regulations create an essential contradiction: scarcity amid plenty. "In New York City on September 11, there wasn't enough spectrum to go around," says Motorola chief technology officer Dennis Roberson, also a member of the Technological Advisory Council. "Yet, if you had

looked at the airwaves using a spectrum analyzer, you would have seen that most of it was unused." Desperate transmissions flooded the bands allocated to cellular services as well as police and other emergency uses, while other bands remained silent.

Spectral congestion has been an issue ever since 1934, when Congress founded the FCC to curb thousands of radio stations' taking advantage of cheap equipment to broadcast on the AM band. Demand for spectrum has kept pace even as technology made it possible to extend the usable spectrum and pack the airwaves more densely. Today, everyone agrees that the FCC's way of managing the airwaves needs reform. "Put simply, our nation's approach to spectrum allocation is seriously fractured," FCC chair Michael Powell admitted at a press conference in late October. The question is how to fix it.

Lawrence Lessig has an answer. Like a public park, he argues, the spectrum should be treated as a commons, freely available to all. Interference might be a problem at first, as it was with early cordless phones. But users would happily pay for developments that improved reception, and - just as spread spectrum technology gave cordless phones greater range - new technology would use the airwaves more efficiently. In fact, spread spectrum is the first test of Lessig's idea. It requires a commons, if only the modest one allowed under Part 15.

The FCC, however, remains worried that unlicensed access to the full spectrum would yield only cacophony. "If you have many spread spectrum transmitters in the same location, the overall noise level will rise," warns Bill Lane, chief technologist at the FCC's Wireless Communications Bureau. "At some point the cumulative noise will become hazardous" - keeping an ambulance en route to a hospital from radioing a patient's vital signs to waiting doctors, for instance.

Without conducting large-scale tests, there's no way to know for sure. Nonetheless, Hendricks has faith that, given enough spectrum, spread spectrum technology is sufficient to make the commons viable - and if not, other technologies can lend a hand.

Ultrawideband, for instance, has been used by the military in radarlike applications for years and is currently under consideration for civilian use. Ultrawideband systems blanket a broad swath of spectrum with impulses of extremely short duration at infinitesimal average power levels. Because they're very weak, these impulses tend not to interfere with other broadcasts.

Hendricks also touts the potential of dense-packet radio networks. In a highly regarded graduate thesis, MIT's Tim Shepard demonstrated that the carrying capacity of a wireless system could grow as it expanded, accommodating millions, possibly billions of simultaneous transmissions. In Shepard's scenario, each node acts as a relay. The closer one node is to the next, the less power it takes to send information. Nodes in close proximity could transmit on the same frequency without hampering each other.

Finally, the overlay capabilities of spread spectrum, ultrawideband, and dense-packet networks could be fine-tuned by software-defined radio. This technology enables a transceiver to change operating parameters such as power level, frequency, and communications protocol. In a variation known as cognitive radio, the Defense Department is working on models that monitor the airwaves and reconfigure themselves to maximize performance and minimize interference.

Hendricks doesn't champion any particular technology. What matters, he says, is creating a regulatory environment in which these innovations can find their rightful place.

As the afternoon wears on, Hendricks waits outside Turtle Mountain's FM radio station. He's in a prickly mood. Earlier today, he had to convince the unenthusiastic station manager that high-speed Internet access would benefit her operation. Now he's ready to install a Canopy node, but there's no ladder. What's more, the technicians who stood him up at the old casino still haven't called in. "Indian time," he mutters.

The real hitch in Hendricks' timetable, he concedes, is bureaucrat time. No single court case, no one government directive, no amount of public enthusiasm will overturn the FCC's approach to spectrum management all by itself. Just as the reservation must be wired one node at a time, regulatory reform can proceed only incrementally.

Pressed to describe the path ahead, Hendricks resorts to a threadbare Trek shibboleth: "To boldly go where no man has gone before." Which is to say, once he has sparked the debate over spectrum management at Turtle Mountain, he'll be off to kindle the flame somewhere else, leaving the job of building the commons to others.

Motorola's Roberson offers one view of how it might happen. A necessary first step, he says, would be to bring the FCC in line with the National Telecommunications and Information Administration, which oversees the airwaves on behalf of the military, and the Department of Commerce, which harmonizes US regulations with those in other countries. Allocations are always shifting as needs change and communications technology advances. When portions become available, a unified spectrum-management authority could throw them into a pool for common use. Over time - a decade, in Roberson's estimation - the commons would encompass much of the radio spectrum.

At the tribal FM station, a technician returns with a ladder. Within minutes, the node is up and Hendricks is running tests. The station is online, and the Turtle Mountain's network is one step closer to the inevitable illicit tweak.

Up on the ladder wrangling cables, Hendricks is in a rare jubilant mood. He recently got a call asking if he might like to install experimental wireless systems at the South Pole. The path to Washington has taken stranger turns.