COMMUNICATIONS

ACROSS THE GREAT DIVIDE

The Alberta SuperNet is a model for the broadband future—everywhere

BY STEVEN M. CHERRY

WINNER

Nowadays, Pam Martin is facing challenges well beyond anything she was trained for in teachers' college, just a few years ago. Since September, she has been starring in a multimedia extravaganza.

Besides the fresh, eager faces in front of her, there are ones she can only see in the two television monitors facing her. When a student leans forward to ask a question, he might be sitting at a desk a hundred kilometers away. When she turns to face him, she has to look at a camera high on the back wall of her own classroom. And when she asks him to come up to the board, it's really to an electronic whiteboard in his class that's connected to an identical one in her classroom by the same high-speed network that joins the cameras and television monitors.

This pedagogical spectacle uses more than a million dollars in equipment for just six schools in the district—or division, as the Canadians call it—of Fort Vermilion, in the western province of Alberta. Martin and her colleagues are now teaching students in up to four classrooms at once, many of whom they've never met face to face. It's the decades-old dream of long-distance learning, come to life here in the remote Canadian outback, thanks to a remarkable new communications network called the Alberta SuperNet.

The SuperNet is one province's determined attempt to create a high-speed telecommunications backbone throughout a land mass bigger than the Iberian Peninsula but with fewer people than Albania. When it's completed, sometime after July, it will tie together 1300 schools, hospitals, and libraries and just about every dot on the map of Alberta—422 dots in all. SuperNet won't itself be an Internet service provider. Rather, it will provide raw network connectivity via the Internet protocol—the fundamental global standard for moving around packets of data.

What's more, SuperNet will let Internet service providers connect to its broad backbone at excellent rates and guaranteed levels of service, making it likely that in a few years, nearly every Albertan will have megabit-per-second broadband access, even

TODD KOROL

BRIGHT LIGHTS, SMALL CITIES: Lorne Taylor, former provincial minister of innovation and technology, conceived of SuperNet as a fiber-optic bridge between the bandwidth-poor rural regions of Alberta and its technologically advanced cities.

WINNER: ALBERTA SUPERNET

GOAL A telecommunications backbone covering the entire province of Alberta, Canada, including 1300 government facilities in 422 communities

WHY IT'S A WINNER SuperNet bridges the digital divide, puts schools and hospitals online, and makes it easy for Internet service providers to enter even the smallest of towns and villages

ORGANIZATIONS Bell Canada, Axia NetMedia, Government of Alberta

CENTER OF ACTIVITY The entire province of Alberta

NUMBER OF PEOPLE ON THE PROJECT 249, across the three organizations

BUDGET US $145 million

in towns with only a few hundred inhabitants. Yes, places without cellular phone service, cable television, or even copper telephone lines good enough to feed a 56-kb/s modem will be able to offer broadband service at rates and prices that would be the envy of Tokyo, Helsinki, or New York City.

And that's precisely the point. The 21st century has dawned with Tokyo having more telephones than all of Africa, and Finland boasting more Internet hosts than Latin America. Countless analysts have lamented the so-called digital divide that separates not just rich and poor but also urban and rural into Information Age haves and have-nots. As the chasm yawns ever wider, rural and remote communities struggle to keep their talented young people educated, employed, and entertained, in hopes of stemming the same sort of brain drain that funnels many of the best and the brightest from poor countries to rich ones.

Now the SuperNet, with its combination of fiber optics and relatively inexpensive radio-based long-distance links, reliance on the Internet protocol (IP), and most of all, its ingenious business model, offers the best blueprint yet for a bridge over that digital divide.

Although the SuperNet isn't quite finished, it's easy to see how it is going to transform life in Alberta. And the beneficiaries won't be just Web surfers, teachers, and students—although it's hard to overstate the advantages of effective distance learning in a school division where some schools are a three-hour drive apart, where the two "big" towns have fewer than 4000 residents, and where the closest sizable city, Edmonton, is nine hours away by car. Hospitals will use the SuperNet to send X-rays to a radiologist instantly, bypassing an eight-hour helicopter ride or a three-hour narrowband modem transmission. The connections will be fast enough to let an obstetrician in Edmonton watch a high-definition ultrasound image in real time, even if her patient is hundreds of kilometers away.

SuperNet will also be a boon to Alberta's critical oil and gas industry, which is spread throughout the farthest corners of the province. Vocational schools in Calgary and Edmonton will feed multimedia digital pipelines that offer instruction in welding and other desperately needed trades to 17-year-old apprentices who will be able to live at home instead of making the lonely move to the big city, where, all too often, they fail. In their off hours, those same teenagers will use those same data pipes for interactive television and video games, in communities too small for cable TV to ever be profitable.

Getting a high-speed telecommunications network into the remotest of Alberta's remote communities took skillful engineering but, even more important, unique cooperation between government and business. So SuperNet is really two networks that operate as one. The base network, owned by Bell West Inc., in Vancouver, B.C., a subsidiary of Bell Canada International and Manitoba Telecom Services, is nearly complete. It will link Alberta's 27 largest cities with a multigigabit fiber-optic backbone that pushes the limits of what Bell would have built anyway. The connections of the remaining 395 towns to the base network, and to one another, make up the extended network, paid for by a CA $193 million (about US $145 million) investment of the provincial government.

Both the base and the extended networks rely completely on IP, increasingly the standard for bundling up packets of data of all kinds and sending them through all manner of network pipes. Though it was originally designed specifically for Internet traffic, such as e-mail and file transfers, network designers are coming around to the idea that IP can replace traditional digital telecommunications standards, such as the synchronous optical network and asynchronous transfer mode protocols that still dominate telco networks. SuperNet's province-wide embrace of IP is a starting point for its bold plunge into telecom's future.

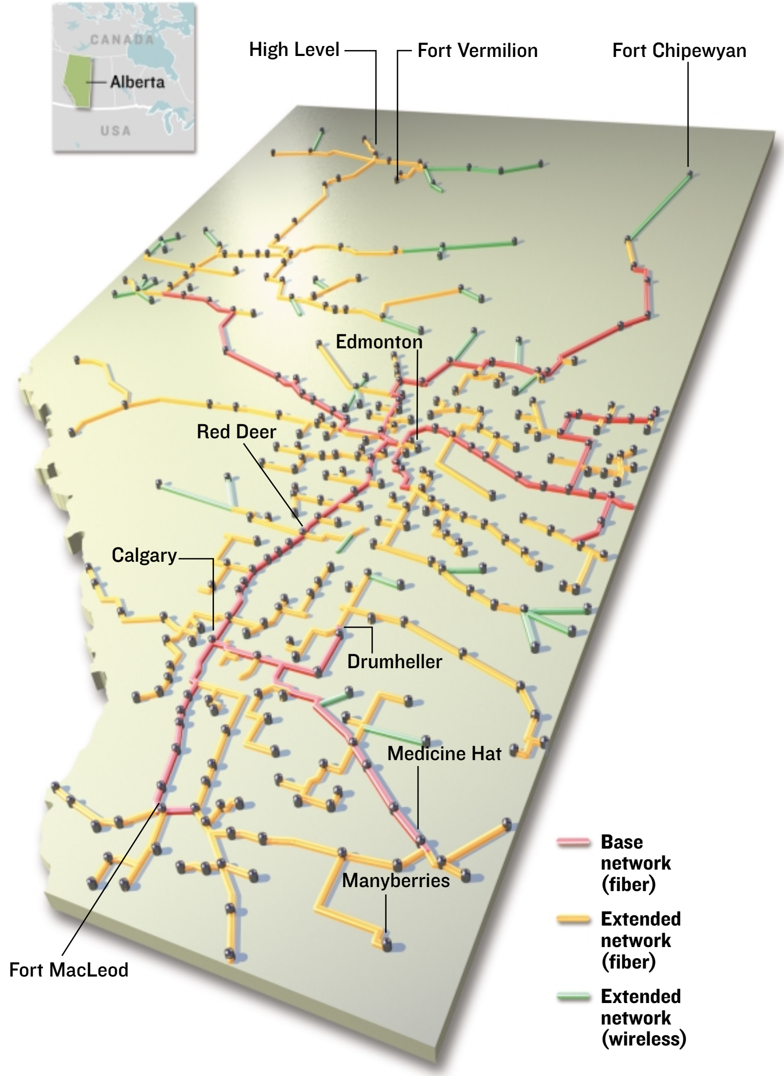
Although the provincial government is financing the extended network, the details of the business arrangement make it a far cry from past government-funded attempts to span the digital divide, which have always fallen into two categories. In the first, the government builds a network, which quickly becomes second-rate (if it doesn't start out that way), because there's no ongoing revenue to keep it up to date. In the second, the government picks a winner, usually the local telecom monopoly, to offer broadband access. But that has problems of its own. Unless required to serve remote areas, the company doesn't. It refuses to allow Internet service providers onto the network, because it's in competition with them. And monopolistic control invariably leads to high rates.

SuperNet, on the other hand, carves out a new path between those two extremes. Bell, Canada's largest communications company but not the local monopoly in Alberta, is building the extended network. The government, having paid for it, will own the extended network, but a local company, Axia NetMedia Corp., Calgary, will control customer access to the entire network.

Axia will give Internet service providers and others a single point of contact for connecting to the network at any location. Monthly rates will be the minimum needed to provide enough revenue for continued investment and upgrading—CA $50 per guaranteed Mb/s. That's almost as much capacity as the traditional T-1 connection of 1.5 Mb/s, which can be as much as 10 times as expensive.

Those rates will be low enough that Internet service providers can themselves charge customers low rates for full Internet access, even in communities where customers are few and far between. Though the network is government owned, having its own revenue stream makes it independent of unsustainable subsidies. This economic model may prove to be SuperNet's greatest legacy, and it may help shape the future of education, medicine, telecommunications, and entertainment, from Fort Vermilion to Tokyo to Helsinki.

How did a land that borders the Canadian Rockies and the Continental Divide come to be the place that may very well have bridged the digital divide? And how did it manage to steer clear of the pitfall of attempting to pick telecom winners and losers? The answer starts with Canada's odd telecommunications past, and how it allowed the government to pit one large carrier against another.



SCENES FROM A NETWORK: The Alberta SuperNet's 10 000 km of optical fiber [above, red and yellow] and 3000 km of high-speed wireless links [green] will be completed sometime this year. In the field, a truck rolls out conduit near Fort MacLeod [left, top], 165 km south of Calgary. A classroom in remote Fort Vermilion [left, center] is taught by a teacher in High Level, 85 km away. Students there will soon be able to remotely visit the fierce albertosaurus [left, bottom] and other dinosaurs at the Royal Tyrrell Museum in Drumheller, when the museum joins SuperNet later this year.

GOVERNMENT OF ALBERTA; ROYAL TYRRELL MUSEUM/ALBERTA COMMUNITY DEVELOPMENT

Telephony in Canada developed regionally—no single national colossus emerged early in the 20th century to dominate the industry, as happened in Europe and the United States. Eventually, a single company, Bell Canada, in Montreal, rose to ascendance in the eastern provinces. In the west, a similar consolidation wasn't complete until 1998, when the monopolies in British Columbia and Alberta, the two richest and most populous western provinces, merged into a single company, Telus Corp., Burnaby, B.C. The existence of two thriving telecom giants set the stage for SuperNet's business plan by enabling one, Bell, to bid for and win a contract to build a key network in the middle of a territory dominated by the other—Telus.

Equally essential is Axia's role as operating and access manager: it's not in Axia's interest to keep anyone off the network, as could be the case if Bell, or the government, controlled access. That's particularly important because SuperNet isn't itself an Internet service provider. Nor is it a telecommunications provider of any sort, not even to the 1300 government facilities that are served through a separate CA $169 million 10-year services contract between the province and Bell.

Internet service providers operate at the highest level of a network—Layer 7 on the standard OSI (for Open Systems Interconnection) model of networking. (Confusingly, it's also called the ISO model, having been adopted by the International Organization for Standardization.) SuperNet provides only what's sometimes called Layer 3 access, referring to the third-from-the-bottom level. It's more than just a physical connection between machines, but much less than Internet access.

The physical network resides at the bottom of the model, Layer 1, a lifeless world of dark fiber and the electronic devices we plug it into. The next layer up, the data-link layer, dictates how data is routed on the network—whether, for example, each device waits its turn to communicate or, if they don't, how the inevitable data collisions are adjudicated. The data can be anything that can stacle, but powering the probes and getting them networked are problems still to be resolved, says Michael Simpson, a principal investigator with the Molecular-Scale Engineering and Nanoscale Technologies Research Group at the Oak Ridge National Laboratory in Tennessee. "To me, it all comes down to the kind of power and communications [used in GEMS]," he says.

Storing a lot of energy in such small objects would be hard, Simpson notes, and RF communications require a lot of power, not to mention a sizable antenna. A probe transmitting in the gigahertz range, for instance, would need a centimeter-sized antenna, an enormous flagellum for such a tiny probe. An alternative might be employing optical technology, but that would require a type of line-of-sight communications, making things much more complicated.

Then, too, disseminating invisible probes all over the seven continents would certainly raise a number of political, environmental, health, and privacy-related concerns. Would other countries accept U.S.-invented invisible and intrusive devices falling on their territories? Would the probes be harmful to the environment or to anyone unfortunate enough to breathe them in? Would society accept these tiny sensors floating around monitoring weather variables—and some would ask, who knows what else?

Nevertheless, the idea of having a self-organizing network of tiny sensors that can monitor their surroundings—"smart dust," as some people call them—has a number of interesting applications. Examples include monitoring chemicals in a factory or troops on a battlefield.

In the same way, GEMS might prove invaluable for tracking other localized events, like a hurricane approaching the Florida coast. GEMS data could then complement the information collected with weather balloons, satellites, airplanes, ground-based radars, and other equipment.

A technology like GEMS "enters into the complex composite of observing systems that we have [and] adds a capability, if we can make it work well," says Alexander MacDonald, director of the Forecast Systems Laboratory, the leading meteorological research and development lab of the National Oceanic and Atmospheric Administration, in Washington, D.C.

In MacDonald's view, researchers should focus on larger devices that they could actually build and release in a thunderstorm or in areas where there are few observations being made, like over the oceans.

That is indeed how the project seems to be evolving. "The near-term objective," says John Manobianco, who is leading the study at ENSCO, "would be, say, in the next five years, to design prototypes and actually test them and release them over limited areas."

For monitoring things like hurricanes and thunderstorms, GEMS might become a very valuable technology. But the leap to a global scale poses huge technical, political, and cost barriers, making the idea of a planetary network of speck-sized flying probes more likely to disappear in the air—like dust. ■

be digitized—telephony, cable television, or Internet traffic. Ethernet, the protocol SuperNet uses, is one of several possible data-link layer protocols.

On Layer 3, information is bundled into sophisticated packets that can be sent to specific destinations, such as Internet addresses. This is the assembly-line world of the Internet protocol, where routers move packets of data like firemen of old passing buckets down the line. The next three layers are used for error correction and reliability, direct communication between two machines, and encryption and data compression. Finally, at Layer 7, data emerges as something recognizable to the telecommunications applications we all know and love the Internet for—file transfers, e-mail, and the Web.

In effect, having the Layer 3 access that SuperNet provides means you can send IP packets across the Internet. A budding ISP would also need some sort of last-mile connection to its customers—copper wire, coaxial cable, or some sort of wireless coverage. It would need equipment to connect to the local SuperNet point-of-presence—3-by-4-meter shacks where customers can attach their networks to SuperNet. (If equipment has to be collocated—placed within the shack—an additional charge is levied.)

Finally, an ISP needs e-mail and Web servers, to provide those services to customers. But because SuperNet is, in effect, one giant wide-area network, those servers can be anywhere—back in Edmonton or Calgary, or Tokyo, for that matter.

Internet connectivity is, in fact, the least of an ISP's costs, but it's also the one least within an ISP's control. Whereas there are many competing companies offering more or less equivalent servers, routers, and application software, often there's only one choice for Internet access, and many small towns don't even have that. Axia, as the access manager, actually has an incentive to add new ISPs and other wholesale customers to the network—its revenues increase with network traffic.

The complex partnership of SuperNet, divided as it is among the government of Alberta, Bell, and Axia, is essential to its success, and is distinctively Albertan. As Axia chairman and CEO Arthur R. Price puts it: "Government isn't in the business of being in business."

Besides that philosophy, SuperNet happened to be in the right place at the right time: the government was running surpluses in the go-go late 1990s. But that money could have gone in any number of different directions. To explain how it ended up being used to pave over the digital divide, Grant Chaney, chief technology officer for the province, credits his former boss, Lorne Taylor, who represents the Medicine Hat area, in the province's southeast. He's now the provincial minister for the environment, but during the time SuperNet was hatched, Taylor headed the ministry of innovation and science.

Taylor, a Ph.D. former professor of psychology and part-time cattleman, has an academician's willingness to rethink first principles and a businessman's impatience to just get the job done. There's egotism and altruism as well—a disconcerting way of starting with what's right in front of his face and writing it as large as Alberta itself.

Why, he asks, should Manyberries, a town of about 200 people, 90 km down the road from Medicine Hat, have any less opportunity than Calgary? "In fact," he adds, "there's no library there, no movie theater; maybe it should have more." Even the city of Medicine Hat, a regional center, could have better connectivity. "Broadband would have come to Medicine Hat anyway," Taylor says. "But when?"

FIBER TO THE HOME

As every Internet surfer knows, broadband is good, broader band is better By Steven M. Cherry

HOLY GRAIL The broadest broadband, of course, is optical fiber, the only medium capable of moving data at multigigabit-per-second speeds. It's fiber that will ferry us into a future of thousands of television channels, videoconference telephony, movies on demand, distance learning, telemedicine, and a digital record of every sight and sound around us.

We've known this for two decades. Yet only rarely is an existing residential connection being refurbished with fiber. That will soon change—in fact, the pace of fiber installation is expected to pick up dramatically in the next few years.

This past summer the three largest U.S. telecommunications providers, Verizon, SBC, and BellSouth, agreed on a common set of standards for residential fiber-optic networks. That congruity is expected to lower costs and unleash a tidal wave of spending—Verizon alone reportedly has plans to embark on a 10- to 15-year US $20 billion to $40 billion upgrade of its fiber-to-the-premises networks.

The reason? Competition from cable companies, who already have more than three million customers in the United States getting telephone service as well as television over their cables. While coaxial cable can't match the gigabit potential of fiber in the long run, it's more than enough for the short term. Comcast Corp., in Philadelphia, the largest U.S. cable provider, is already upgrading some customers to a 3-Mb/s Internet service—roughly six times the speed of the phone companies' garden-variety digital subscriber line (DSL). That's in addition to the hundreds of television channels traveling down the same pipe.

One place to see telecom companies fight back is Iowa, a state where tiny telephone companies are the rule instead of the exception. Take the Huxley Communications Cooperative. Just a few years ago, the company, which provides telephone, cable television, and Internet access to one region of the state, upgraded the copper and coax of the eponymous town of Huxley,spending about $800 per home. But last year, it went with fiber all the way to the premises of every single customer in two neighboring towns, Slater and Kelley, despite an average cost of $2000.

The network upgrade has increased revenues, due to new cable and high-speed Internet accounts. It has also lowered maintenance costs. Yet an investment in fiber can still take as many as five additional years to be paid back. That's because, however puny, 1-Mb/s DSL or digital cable connections meet most customers' current needs—the gigabytes-of-content future is at least a few years away. Savvy telecom consumers aren't eager to spend more on the new connections without compelling applications running through them.

So a high-speed infrastructure is one thing, and high-speed service is another. Though the residents of Slater and Kelley now have the latest in pipes, their service is, for now, limited by their provider to classic DSL speeds. Still, as they say in Iowa, if you build it, the applications will come. ■

As it happens, when Taylor was ready to take on Alberta's digital divide, the province was flush with drilling royalties from the overheated economy of the mid- to late 1990s. "We were lucky," Taylor says. "We had the $193 million to invest."

SuperNet is just one aspect of Alberta's technocentric future—the province is funding research and development in a number of information technology areas—but it's the part that will benefit its citizens directly. Even the wireless sections will enjoy data rates exponentially greater than those of many wired networks elsewhere—155 Mb/s to start. That's enough bandwidth for 2000 simultaneous telephone calls, or tens of thousands of Internet customers.

In fact, the wireless portions of the network were the greatest concern. "Back in 1997, wireless technology wasn't as straightforward as it is today," Taylor says. "We knew that there were areas in the province where you couldn't run wires. We weren't sure they could be served at all." Serving them, though, was critical—without it, Taylor could have never gotten his legislative colleagues to share his vision. "One of the ways I sold SuperNet was as a rural development scheme," he says. As it was, it took almost two years to go from concept, to request for proposals, to legislative appropriation.

Even in 2004, SuperNet's wireless connections are no sure thing. They require the very latest in radio electronics and more. They are taxing Bell's civil engineering skills, as well as those of its prime subcontractor for the wireless legs, Morrison Hershfield Ltd., Toronto. Nowhere is that more evident than in the province's far northeast, where all the major connections are wireless. And the most taxing are a pair of wireless shots that bring the extended network to Fort Chipewyan, a swampy region of 1400 hardy denizens that claims to be the oldest non-native settlement in Alberta.

Bringing Fort Chip, as people call it, into telecom's 21st century is proving to be hard for a geographical reason: water. The swamps and streams that flow in and out of nearby Lake Athabasca were a godsend for the trappers who first explored and settled the area, traveling, as they did, in bark canoes. All that water is anything but helpful, though, to SuperNet, or to the company that's designing and building its 3000 km of wireless connectivity. Basically, the ground is too soggy to efficiently install and maintain fiber in it.

Water isn't the only reason the network segment to Fort Chip is wireless. The town lies on the edge of Wood Buffalo National Park; construction within the park is prohibited. Even outside the park, environmentally sensitive marshlands are a breeding ground for sedges of whooping cranes, herds of bison, and other threatened species. Laying fiber is out of the question. So the radio link into Fort Chip comes from a promontory, Birch Mountains, 120 km away.

That 120-km wireless shot, probably the longest in North America—and perhaps anywhere else, at its capacity—would be a challenge even for a wired connection. The SuperNet design calls for the long-haul radios to be the network equivalent of a land network's optical carrier Level 3 (OC-3) data rate of 155 Mb/s.

The radios being used for these long SuperNet connections, from Alcatel SA, Paris, France, can handle that speed. Unfortunately, they were designed to transport data using the synchronous optical network (Sonet) protocol, not the Ethernet protocol that SuperNet uses. The two are, essentially, different protocols operating at the second-from-the-bottom level, the data-link layer, of the seven-layer network hierarchy.

Sonet (or the equivalent international standard, synchronous digital hierarchy) is the traditional protocol for digitized telephony.

It's as fundamentally different from Ethernet as serial and parallel electrical wiring.

The Morrison Hershfield engineers will run Ethernet on top of Sonet at a cost of some inefficiency. The data will first be made into packets for Sonet and then repacketized for Ethernet. It's as if someone in your office mailroom noticed that a bunch of letters were destined for headquarters and packed them up, envelopes and all, in a FedEx box. The Sonet "envelopes" would be wasted bytes of data.

According to Morrison Hershfield electrical engineer Jack McMullen, a bigger problem is something called multipath fading—basically, a signal's interfering with itself. As a radio signal travels between two antennas, it can take multiple paths. Some go directly through the atmosphere, others bounce up off cloud layers or down onto wet or smooth ground surfaces, like ponds or especially flat areas of land.

The problems are worst, McMullen says, at dawn and dusk. The result is a distortion of the signals, or, in the worst case, complete cancellation. Think of, say, a rock concert in a sports arena. Sometimes you can hear the music twice as it fills the hall, once from the front, then a moment later from the back. If you sit at exactly the right spot, the two can even effectively cancel one another out—resulting in a dead spot where you can hardly hear anything.

The problem is especially great at higher frequencies; lower frequencies are less prone to severe multipath fading. So the Morrison Hershfield design engineers can step down from the 8-GHz band to 6 GHz, which they've already done for the Fort Chip shot. They can even go down to the 2.1-GHz band (all three are frequencies for which SuperNet already has licenses), but doing so would also mean lowering the data rate to 45 Mb/s. That's a huge decrease, 70 percent, making it the solution of last resort.

The engineers' mathematical model of the radio signals' 120-km path from Birch Mountain to Fort Chip is part science, part art, and part educated guesswork, based as much on topographical maps and field surveys as on device specs and discussions with their counterparts at Alcatel. The winter installation clock is ticking, so in late November they stopped their calculating and were ready to start building.

The benefits that Fort Chipewyan will soon gain are already being enjoyed in Fort Vermilion, in the northwest corner of the province. There, an archipelago of SuperNet is already up and running, self-contained, unconnected to the rest of the network until later this year. Pam Martin and her colleagues there are already teaching their multiple-location math and other classes to schoolrooms connected by optical fiber, some of which had been put in the ground several years ago by Telus, the incumbent phone company. Telus never used it, and sold it to SuperNet in 2002.

The most important job of a telecommunications network is to collapse distances. So SuperNet could hardly come to a more apt location—at 250 000 km^2, Fort Vermilion is one of the largest, most thinly populated school districts in North America—the size of five Denmarks, says Ken Dropko, the division's superintendent. It takes three hours or more to drive from the mostly aboriginal and mixed-immigrant communities of the northwest to the Mennonite settlements in the southeast.

Before SuperNet, the only way to collapse distances was by ordinary telephone. As recently as last spring, Martin was trying to teach her advanced high school math classes remotely, without the benefit of eye contact, by audio-only conference calling. "It didn't really work," she says. "I had no idea what the students did and didn't understand, or even if they were paying attention. I found out once that two kids had been playing chess."

While not the first school division to be "SuperNetted," Fort Vermilion is the first to multicast classes—teaching two or more remote schools at the same time. Superintendent Dropko can't wait to be connected to the rest of SuperNet. "We're arranging with the University of Alberta to have some courses for our teachers," he says. "And we want to expand our apprentice welding program. Right now, we pair them up with experienced welders for the practical part of their apprenticeship. But then they have to go to Edmonton for the theory. Many of them don't do well. They're off in the big city, all alone. The First Nations kids have it especially hard—theirs are very family-oriented cultures. We think we can do the theory part with SuperNet."

There's also the matter of a relatively new regulation requiring that schools make a variety of second languages available to students. Besides French, which is Canada's official second language, that might include German, for the Mennonite families who want their children to learn it. "Or Spanish," Dropko says—there are Mennonites in Bolivia who have been re-emigrating to the area. With SuperNet, the district's Spanish teachers could be in Edmonton—or Bolivia.

A mathematical model of the radio signals' 120-km path is PART SCIENCE, PART ART, AND PART EDUCATED GUESSWORK

Distance learning mainly flows from the large to the small. Martin's math class, which is sent from High Level, a town of about 4000, to Fort Vermilion and three even smaller schools, is typical. Occasionally, though, it goes the other way. In another school division, in central Alberta, a forestry class is taught to kids in the relatively large city of Red Deer (population: 68 000) from the small town of Rocky Mountain House, one-tenth its size. Though the towns are only 85 km apart, before the course the kids in the "big" city knew almost nothing about "Crown [state-owned] forests"—in fact, most hadn't even heard that phrase before.

It's hubris, or worse, to think that large cities have nothing to learn from rural areas. New Yorkers, for example, grow up thinking they live near the best dinosaur museum in the world, the American Museum of Natural History. But that distinction might very well go to the kids in Drumheller, about 140 km east of Calgary, home of the Royal Tyrrell Museum. Built on the site of many of North America's most significant dinosaur excavations, the museum is a marvel, and it will be on SuperNet early next year.

When that happens, schoolchildren throughout Alberta will eventually be able to tour the museum online, gaping remotely at its bone-plated stegosaurus, terrifying tyrannosaurus, and equally fearsome home-grown albertosaurus. Schoolchildren in New York, though, won't have the bandwidth. New York needs a SuperNet as much as Alberta does. We all do. ■