The K-Net Development Process: A Model for First Nations Broadband Community Networks

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Abstract

The Kuh-ke-nah Network (K-Net) is a community network that currently comprises 60 First Nations communities across Ontario, and Quebec, Canada. K-Net Services is the telecom and ICT arm of Keewaytinook Okimakanak Tribal Council (the Northern Chiefs), an organization located in northwestern Ontario that brought the original vision of K-Net to life amongst the Tribal Council's six member communities in the mid 1990's.

Currently the telecom infrastructure under K-Net control comprises a C-Band Public Benefit transponder, IP video conferencing and telephony, web and email server space, and a variety of terrestrial and wireless links that effectively connect small, scattered First Nations communities with each other as well as the wider world. In the space of less than a decade, these K-Net communities have gone from a situation in which it was common for there to be but a single public payphone in a settlement, to the point where forty of these communities have broadband service to most households. This level of service exceeds that commonly found in large urban centres such as Toronto.

But K-Net is far more than a provider of basic carriage services. Rather than be a seller of products, it is a facilitator for First Nations organizations and communities. In this capacity it brokers relationships among various agencies to provide a wide range of public and civic services in remote communities (e.g. telehealth applications, Industry Canada's First Nations SchoolNet, the Keewaytinook Internet High School (KiHS), personal homepages and email addresses, video conferencing and webcasting/archiving of public events). It thus constitutes a (nearly) full-spectrum, vertically integrated service provider oriented to meeting the social and economic development needs of its primary constituents.

First Nations community ownership and control over local loops means that each community can adapt broadband services to address local challenges and priorities. For some communities, the priority is creating residential telephone access or cable plant for entertainment purposes, for others it is promoting education opportunities and public health online, and for others it is economic development. This aggregation of demand from disparate users creates economies of scale and allows the dynamic reallocation of bandwidth to meet social priorities (high school classes, remote eye examinations, residential connectivity). While a reflection of the technical savvy and political acumen of its initiators, K-Net's success also derives from its adoption of core principles rooted deeply in the traditional First Nations values. This is seen in its decentralized structure, which encourages resource pooling, knowledge sharing, and respect for local autonomy. Together these values support community-driven needs and objectives to shape the network and its applications.

This paper traces the evolutionary trajectory of K-Net development and examines the advantages and drawbacks to the emerging model of telecom service provision in which K-Net is a pioneering exemplar. First, it chronologically charts the expanding set of relationships among the heterogeneous key actors across the public, private and civil sectors. Then it reviews the contemporary situation of K-Net, how the combination of such vital factors as community ownership/control, bandwidth aggregation and dynamic allocation, local (ICT) skills development, and social-needs orientation interact with each other and are operationalized within this network of relations. Finally, the paper draws some preliminary conclusions about the principles and viability of this model, likely future development, and the prospect that it offers a workable model for other community networking initiatives, especially in traditionally underserved areas.

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Introduction:

This paper describes the current situation and development process of the Kuh-Ke-Nah Network (K-Net), a regional network of more than 60 aboriginal communities and related points of presence, clustered around northern Ontario and Quebec. K-Net primarily serves a "high cost serving area"[1]. Its primary constituents are remote and sparsely populated First Nations communities that inhabit the Sioux Lookout district, an area of northwestern Ontario that spans 385,000 square kilometres. There are 25 First Nations communities in the district, and only one has fulltime road access. When the town of Sioux Lookout is included (pop. 5336), the district's total population reaches approximately 20,000. This gives it a total population density of approximately half a person per square kilometre. Indubitably, distance and isolation have shaped the fabric of this society. The challenges of its geography have also made it a rigorous test case for telecommunications. K-Net is the most recent, and possibly the most significant test. It poses the option of a locally owned regional public telecommunications system, and through its extensive employment of broadband applications, the promise of a First Nations network society.

For the past 30 years, efforts have been made to address the salutary role of public telecommunications in the Sioux Lookout district. In the mid 1970s community radio became a prominent catalyst for regional news and public discourse (Cf. Wawatay 1974, Hudson 1977, Mohr 2001). By the mid 1980s communities were building local cable plants and receiving public satellite television broadcasts from Wawatay (out of Sioux Lookout), TVOntario, and the Canadian Broadcasting Corporation. By the mid 1990s

[1] The Canadian Radio-television and Telecommunications Commission (1998) defines a "high cost serving area" as an area where the telephone company's monthly costs to provide basic telephone service are greater than the associated revenues that the telephone company receives for providing the service

commercial satellite television and the multi-channel universe had expanded to most northern Ontario residences. But a critical element was missing.

Despite the advances in broadcast media, what continued to be needed were affordable two-way linkages between the communities, and with the outside world. Only within the past five years has residential telephony become a reliable utility for the district's remote First Nations[2]. Until 2000, there have been pockets in the district where a single public telephone served populations of 150 or more. In some cases no telephone lines existed at all. It is from this context of a communications gap between communities (and with the outside world) that K-Net emerged[3] to stake its claim as a new model for public telecommunications in the district and beyond.

But K-Net was not originally conceived as a telecommunications model. When it emerged in 1994, it was a tool meant to address a pressing social need shared by the First Nations communities of the Sioux Lookout district. Conceived by the education advisory service of Northern Chiefs tribal council, K-Net began as a Bulletin Board System (BBS) that enabled high school students from the tribal council's six remote First Nations communities[4] to text message with family and friends back home. The students were based in Sioux Lookout, living eight months of the year on their own. They felt isolated and alone. Through the BBS they could let their home communities know how they were

[2] Following the Canadian Radio-television and Telecommunications Commission's 1999 decision on "high cost serving areas" (99 – 16), incumbent telcos had to provide plans to deliver touchtone phone service and the ability for toll free Internet connections to remote areas such as the Sioux Lookout district.

[3] Even with the advent of an improved public switched telephone network (PSTN) in the district, affordable linkages between communities continue to be sought. The majority of First Nations pay long distance charges to make connections outside their communities.

[4] Northern Chiefs' First Nations are Deer Lake, Fort Severn, Keewaywin, McDowell Lake, North Spirit Lake, and Poplar Hill. First Nation is a contemporary term used to designate an Indian band registered with Indian and Northern Affairs Canada (under the *Indian Act*, R.S. 1985). Each First Nation or Indian band occupies its own reserve, and participates in local governance through the auspices of a band office directed by an elected Chief and Council. Tribal councils are voluntary organizations that assist and advise groups of First Nations in service areas such as health, education, public works, and economic development.

doing and have them do the same, on a regular basis. The project rapidly gained support across the district. By the end of 1995, all 25 First Nations communities of the Sioux Lookout district were participating (Fiddler 1997).

Since that initial experiment, K-Net has been a rallying point for innovation, partnership, and autonomous telecommunications development (Cf. Ramirez 2000). Originally conceived as a 'stay in school' BBS, K-Net steadily evolved to what is now a scalable, carrier class network that serves broadband applications to 40 First Nations communities (and counting). The objective of this paper is to describe the patterns of development that facilitated K-Net's rapid transformation of public telecommunications in the Sioux Lookout district and partner communities.

In the first section of this paper we present a chronology of the network followed a general overview of K-Net's current manifestation (circa 2005). The network chronicle breaks K-Net down into four phases of growth. At each phase we describe K-Net's dominant characteristics, its partners, and the projects that lead to further growth. Our contemporary overview of K-Net comprises the most substantial portion of this paper. It includes a description of the socio-economic challenges that inhabitants of the Sioux Lookout district face, including health, education, employment, and the cost of amenities and transport. We believe it is important to qualify the everyday stresses and costs that shape this society in order to be capable of discussing the network's potential salutary effects later on in the paper. Following this we break down the organizational structure of K-Net Services, the network manager and catalyst of K-Net's innovations. K-Net Services is a unique organization based on informal teamwork and longstanding community ties. It works closely with the communities and maintains efforts to

decentralize operations for their benefit. Following this discussion we address the arrangement by which community partners operate local loops within K-Net. K-Net's operations rely on a distributed network of community technicians. Due to the high turnover of technicians, K-Net Services and its partners have had to find ways to embed an IT knowledge base in the communities. A variety of network solutions are used. K-Net also exhibits a decentralized applications development process. K-Net Services enrols community champions who act as local primers for applications development and community based innovation. Champions articulate social needs, contribute local vision, and mobilize extensive contacts on behalf of Northern Chiefs. In return, they receive access to pooled resources and have a tangible influence on applications development (from ideas to evaluations). Following our discussion of the local loop, we address the current situation of K-Net's aggregated business model and leading network applications. The aggregated business model is K-Net's primary assurance of sustainable revenue. It specifies how communities and partner organizations share costs to make K-Net's broadband services affordable in a high cost serving area. We conclude this section with a special focus on K-Net's applications for telecommunications, health, and education. We contend that these applications emerged in response to critical social needs in the Sioux Lookout district and northwestern Ontario, needs that K-Net Services understood well as a branch of Northern Chiefs tribal council. Without a basis in these needs K-Net would have had little buy-in from the communities to entertain broadband development.

Following the general overview of K-Net's current situation we present an account of its development process. In this second section of the paper we draw examples from Northern Chiefs' early projects with regional Bulletin Board Systems and

compare them to later projects in telecommunications, health and education to suggest recurring patterns of development in K-Net's evolution. Our main point of emphasis is that Northern Chiefs' K-Net Services enabled its constituent communities to pool resources, share expertise, and maintain autonomy over the development process. We propose that these three patterns form the blueprint of Northern Chiefs' approach to community networking: 1) Pooling resources enables the communities to sustain broadband services in a high cost serving area. 2) Sharing expertise enables the constituent communities to build a local IT sector and maintain local loops by their own initiative. 3) Autonomy enables the communities to manage local loops as they see fit (e.g., as an enterprise, or public service), and elicits their participation to determine applications and network services that reflect local social needs. Each of these patterns fosters decentralizing tendencies. They are contrasted by the needs of the network manager to ensure equitable access to limited bandwidth and credible funding sources. The creative tensions that ensue require a development process that is neither too flexible nor too rigid, but opportunistic in its endeavour to link the tropes of grassroots initiative with those of external funding agencies (i.e., policy frames that may or may not be relevant to the social needs of constituent communities). We believe the tribal council blueprint resonates with development roles recently proposed in (Wilhelm 2004). Despite having emerged from a particular First Nations context, at a particularly opportune moment in Canada's Connectivity agenda, K-Net's development process should be recognized as a model for remote and rural public telecommunications.

The claims made in this paper are based on an extensive archive of documents, videos, and other electronic media that K-Net Services has maintained over the past ten

years. Much of this material is online and available for the public record. Northern Chiefs has made a commitment to document its operations and development through the tools of the network. It upholds a policy to share grant submissions, project evaluations, and publications freely over the Web. The diagrams, images, and maps in this paper belong to K-Net Services. We also benefited from reviewing a portion of K-Net's extensive videoconference archive. This archive captures meetings, consultations, and training situations amongst staff, community representatives, and various stakeholders. This paper is also based on extensive interviews with K-Net Services staff and members of communities in the Sioux Lookout district. Since 2003 we have maintained an ongoing dialogue with staff at K-Net Services, which continues to enrich our understanding of the network. Visits to the Sioux Lookout district in 2005, conducted by Brian Walmark of KORI and Adam Fiser of CRACIN, helped inform and clarify our understanding of K-Net's role in the communities.

This paper is a preliminary contribution to the Canadian Research Alliance on Community Innovation and Networking (CRACIN), a three-year project to study community-based information and communications technology initiatives. CRACIN is funded by the Social Sciences and Humanities Research Council's Initiative for the New Economy (www.cracin.ca).

Section 1: Overview

1.0 Placing the Network:

The Sioux Lookout district is part of the Nishnawbe Aski Nation, a political territory that includes 53 First Nations across Northern Ontario.

On the map to the left, the 25 Sioux Lookout district First Nations communities occupy the northwestern portion of Ontario, and include, from the legend: Sandy Lake (an independent band), and communities represented by four tribal councils – the Independent First Nations Alliance, KO/Northern Chiefs, Shibogama, and Windigo. The communities are remote. Some are only accessible by air. For others, a temporary winter road links them to a southern supply corridor during the months of February and March. Without winter roads it costs from CAD$400 to CAD$1000 to make a one-way trip by chartered aircraft to the nearest town Sioux Lookout (Ont.), or the larger cities of Thunder Bay (Ont.) and Winnipeg (Man.).

Populations in the communities vary between 100 and 2000 people. District tribal councils and Statistics Canada calculate that 50 per cent of the district's First Nations population is below 20 years of age, and that less than four per cent of the population is 60 years of age or older (Cf. Ramirez 2000, Statistics Canada 2001). Although English is spoken by most of the communities (especially the generations below 30 years of age), their indigenous language is Oji-Cree or Cree. The indigenous languages are primarily

oral but a version of syllabic script exists and is taught in many of the communities' elementary schools.

Figure 2.
Syllabic Keyboard layout produced by K-Net Services http://www.knet.ca/keyboard.html

Health, education, and employment are critical issues in the Sioux Lookout district and Nishnawbe Aski Nation. With regards to health, there are not enough general practitioners and specialists to treat and monitor patients in their home communities. A number of long-term health challenges are common to the district. Type II diabetes mellitus has reached epidemic proportions (Young 2003). Health professionals also consider heart disease, obesity, and addiction to be particularly prevalent chronic conditions in the district (Smylie 2001). All of these conditions require continual assessments, therapies, and lifestyle coaching. In addition, mental illness is a major concern. Depression and suicide have become a serious burden on the society, especially amongst generations under twenty (Cf. Smylie 2001; McKenzie et al. 2002). Self inflicted injuries and attempted suicides have been documented in the Sioux Lookout District as the most common injuries to young people aged 10 to 19 years of age (Whalen & Johnston 1995). To obtain adequate treatment and support for these critical health issues patients have to fly to Sioux Lookout, Thunder Bay, or Winnipeg for hospital care and therapy. The Northern Chiefs and its partners have invested over CAD$9M in K-Net's telehealth applications with the hope that they will enable a substantial portion of consultations and therapies to be performed over the network, so patients can stay at home.

With regards to education, there are not enough teachers and staff to handle the needs of First Nations students in the Sioux Lookout district. Recent tests have demonstrated that from grades one to eight, First Nations students in the district are, on average, at least two grades behind the average Ontario student in vocabulary, reading, and math (Sioux Lookout District Education Planning Committee 2003). Many of the students tested also demonstrated special needs that district schools are ill equipped to handle, including deafness, speech impairments, dyslexia, and foetal alcohol syndrome. The students who embark upon high school face further obstacles. Once they graduate from elementary school, they will leave their communities for boarding schools in Sioux Lookout or Thunder Bay. Many are unprepared to deal with the resulting independence of living away from home eight months of the year, and drop out.

Employment in the communities is significantly low and temporary. Government services and natural resource industries (forestry, mining) are the biggest employers. Jobs tend to wax and wane with the cycles of short-term grants, pilot programs, and seasonal work. Individuals working in this kind of environment tend to be self-reliant, flexible, and possessive of a variety of skill sets to match the cycles of employment. In 2000, Northern Chiefs assessed the unemployment rate for its six communities to be at around 36 per cent. In the community of Sandy Lake, the largest community of the Sioux Lookout district (pop. 2000), 75 per cent of residents receive social assistance (Brown 2005). As a result of high unemployment, on top of a high cost of living, residents in the communities continue to maintain traditional economic practices, e.g., hunting, trapping, and gathering. Depending on the season, these traditional practices take priority in the communities, and it is not uncommon for local schools and offices in the district to

regularly close to accommodate weeklong activities. The addition of a community network does not in itself improve employment conditions for the majority of community residents. It has however, introduced new skill sets and an IT knowledge base that K-Net Services and its community partners have worked hard to locally embed. It also creates a potential for vocational e-learning applications. We will address the employment opportunities and knowledge base introduced by K-Net in our discussions of the local loop, aggregated business model, and education applications below.

Amenities come at a high price to the communities. For example, in Deer Lake First Nation (pop. 900), the cost of electricity is $0.85/kilowatt hour. To illustrate the ramifications of this cost, Deer Lake's elementary school has 100 computer workstations. A flat panel monitor is about 40 watts running. Each computer is about 100 watts running with hard drive and heavy CPU usage. The 100 workstations may therefore generate 14 kilowatts at a cost of $11.90 an hour. This illustration does not include the cost of printers, faxes, servers, switches, scanners, IP phones, and other devices in the community. The cost of flying food in from the south raises the cost of living tremendously. For example, in Sandy Lake, a box of cornflakes costs CAD$9.19, three bananas CAD$2.56, a pack of 12 processed cheese slices CAD$7.69 and two tomatoes CAD$4.15 (Brown 2005).

Obviously these various stresses and costs affect the attitudes and beliefs of First Nations peoples in the Sioux Lookout district. A 2001 survey of First Nations communities conducted by Indian and Northern Affairs Canada found that Ontario First Nations residents had the most negative outlook on their standard of living amongst First

Nations in Canada (2001: 34). However, residents of Ontario First Nations were also most likely to affirm that they could get the support they need from their communities.

We have found that this resolve to affirm the support of one's neighbours has been a strong influence on how K-Net operates. Communities share knowledge, pool resources, and work together to tackle the stresses of their environment. Through the potential of locally controlled telecommunications and Information Communications Technology (ICT), the hope is that First Nations can better face the challenges of life in remote and isolated communities as part of a regionally integrated network society. This potential was recognized by the First Nations leadership as early as 1994, and harnessed for community development by Northern Chiefs and the K-Net Services team. Northern Chiefs strives to accomplish this vision based on a development process that focuses on local revenues, local long-term employment, and locally driven applications.

1.1 Network Society:

The Kuh-ke-nah[5] Network (K-Net) is a carrier class broadband network. Now in its tenth year, it has become a national aggregator for communities and regions. Indeed K-Net is the oldest and largest aboriginal network of its class in Canada.

At the heart of K-Net is a terrestrial network of 23 remote First Nations in northwestern Ontario (occupying the Sioux Lookout district), linked to a satellite network of 14 fly-in First Nations and Inuit communities in northern Ontario and Quebec. An additional 11 First Nations have points-of-presence in central and southern Ontario.

K-Net also maintains points-of-presence at a number of urban sites that are important to northern Ontario aboriginals, including Sioux Lookout, Thunder Bay,

[5] Kuh-Keh-Nah is an Oji-Cree word meaning "Everyone Together" or "Everybody" as in "Everybody's network".

Timmins, and Toronto. These sites are centres of administration for health, education, business, justice, and governance. They are hubs for lateral movements across regional territories in the north. They also maintain valuable supply corridors to and from the north. They include First Nations councils, social service organizations, and regional government offices.

Moreover, K-Net is a link in an emerging national aboriginal network. It facilitates multipoint videoconferencing and Quality of Service for counterpart networks in British Columbia, Alberta/Saskatchewan, Manitoba, Quebec, and the Maritimes. Its members have virtual access to aboriginal communities across Canada, including First Nations and related organizations near Vancouver (BC), La Ronge (Sask.), Winnipeg (Man.), Thompson (Man.), Wendake (PQ), Kuujjuac (PQ), and Sydney (NS).

Figure 3.
K-Net provides QoS for IP videoconferencing and other high-speed network applications as part of a national network of aboriginal and urban sites.

With the integration of remote First Nations, regional hubs, and national aboriginal organizations, K-Net is the backbone of a robust and complicated aboriginal network society. For researchers, as for the participants, the implications of all these various levels of connectivity are emergent and unpredictable.

1.2 Network Chronicle:

Our reading of K-Net's evolution identifies four distinct phases of growth. To orient the reader, this section briefly reviews each phase. The first phase spans from 1994 to 1996.

During this period K-Net was a regional Bulletin Board System. The second phase spans from 1997 to 2002. During this period schools involved with K-Net began to access the Internet. The third phase begins in 1999. That year school connectivity began to migrate to other public institutions. The fourth phase begins in 2001. That year K-Net became a broadband network, and residential access schemes started to appear.

K-Net began in 1994 as a 'Stay in School' BBS for the Northern Chiefs' six communities. An initiative of the Northern Chiefs' education advisory service, it received support from the Sioux Lookout Aboriginal Area Management Board and Indian and Northern Affairs Canada. By 1996, schools from all 25 communities in the Sioux Lookout district had access to K-Net's regional BBS. There was no Internet access offered by K-Net during this period, and all of the online connections went through dialup over the public switched telephone network (e.g., Bell Canada for the Sioux Lookout district). Schools dialled long distance and paid an average rate of CAD$25.00 an hour during peak times. At best they were achieving download speeds up to 14.4 kbps. Very remote schools that were offline had floppy disks periodically flown out to Sioux Lookout where the BBS server was updated with messages, and vice versa. It made a strong impression that no community wanting to participate would be left behind.

From 1997 to 2000, K-Net Services partnered with Industry Canada's First Nations SchoolNet, Telesat and the Stentor Alliance to install DirecPC/MSAT technology in schools. This gave the schools enough bandwidth to download web graphics and image files. Although the Stentor Alliance disbanded in 1999, First Nations SchoolNet and Telesat continue to be strong K-Net partners. During this period, K-Net Services began to provide Internet connections to the schools (via Telesat and the

Education Network of Ontario), and email service over the BBS. Through First Nations SchoolNet the schools paid approximately CAD$30.00 a month (plus ISP charges) for unlimited access, at download speeds up to 400 kbps (over a bandwidth resource shared by participating First Nations schools across Canada). DirecPC/MSAT units continued to be operational in some communities until 2002. In 1997 K-Net Services also began to receive support from Industry Canada's Community Access Program (which ended in 2004) to establish public access sites in communities.

In the Spring of 1999, a partnership with Industry Canada FedNor enabled K-Net Services to add a second MSAT unit in each of the six Northern Chiefs communities. From that time onwards FedNor would prove to be K-Net's greatest ally, contributing approximately CAD$14M from 1999 to 2005, and liaising on behalf of the Northern Chiefs with other Industry Canada programs and federal departments. The additional infrastructure in 1999 enabled band offices, nursing stations, constabulary, and other public institutions to internetwork with the school and access the Internet. From that time onwards K-Net was the backbone of a functional Wide Area Network. 1999 also saw the Sioux Lookout districts local incumbent Bell Canada begin a series of infrastructure upgrades, which would amount to approximately CAD$15M in investments and allow K-Net to establish a terrestrial broadband network two years later.

In 2001, K-Net became one of Industry Canada's SMART Demonstration Projects (Cf. Ramirez et al. 2003) for which it received CAD$4.6M in development funds, and technical advice from Communications Research Centre Canada[6]. SMART stands for Satellite Multimedia Applications Research and Trials. It was intended to

[6] Communications Research Centre Canada, an agency of Industry Canada, is the leading federal laboratory for research and development in advanced telecommunications.

demonstrate broadband community networking, and design prototype e-government services in a variety of urban, rural, and remote settings. This event would prove to catalyze K-Net's evolution into a competitive telecommunications model. Support leveraged from project partners, including matching funds from Fednor and the Northern Ontario Heritage Fund, upped the ante to CAD$9.36M over three years. It enabled K-Net Services to order T1 services from Bell Canada for five of the Northern Chiefs communities and establish high-speed satellite services for its most remote community Fort Severn. A year later, this experience with Fort Severn would lead K-Net Services to partnerships with Telesat and Industry Canada's National Satellite Initiative under the C-Band Public Benefits Transponder agreement. A logical extension of SMART, C-Band would help connect over 22 remote First Nations in the Sioux Lookout district at a total investment of CAD$13M. Through the SMART project and C-BAND, K-Net Services developed high-speed applications for telecommunications, health, and education. Videoconferencing units proliferated to participating communities, which enabled virtual band office meetings, regional conferences, and two-way applications for health and education. Moreover, with broadband, residential access finally followed. The ensuing years to the present have seen K-Net expand broadband services to 40 communities in the Nishnawbe Aski Nation.

1.3 K-Net Services:

K-Net is managed by K-Net Services, the telecom and ICT branch of Keewaytinook Okimakanak tribal council (an Oji-Cree word meaning Northern Chiefs). The Northern Chiefs maintains offices in Balmertown, Fort Severn, and Thunder Bay. K-Net Services maintains a network headquarters in Sioux Lookout, with staff in Balmertown and

Toronto. Maintaining such a distributed organization across these communities would not be feasible without K-Net. The network's circuits are collocated in Toronto at 151 Front St, a carrier hotel/data centre for over 150 international telecommunications companies. Through the carrier hotel, K-Net can negotiate access to Bell Canada, Telus, Allstream, CANARIE, and more. The carrier hotel also connects K-Net to Sunnybrook Hospital's Northern Ontario Rural Tele-Health Network, and the Education Network of Ontario (where it was previously collocated).

The core members of K-Net Services have worked together since the mid-1990s. Informally, they work in two teams. One team comprises a fulltime network manager, network systems analyst, and three network technicians. The network manager currently coordinates network services between the Northern Chiefs, K-Net communities, and other clients (e.g., government services, tribal councils, municipalities, businesses). He worked in a number of First Nations communities in Saskatchewan, Manitoba and Ontario. He has been an auditor and telecommunications engineer prior to joining K-Net Services. As network manager he is responsible for the overall design, implementation, and technical operations of the network.

The Network Systems Analyst designed K-Net's network architecture with the Network Manager. He monitors performance, and supervises upgrades and repairs of the network. He designed an embedded Linux distribution that K-Net employed to route DirecPC satellite technology during its second growth phase from 1997 to 2002 (peeweelinux.com). Prior to joining K-Net Services he operated a satellite TV installation and repair service out of Sioux Lookout. The Network Systems Analyst is currently training an assistant who will eventually replace him. The assistant, a member

of Eagle Lake First Nation, is the newest addition to K-Net Services. He studied computer systems at St Lawrence College in Kingston, and in previous work developed a community cable modem management system. Two technicians, one a member of Flying Post First Nation, and the other a long time resident of Sioux Lookout, operate K-Net's toll free helpdesk. The helpdesk serves all the K-Net communities and supports Ontario schools participating in Industry Canada's First Nations SchoolNet program. It is a line meant to help K-Net users troubleshoot hardware installs, virus protection, network failures, and the like. Alongside helpdesk duties, the technicians operate K-Net's call manager system for VOIP, and support the communities that employ K-Net's videoconferencing facilities. They also provide hardware and software maintenance.

The K-Net Services Coordinator oversees service delivery, special projects, and network applications. He directs the second informal team. He works closely with the Northern Chiefs' other branches in health, education, economic development, public works, justice, finance, and administration to mobilize ICT use policies and network applications for these areas. Prior to joining K-Net, the Services Coordinator worked with Contact North and Wahsa Distance Education Centre, two distance education programs that made inroads to northern Ontario First Nations during the late 1980s and early 1990s. He has cultivated extensive ties with area First Nations, neighbouring tribal councils, federal, provincial, and municipal governments, regional organizations, colleges, universities, and many other partners across Canada and abroad. He directs a team that consists of a Business Manager, a Graphic Designer, and a Multimedia Applications specialist.

The Business Manager, controls staff payroll and accounts. She is a status Indian

living on an off-reserve community near Sioux Lookout. The Business Manager will take over the network manager's responsibilities when he retires. She has worked in various positions with the Northern Chiefs since the early 1990s. The Multimedia Applications specialist and Graphic Designer are responsible for designing and maintaining K-Net's web applications (e.g., portals, web mail, MyKnet homepages). The Multimedia Applications specialist is a member of Sandy Lake First Nation. He studied computer science at the University of Windsor and began working with K-Net as a summer student in 1995. He administers K-Net's web servers, which are all LAMP based (i.e., Linux, Apache, MySQL, and PHP). He designed the original ZED platform for K-Net's Internet High School in 2001. He also conducts "train the trainer" sessions in host communities on database management and web design (e.g., PostNuke CMS, Macromedia Flash, Dreamweaver, Adobe Photoshop). He is K-Net's first teleworker and manages the servers remotely from his home in Sandy Lake.

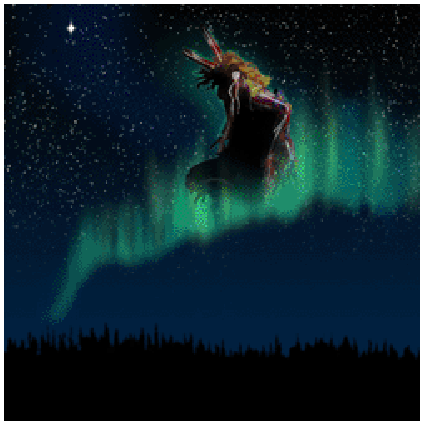


Figure 4.
"Northern Lights Dancer", a template designed by Cal Kenny for K-Net's online Adobe Photoshop tutorial http://tutorials.knet.ca/photoshop/dancer.htm

The Graphic Designer is a member of Lac Seul First Nation. A visual artist and photographer, he designed the look and feel of the K-Net portal (www.knet.ca). He also produces videos, web-casts, and publicity materials for the Northern Chiefs and affiliate community services. As part of K-Net Services' mandate to bolster the talents and

capacities of its constituent communities, the Graphic Designer and Multimedia Applications specialist produced a series of online tutorials that introduce website production concepts, and multimedia applications such as Dreamweaver, Fireworks, and Photoshop (http://tutorials.knet.ca/).

In their mid-twenties, both men are the first generation of a growing constellation of emerging artists and web designers who have matured with K-Net. The concepts and tools of the World Wide Web have enabled these artists to amplify and manipulate the artistic traditions of their society. The Sioux Lookout district is home to a vibrant artistic community. These young graphic designers and multimedia artists are direct descendants of the Woodland School, made famous by Norval Morriseau in the 1970s. Traces of the Woodland style are apparent in the colouring and design of K-Net's gateway and community portals. K-Net also hosts an online gallery to feature the artists' works (http://arts.knet.ca/). Moreover, a pool of artists from the communities contributes graphics, website designs, and video documents to promote the Northern Chiefs and partner organizations of Nishnawbe Aski Nation. This connection between the network and art adds a new texture to the unique spirit of the Sioux Lookout district and Nishnawbe Aski Nation. It also challenges the fear that local community networks sacrifice socio-cultural identity to have a presence on the Web (Cf. Pannekoek 2002).

1.4 The Local Loop:

In 1999, K-Net communities such as Keewaywin and North Spirit Lake had but a single public payphone to serve constituent bases of around 150 residents. Now, after less than a decade, 40 of these communities have broadband service to most households.

Each participating First Nation owns and manages the Municipal Area Network

(MAN) that renders K-Net operable in its community. This arrangement is maintained by the band office[7], the local First Nations government. Moreover, the Northern Chiefs requires that participating communities support the training and employment of local network technicians to cover repairs, upgrades, and general maintenance of the MAN. Per community, this requirement commonly translates to the positions of a Network Services Manager, one fulltime technician, and additional part-time workers who are familiar with standard operating procedures and are hired as needed. Due to their small populations (e.g., between 100 and 2000) some communities share technicians. Northern Chiefs' K-Net Services provides regular training sessions, and consults with community technicians on an as needed basis via listserv-s, email, videoconferencing, and VOIP.

K-Net's decentred relationship with community technicians evolved incrementally. Initially K-Net Services staff installed equipment, and invited the assistance of any local First Nations members who were interested in learning more to provide technical support. The Network Manager recalls that participating communities had at least one or two members who asked questions and dedicated responsibility to maintaining technical knowledge about the local loop, at the local level.

High turnover rates among band members proved a challenge for informal knowledge transfer to the communities. K-Net Services produced online manuals, FAQs, and news bulletins to maintain a knowledge base. But the communities derived their own remedy for brain drain. As the Network Manager recalls, during K-Net's mid-1990s expansion from dialup to DirecPC/MSAT technology, community technicians started to

[7] A band office is composed of an elected Chief and Council, and hired administrative staff. Chief and Council are elected every two years. They devise community policy, represent the community's interests, and manage the community's relations with neighbours, tribal councils, and external governments (e.g., Indian and Northern Affairs Canada).

answer each other's technical queries over K-Net's Bulletin Board System. Individuals were using the BBS to pool their knowledge about the network on their own initiative. This inspired an online dialogue between K-Net Services staff and community members, as staff stepped into the online forums to correct misunderstandings and elaborate details about the technologies. It also bolstered K-Net Services' confidence to intensify its decentred approach to development. With each follow up visit K-Net staff offloaded more of the regular technical duties to community technicians until community members could handle MAN maintenance confidently. Today K-Net Services maintains various listserv-s and webpages to propagate and archive the knowledge pooled amongst community technicians and K-Net Services staff.

Besides its recruitment and support of community technicians, K-Net Services also enrols local "community champions" (Ramirez 2000). Champions do more than represent community interests. They help develop network applications and maintain local accountability for the Northern Chiefs. They are responsible for articulating the fit between a community's perceived needs and the perceived benefits of a particular technology. Champions may be concerned citizens, social service professionals, or members of local government. They believe passionately about a concern, have extensive contacts in their communities, and want the proper tools to help make a difference. The tools they help conceive may not necessarily be ICT based, at least not right away. They could be a way of organizing human resources to address a social need, one that later could be augmented by ICT for rapid regional deployment or to cut the costs of travel. Through Northern Chiefs and K-Net Services, champions have an outlet to build upon the talents and capacities already in their communities. They are given

resources to “think big” and work with other champions from the district. However, there need not be a new technology or work flow built into the process. Before embarking on a new project or infrastructure upgrade, communities (largely through their champions) have to justify why they believe a certain technology would benefit their social needs. Plans and visions are deliberated through town hall meetings and call in sessions over community radio. Moreover, once K-Net Services proceeds with a project, the community champions become enrolled in the development process, from the initial needs assessment to follow up evaluations. They rally community members for town hall meetings, they go door to door to explain project proposals, they create buzz through local media (e.g., community radio, newspapers), they lobby local members of parliament for recognition and support, and they continue the process of enrolment by identifying potential partners in the community.

Partnerships are crucial for sustainable community networks. K-Net Services believes that local organizations and service agencies in the communities should contribute to the ongoing operation and maintenance of the local network, thus splitting the costs amongst an aggregated user base so network services can be affordable for as many consumers as possible. In 2003, K-Net’s aggregated business model was formalized into regional policy by the Nishnawbe Aski Nation of 53 northern Ontario First Nations, by order of Chiefs in Assembly Resolution 03/49: Support for the Development of the NAN Broadband Regional Network for First Nations (NAN 2003). The NAN resolution directs federal and provincial programs and services along with other regional agencies to work cooperatively with and utilize local First Nations community networks. It also directs NAN’s Executive Council (i.e., the elected Chiefs of

northern Ontario) to lobby all levels of government for alternate service delivery models based on broadband.

1.5 Aggregated Business Model:

K-Net's sustainability depends on an aggregated business model. In this section we review the ongoing costs to deliver broadband to K-Net communities. K-Net encompasses two basic sets of Wide Area Network infrastructure, terrestrial and satellite. At the local loop level a variety of last mile solutions may be in place depending on the circumstances of each community. K-Net communities have employed Ethernet, DOCSIS, DSL, Fiber Optic, and WLAN, among others, to link local institutions and residents.

Data released by the Northern Chiefs in 2003 and 2005 presented the following costs scheme for terrestrial network services (Cf. Ramirez et al. 2003; Rowlandson 2005). The figures are subject to change with fluctuations in the market, but what is quoted below presents as close an account as can be obtained. Each community on K-Net's terrestrial network owes the Northern Chiefs approximately CAD$2,675 per month for bandwidth. From this amount, K-Net Services pays Bell Canada, the incumbent telco, a monthly fee per community of CAD$2,075 for bandwidth. The balance of CAD$600 consists of CAD$300/month for T1 Internet access (1.544Mbps), which K-Net purchases in bulk, CAD$200 for the shared portion of a Toronto linkup, and CAD$100 for service support.

The monthly community fee of CAD$2,675 is made affordable by aggregate demand. To become eligible for service each community must devise a scheme to harness the purchasing power of a variety of customers. This condition defines K-Net's

business aggregator model. Primary customers include the band office, school, constabulary (Nishnawbe Aski Police Services), nursing station, local businesses, and special online services such as the Northern Chiefs' Keewaytinook Internet High School (subsidized by Indian and Northern Affairs Canada). Together, these various institutions, companies, and residents deal with K-Net Services through the auspices of the community band office. There are certain exceptions. The nursing station is an "anchor tenant" whose consumption of bandwidth exceeds half of the total bandwidth allocated for community usage. As a result, Health Canada deals directly with K-Net Services to purchase bandwidth. Currently, community schools are also an exception, as K-Net Services subsidizes their bandwidth consumption with funds from Industry Canada's First Nations SchoolNet program. The subsequent regional network of community aggregates allows K-Net Services to negotiate bulk rates from Bell Canada and other suppliers, such as Cisco, and ADCOM (a Canadian supplier of videoconferencing and telemedicine products).

The scheme for the 13 northwestern Ontario satellite served communities is based on an arrangement made between the Northern Chiefs, Industry Canada, and Telesat under the C-Band Public Benefits Transponder Agreement (Walmark 2005). It too exemplifies an aggregated business model. In 2002, Industry Canada agreed to have Northern Chiefs administer satellite services to remote communities, via transponder space that Telesat Canada had donated to Industry Canada's National Satellite Initiative for the purposes of public benefit. Telesat donated 12.5 MHz of transponder space to K-Net. K-Net Services chose not to rigidly divide the public benefit bandwidth amongst communities as no community would then have had the 880 Kbps required to support

videoconference based applications such as telehealth. They chose to employ Time Division Multiplexing (TDMA) technology, an older protocol common in terrestrial networks, to pool the public benefit resource and supply sufficient bandwidth for applications at the times required. While Internet and email might slow down in order that one community had the necessary bandwidth to do video conferencing or a telehealth consult, no individual community was ever completely cut off from the network.

By November 2002, the northwestern Ontario First Nations of Fort Severn, Slate Falls, Fort Hope, Webequie, and Kasabonika, and the Inuit community of Kuujjuaq, Quebec were sharing the 12.5mhz service. By May 2004, the northernwestern Ontario First Nations of Cat Lake, Weagamow and Sachigo Lake had joined the network. Eight Ontario and one Quebec sites were now sharing 12.5 MHz – nominally 1.4 MHz each. Shortly after, K-Net installed a DVB carrier to increase the output of the public benefit. Two 3.25 MHz TDMA carriers delivered up to 2 Mbps each of two-way traffic. The 5.9 MHz DVB carrier delivered between 6 and 7 Mbps. The nine communities therefore shared approximately 11 Mbps of bandwidth within this configuration. Neskantaga First Nation joined the public benefit network in August 2004. Several more First Nations joined in 2005. Muskrat Dam, Ontario and Obedjiwan Quebec came online in spring 2005, followed by Martin Falls, Peawanuk and Attawapiskat in the summer.

The cost of service is based on a price comparable to the cost of terrestrial service to remote communities. Currently each satellite served community pays CAD$2,700 for T1 capacity. As in the terrestrial network arrangement this fee is split amongst an aggregate consumer base. Moreover, Health Canada is an anchor tenant, and First Nations SchoolNet subsidizes school connectivity. However, revenues to Northern

Chiefs raised under the terms of the agreement may only be used to pay expenses incurred in accordance with K-Net's proposal to deploy satellite services as a public benefit to remote fly-in communities across Canada. Revenues generated from 2004 for example, went to improvements to hardware and software protocols and activities that promote Telesat's public benefit policy objectives.

Figure 7.
The "Big Dish", a 7.3 metre satellite earth station located at Sioux Lookout. The earth station is part of K-Net's facilitation of the C-Band Public Benefits Transponder, a joint project with Telesat and Industry Canada.

In each K-Net community the band office generally manages the Municipal Area Network (MAN). This includes service provision to community residents, businesses, and regional service agencies such as the local constabulary (Nishnawbe Aski Police). The band office therefore operates as a local ISP and resells bandwidth to residents according to a commercial scheme it devises and regulates. A common scheme is to offer residential Internet access bundled with cable television and/or telephony packages. In some instances the band office allows a member of the community to provide ISP services. Subscribers pay a monthly fee that varies per community (for example CAD$60.00 for cable/Internet versus CAD$25.00 for Internet only). The local ISP, whether the band office or a community enterprise vested by the band, also performs

technical work, such as upgrades, repairs and maintenance on the MAN as required by the Northern Chiefs' service agreement. It therefore charges service fees to all of the consumers of bandwidth in the community for maintenance of the MAN, including the schools and nursing station.

An overview of the aggregated business model does not explain the capital costs that established K-Net's infrastructure, estimated at over CAD$50M. A point-by-point analysis of these costs, which would address the costs of services and applications, is beyond the scope of this paper. As in the aggregated business model, capital costs have been similarly split amongst a consortium of partners. However, by comparison there was little local investment of capital by the communities. Their contributions were largely in-kind. For the terrestrial network the biggest capital costs were covered by Bell Canada in 2000 and 2001, during the North of Red Lake and North of Pickle Lake digital infrastructure projects. Bell Canada's contribution to these projects is valued at approximately CAD$15M. Industry Canada FedNor, Human Resources Development Canada, the Northern Ontario Heritage Fund, Indian and Northern Affairs Canada, the Sioux Lookout Aboriginal Area Management Board, and district First Nations also made contributions valuing over CAD$10M. For the satellite network it is estimated that a total over CAD$13M was required to cover capital costs. This total reflects investments made by Telesat and three programs under Industry Canada. The value of Telesat's transponder space over 15 years is approximately CAD$8M. The first K-Net satellite community, Fort Severn, had benefited from CAD$1.8M in SMART funding in 2001. During the expansion of the satellite network from 2002 to 2005, Industry Canada FedNor contributed approximately CAD$5.1M to cover capital costs, at per community

investments ranging from CAD$200K to CAD$500K. These costs included establishing earth stations and network management systems in Sioux Lookout. Industry Canada's Broadband for Rural and Northern Development program contributed CAD$380K to supplement capital costs for two communities.

Clearly Northern Chiefs could not scale up without the partnerships federal and provincial governments, and the local incumbent Bell Canada. Beyond K-Net's phase two growth (from 1998 onwards) Northern Chiefs would have been hard pressed to construct prototype applications without the external support of Bell Canada, Industry Canada FedNor, First Nations SchoolNet, the Northern Ontario Heritage Fund, Health Canada, and others. Thanks to serendipity and fortunate historical alignments, at the time the Northern Chiefs wanted to expand beyond a BBS, the governments of Ontario and Canada had shifted policies towards investment in telecommunications and connectivity related projects. The era of the federal government's "Connecting Canadians Agenda" had officially begun in 1994. Aboriginal connectivity came onto the agenda in 1996. Partners such as Industry Canada FedNor, First Nations SchoolNet, and the Northern Ontario Heritage Fund were thus in the proper policy frame to give the Northern Chiefs major support for capital costs. In 1998, the CRTC's hearing on High Cost Serving Areas coincided with K-Net's next big step into community networking. It gave incumbent telcos such as Bell Canada an ultimatum to improve existing lines, which enabled K-Net Services to install T1s in the communities. Hence, the infrastructure upgrades across the Sioux Lookout district in 2000 and 2001.

Logistically, the Northern Chiefs' communities offered a number of valuable risks and advantages to its government partners. It represents some of the more remote,

economically underdeveloped, and hard-pressed communities in the Sioux Lookout district. Driving satellite equipment over temporary winter roads opens the door for all sorts of unpleasant circumstances. High turnover amongst community staff members makes brain drain an ongoing concern. But proving a business case with great risk seems to have made a far greater impression on external funders and local agencies then attempts at setting up pilot projects in the urban centres of Sioux Lookout or Thunder Bay. That is what K-Net Services did in establishing a sustainable network based on the parameters offered by the aggregated business model. The communities may be at risk, but their network can deliver QoS for broadband applications that in the long run, appear to save government service costs to remote areas. This is already the case with Health Canada. The notion of overcoming the odds also appears to have impressed allies who were in a position to help Northern Chiefs contain K-Net's evolving capital costs. After a series of successful upgrades in 1998, Industry Canada FedNor and the Northern Ontario Heritage Fund began to seriously consult K-Net Services about how to handle telecom development in northwestern Ontario and rural areas in other parts of the province. They contributed matching funds to bolster K-Net's bid for SMART Community Demonstration Project status, and have continued to fund successive projects since. K-Net has been a kind of laboratory for these groups. The staff at K-Net Services tested their development model one step at a time, building through deliberate phases, with caution and care. Along the way they succeeded in building up enough credibility to secure successive investments from their partners.

1.6 Applications and Services:

Although each community has its own policies and social needs for joining K-Net, there is agreement regarding the social benefits of health and education applications, and underlying telecom services. 25 communities in the Nishnawbe Aski Nation participate in the Northern Chiefs' telehealth program, 13 employ the Northern Chiefs' Keewaytinook Internet High School, and at least 40 communities in the district employ videoconferencing units for administrative purposes. Mobilizing telecom services, and the related applications that ride on top, requires a coordinated effort amongst the participating communities, their respective tribal councils, and social service agencies. Mobilizing and coordinating these groups is facilitated by the communities' political identification with the Nishnawbe Aski Nation (established in 1973). NAN provides participatory mechanisms for regional policymaking and consensus formation. Its resolutions reflect the strategic goals of the communities, including how they want to invest band funds. Earlier, we mentioned that the Chiefs of NAN's 53 communities resolved to support K-Net and broadband development. This consensus driven policy has legitimated the work of K-Net Services to lay the groundwork for a regional network society.

With regards to K-Net's health and education applications, overall responsibility for regional coordination belongs to the health and education advisory services of Northern Chiefs. The advisory services manage program development, including finance, technology transfer, employment, training, and program evaluation. They work in concert with K-Net Services, which generally acts as a technical consultant for all applications and manages the dynamic allocation of bandwidth for the telecom services that underlie health and education applications (e.g., videoconferencing, VPN tunnelling).

The revenue to sustain the health and education applications is derived from a federal e-government services model. Health Canada funds telehealth as an alternative to costly Medevac services, and Indian and Northern Affairs Canada funds the Keewaytinook Internet High School as an alternative to First Nations boarding schools. Telecom services are covered by the combined purchasing power of K-Net's aggregated business model. With respect to Health Canada and Indian and Northern Affairs Canada, Northern Chiefs draws funds from these departments in exchange for the responsibilities of government service delivery. This federal devolution to a regional management structure enables the Northern Chiefs and its First Nations partners to shape program development, employment strategies, and evaluation. But it does not free them from the constraints of federal and provincial legislation, nor does it exempt them from departmental oversight. Telehealth must produce ongoing statistical records of its activities for Health Canada and its regional partner at the Sunnybrook Hospital in Toronto. Its program evaluations so far have emphasised Health Canada's e-government services strategy, to employ telehealth as a cost cutting measure. Keewaytinook Internet High School is designated as a regular school under Indian and Northern Affairs Canada. However, because it enables students to remain in their home communities, its funding dollars have been reduced by the amount INAC estimates would go to support students if they had to travel and live abroad.

Telehealth has rapidly expanded from six Northern Chiefs communities in 2001 to 25 Nishnawbe Aski communities in 2005. A variety of ICT program initiatives, shaped by Northern Chiefs and the participating communities, are being introduced through the telehealth platform, including medical consults, telepsychiatry, retinopathy,

elder care, art therapy, speech therapy, and more. Each program is modular, as it may introduce its own regional partners (e.g., specific hospitals, specialists, health organizations) and participating communities. The Internet High School has expanded from six Northern Chiefs communities in 1999 to 13 Nishnawbe Aski Nation communities in 2005. Northern Chiefs' education advisory service hires teachers and teachers' aids for the communities, and enforces curricular standards based on the Ministry of Ontario's curricular guidelines. The majority of teachers are hired from outside the communities, as there are not enough qualified teachers from the Sioux Lookout district. There is high turnover amongst the teachers. Isolation and cultural differences have a detrimental influence on their acclimatization to life in remote First Nations communities.

As for K-Net's regional telecom services, residents of participating communities and staff at regional service agencies employ ICT tools that strengthen lateral communications between communities and regions. Their employment of K-Net's telecom services subverts the stigma of a "high cost serving area" classification. The tools that have made the biggest impact on interpersonal communications in the region are of the low-bandwidth, Web-based variety. All of K-Net's servers are Linux, Apache, MySQL, and PHP based. Statistics from K-Net's Web servers indicate a thriving network of email addresses, homepages, and multimedia galleries (that include digital stills, audio files, and video). The K-Net Portal (http://knet.ca) receives over a hundred million hits a month and over thirty thousand daily visits by users browsing to access information resources about health, education, youth, native languages, employment, regional news, and more. Through the portal, users may also access K-Net Mail, My K-

Net Homepages, and a variety of photo galleries. There are currently thirty-eight thousand K-Net email account holders. These statistics are impressive given that the Sioux Lookout district's total population is approximately 20,000. K-Net Services estimates an almost total penetration of K-Net mail in the district. Registration is free, and access is web-based. There are over 18,000 individuals and groups hosting sites on My K-Net. Currently, the most popular site designs are based on the Open Source Post Nuke content management system (CMS). Users can add modules that expand sites into chat rooms, auctions, media players, and photo-galleries. Although K-Net Services specifies a 5M storage limit for homepage users, to date it has not enforced the rule. As a result, most homepages feature a soundtrack, video clips, and dynamic scripts. Because news travels fast over the Internet, in 2004 K-Net Services began to restrict new homepage accounts to First Nations and members of northern communities.

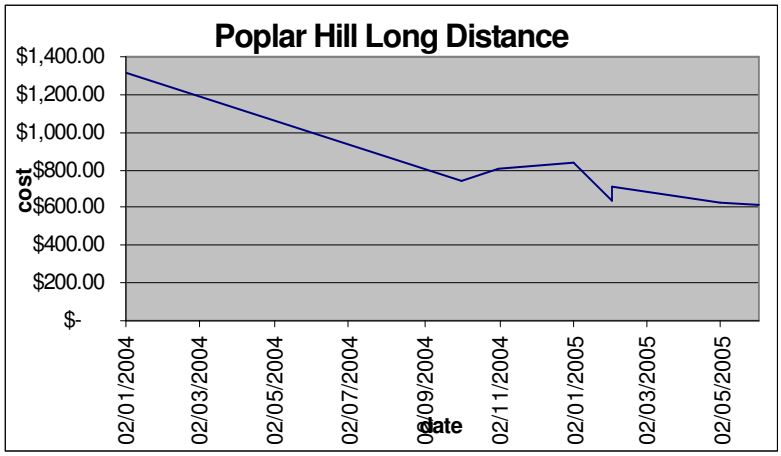
The K-Net portal is populated with numerous photo galleries that depict people and events of importance to community members. In total, the K-Net portal has archived over 13,000 photos, videos, and multimedia contents presented through the open source Galleries and Post Nuke CMS. Some galleries are personal additions to homepages, others are modules of community portals, or special sites created to commemorate events, and so forth. The Northern Chiefs' various branches also employ photo galleries to report activities back to community members (e.g., network upgrades, training workshops, regional meetings). Cameras, digital video equipment and multimedia workstations are available to members in most of the K-Net communities. For example, through its work with Industry Canada's First Nations SchoolNet, K-Net Services has delivered multimedia workstations (including Pinnacle Studio 8/9, Macromedia

Dreamweaver 8), scanners, colour printers, GPS units, and digital cameras to 85 First Nations schools across Ontario.

As for high-speed telecom applications, Voice over IP and videoconferencing have become top administrative choices for telephony amongst K-Net community band offices and affiliated regional organizations around the Sioux Lookout district. In 2004, K-Net Services and the Northern Chiefs communities started to explore residential VOIP services. In 2005, the fly-in community of Slate Falls, which had no residential telephony system, now has VOIP in most homes. Because the VOIP network is an application of the MAN, it is owned and operated by the community's band office (or designated community ISP). Using Asterisk Open Source software, communities are becoming their own private branch exchanges.

In 2005, K-Net Services commissioned the Keewaytinook Okimakanak Research Institute (KORI) to study the comparative costs of calls over the public switched telephone network versus K-Net VOIP. KORI's preliminary analysis found that use of K-Net (and related tools such as email, videoconference, and VOIP) by administrative offices in Northern Chiefs communities, between 2003 and 2005, demonstrated a 40 per cent cost savings in long distance charges (Seibel 2005). When calling outside their communities over the public switched telephone network, Northern Chiefs First Nations pay long distance rates from CAD$0.06 to CAD$0.08 a minute. They also incur average monthly service charges of around CAD$350 a month. Through their MAN, and improved VOIP systems, substantial savings are incurred (see **Figure 5**).

Figure 5.
Long Distance rates for Poplar Hill community from 02/2004 to 02/2005. Poplar Hill pays CAD$0.08/minute and a monthly service fee of CAD$350. Graph visualizes impact of MAN tools (e.g., email, videoconference, and VOIP). Graph courtesy of KORI, (Seibel 2005).



K-Net Services introduced videoconferencing units in 2001 through its participation in Industry Canada's SMART demonstration project. Later funding from Industry Canada's First Nations SchoolNet program and FedNor enabled K-Net Services to distribute units to schools and nursing stations across the Nishnawbe Aski Nation. They are publicly available in community band offices, health units, and schools. As a regional management organization for Industry Canada's First Nations SchoolNet program, K-Net Services has distributed over 200 videoconferencing units amongst 60 First Nations communities in Ontario, Quebec, and Manitoba. K-Net Services also maintains a multipoint video Accord bridge, an ISDN/PRI gateway and a Cisco IP audio Call Manager to handle IP multipoint conferencing connections. It also maintains a Macromedia Breeze server to facilitate multipoint web-casts and simultaneous chat sessions for conferences and e-learning applications.

Figure 6.
In March 2004, Northern Chiefs communities held its SMART International Gathering. Seen here is a videoconference with Maori leaders from Tuhoe, New Zealand.

In March 2004 K-Net officially expanded its influence to global status with its two-day SMART International Gathering. Employing their Macromedia Breeze platform and a combination of audio and video bridging, K-Net Services facilitated a series of multipoint videoconference workshops for an international coterie of indigenous groups. 85 delegates from 16 countries participated in the multimedia spectacle to discuss issues of ICT and community development. Archives of the event are available online (http://smart.knet.ca/international/).

1.8 Health Applications:

Among the network applications available to K-Net communities, telehealth consumes the greatest share of community bandwidth. It also pays for over half of the total cost of community bandwidth under the aggregated business model. At the centre of telehealth is the community nursing station. A nursing station is a medical clinic in remote First Nations communities that looks after routine medical examinations, homecare, and public health. The nursing station is an important fixture of service in the communities. It is funded by Health Canada.

Northern Chiefs' telehealth program began in 2002, when its six communities constituted the first clinical First Nations telehealth network in Canada. It has facilitated more than 1500 telehealth sessions from March 2002 to March 2005 (Rowlandson 2005).

The K-Net telehealth network's origins date back to 1998, when the Northern Chiefs began an effort that leveraged more than CAD$50M in both public and private investments for regional upgrades. These upgrades to terrestrial and satellite accessibility made telehealth possible across the Sioux Lookout district. The Northern Chiefs' partners in this endeavour include First Nations communities and tribal councils, Health Canada, Industry Canada FedNor, the Northern Ontario Rural Tele-Health Network (NORTH), the Northern Ontario Heritage Fund, Bell Canada, ADCOM, and CISCO.

To render telehealth operable K-Net maintains a VPN tunnel to the NORTH Network. NORTH provides remote community access to more than 70 hospitals located across Ontario, and to the Health Science Centre in Winnipeg, Manitoba.

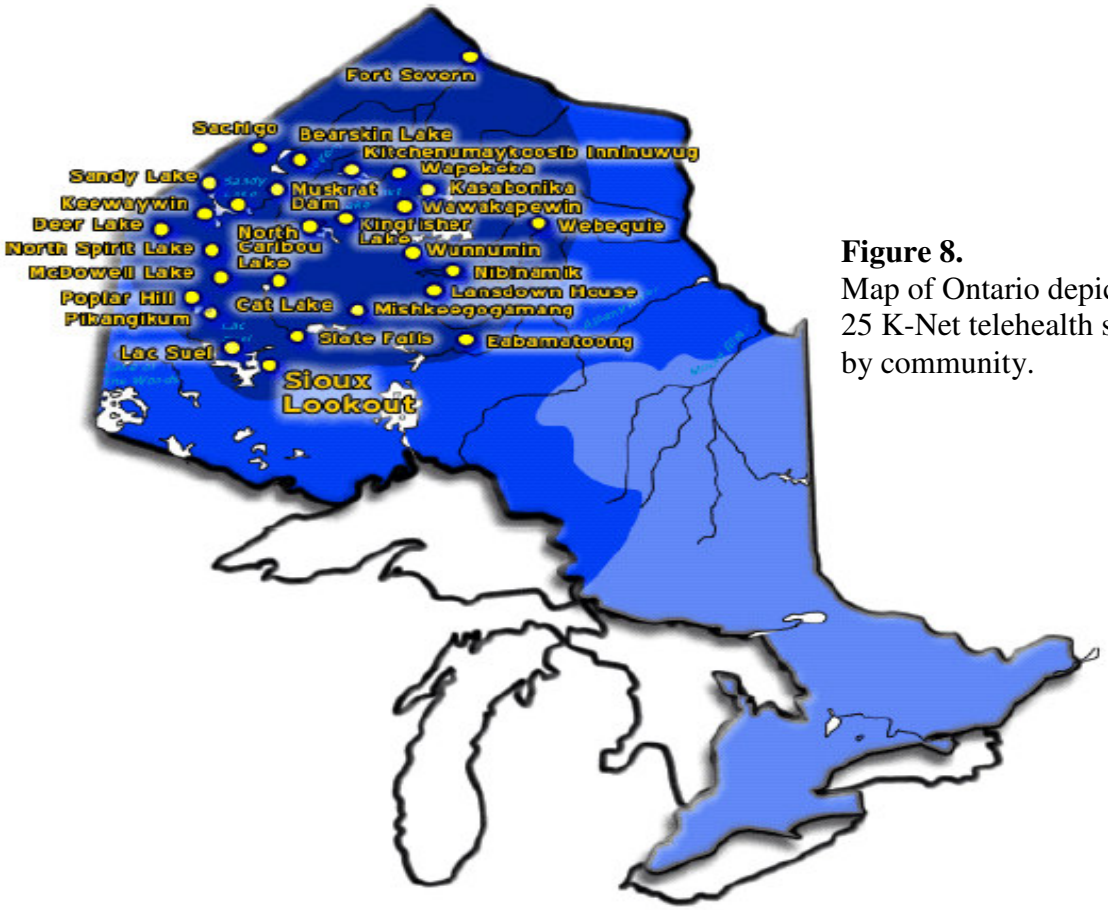


Figure 8.
Map of Ontario depicting 25 K-Net telehealth sites by community.

Currently 25 K-Net communities have nursing stations that support telehealth applications, including all the First Nations communities of the Sioux Lookout district. These applications involve a standard set of equipment purchased for the communities by Northern Chiefs in partnership with allied tribal councils, Health Canada and Industry Canada FedNor, who have collectively invested over CAD$13M. The equipment is purchased from ADCOM (now owned by Telus) at a "best price" bulk rate. Each nursing station involved employs a Polycom videoconferencing unit and an ADCOM iDOC telemedicine workstation (featuring Polycom components). The Polycom unit is employed for general meetings and training sessions across the telehealth network. It also facilitates therapy sessions for telepsychiatry and special needs education programs. The iDOC telemedicine workstation comes with a basic Polycom videoconferencing unit and peripherals such as an otoscope, a stethoscope, and a patient view camera.

Figure 9. From left to right: Otoscope, Stethoscope, Patient View Camera

The otoscope can reveal a patient's eardrum or other internal cavities to a health care specialist hundreds or thousands of kilometres away. With the stethoscope, a distant health care provider can assess a patient's heartbeat or breathing. The patient view camera can magnify a patient's skin rash or wound up to 50 times, and transmit the footage in real time or captured as a still image. K-Net can allocate enough bandwidth to support two consults at a time within a single nursing station.

The latest statistics on usage collected by the Northern Chief's telehealth team indicate a busy schedule for the telehealth network. From April to May 2005 there were 399 telehealth related events over the network: That breaks down to 171 clinical consults, 24 telepsychiatry sessions, 55 meetings, 73 education sessions (for staff), 5 family visits, 13 demos, 64 training practices, 18 tests, 60 cancellations, 4 spontaneous sessions, and 143 other events including consultations. The nursing stations also host lunchtime sessions for elders with the Polycom videoconferencing unit. Because many community elders seldom have the means to leave their reserve, the sessions enable them to see how old friends and relations are doing outside.

The Northern Chiefs and regional health partners have developed a number of therapeutic contexts for telehealth. In 2005, Nodin Family Services began to deploy an Art Therapy program over telehealth, to help young children open up and talk about difficult subjects such as physical and sexual abuse (Rowlandson 2005: 18). In partnership with the George Jeffrey Children's Treatment Centre, Northern Chiefs have proposed a model to deliver speech and language therapy over telehealth. These types of programs are seen as critical social needs in the Sioux Lookout district (Minthorn-Biggs 2004).

Nursing stations have also converted the traditional chemical process for developing X-rays into a digitization process. Now X-rays can be sent directly to a distant hospital in Sioux Lookout or Thunder Bay for a specialist to assess, instead of having to be processed on film and flown down. The VPN tunnelling K-Net provides ensures the secured transmission of confidential medical data.

To achieve this evolution in healthcare, Health Canada pays CAD$1,600 per month for bandwidth and support in each of the 25 K-Net telehealth communities. That is more than half of the cost of aggregated user bandwidth per community (i.e., approximately CAD$2,700). Cost analyses conducted by Northern Chiefs, Health Canada, and their regional healthcare providers estimated that without telehealth applications Health Canada pays an average cost of CAD$1,000 per patient. This fee per patient is mostly taken up by Medevac costs between Sioux Lookout and the remote communities (Walmark 2005).

The health costs escalate the farther out one goes. For example, digital X-ray services in Fort Severn (the most northerly community in Ontario) have improved both emergency and regular health care. In one documented case (Walmark 2005: 19) a patient with a bad fracture was diagnosed and referred to the nearest specialist on duty, 800km away in Winnipeg – before the Medevac had reached him in Fort Severn. In the days of film X-ray, the patient would have been flown to Sioux Lookout, which is a four-hour trip by Medevac. The X-ray would have been taken and read in Sioux lookout, then the patient would have been referred to the Winnipeg specialist and the Medevac would have been called back to take him to Winnipeg. The digital X-ray unit resulted in the patient receiving care from the specialist four hours earlier than would have previously been the case and saved four hours of flight time for the Medevac (i.e., a cost of approximately CAD$4,000).

1.9 Education Applications:

Education has been another rallying point for network applications in the K-Net communities. In fact, education has been a driving policy theme behind pre-broadband

connectivity in the Sioux Lookout district. Through an initiative begun in 1996, Industry Canada's First Nations SchoolNet (FNS) program funds First Nations school connectivity across Canada. In 2002, K-Net Services began to administer the Ontario portion of these program funds as a Regional Management Organization for FNS. The funding scheme applies to all 140 First Nations schools in Ontario. In Ontario the scheme pays out CAD$300.00 per month for T1 access to schools. There are similar schemes managed by five other RMO-s in British Columbia, Alberta/Saskatchewan, Manitoba, Quebec, and the Maritimes. These five RMOs also manage regional broadband networks that serve First Nations schools. With K-Net they form a national aboriginal network that allows First Nation schools across Canada to videoconference and share e-learning applications.

The Ontario First Nations schools connected to K-Net currently have access to two education applications the Northern Chiefs developed and deliver: the Keewaytinook Internet High School, and the G8 Program. Both programs are subsidized by federal government departments. KiHS is funded by Indian and Northern Affairs Canada. The G8 Program is funded by Industry Canada's First Nations SchoolNet program.

Founded in 1999, Kewaytinook Internet High School (KiHS) provides secondary school courses to Grade Nine and Ten students through network access in their home communities. Until KiHS, students as young as fourteen had to leave home and attend boarding schools in Sioux Lookout or Thunder Bay. With KiHS, these students can remain home during critical years of maturation so that they are better equipped both academically and socially to cope with the challenges of city life when they choose to complete their high school education in the south. Currently KiHS offers Applied course

credits, which, under the Ontario curriculum, make graduates eligible for some college courses but not university.

What distinguishes KiHS from traditional distance education models is its focus on the home community setting. Students work together in a physical classroom under the supervision of a teacher resident in their community. In some cases KiHS also offers course credits to adult students who work with minimal supervision at their own pace. Through the network KiHS allows each participating community to share a pool of teachers in order to cover curricular gaps that would exist without the opportunities to network online. Thus, one teacher in Keewaywin may be a math specialist, while another teacher in Fort Severn prefers teaching English. Through the network they complement each other, and teach for an entire networked student body. Some communities do not have a teacher. Instead, a mature classroom assistant from the community guides students at their home location. The result is a distributed high school environment wherein computer-mediated and face-to-face communications provide complementary systems of instruction. There are currently 13 communities participating in KiHS. The application's history of enrolment and accreditation breaks down as follows (Walmark 2005: 23):

Year	Student Enrolment	Credits Granted
2000 – 2001	30	53
2001 – 2002	79	78
2002 – 2003	136	206.5
2003 – 2004	141	269

If we divide the number of credits by the number of students for each year, and hypothesise that each student acquired at least one credit during the school year, then it appears that students have consistently acquired less than two credits a year. This conjecture does not factor in student retention rates, and information about students who

acquired more credits or failed to acquire a single credit. Nevertheless, in the 2001 – 2002 school year there were fewer credits handed out than students enrolled. The most recent school year, 2004 – 2005, saw the strongest performance with almost 2 credits awarded per student. There are 18 compulsory credits required for the achievement of an Ontario Secondary School Diploma, and 14 compulsory credits required for the achievement of an Ontario Secondary School Certificate. The conjecture suggests that KiHS student performance is below the norm in Ontario. In our introduction we raised the challenges to education found in the Sioux Lookout district. One cannot expect KiHS to clear those hurdles with ICT. While KiHS allows students to stay at home, its budget is no different from any other First Nations operated boarding school. The per-student operating grant of a First Nations operated school is not vastly different from the per-student grant elsewhere in Ontario – about CAD$7,500 a year. But its purchasing power is limited by the high cost of business in the north. In a 2004 review of Indian Northern Affairs Canada, Canada's Auditor General estimates that with current funding rates it will take 28 years to close the performance gap between First Nations students and their non-native peers (Office of the Auditor General 2004: 7).

The Northern Chiefs and its partners continue to search for ways that a network environment could help students achieve personal excellence. Special needs consults and learning therapies over the telehealth network are some of the options to be explored over the coming years. Students may also need a clearer picture of how high school credits complement their future employability. KiHS participants from Fort William First

Nation, which adjoins the city of Thunder Bay[8], are currently discussing the adoption of a KiHS model to support trade related programs and professional tutoring for vocational placements relevant to the employment needs of northwestern Ontario (e.g., construction, public works, forestry, mining). A link drawn between such vocational programs and high school could improve the students' vision of a career path at home. It could also bring KiHS closer to a model for lifelong learning.

Through its Regional Management work under Industry Canada's First Nations SchoolNet, Northern Chiefs also serves Grade 8 supplementary courses online. The G8 Program, created in partnership with a consortium of teachers located across Ontario, attempts to bridge the grade gap in science, literacy and mathematics. It provides resources to assist teachers in preparing First Nation students for high school. It reinforces academic skills in core subjects and encourages teachers to make better use of computers and the Internet to prepare lessons. Annual operating costs for the G8 Program are approximately CAD$80,000 annually. Northern Chiefs have yet to assess the impacts of the G8 program on students' integration and performance at the high school level.

Section 2: Discussion

2.0 Tribal Council Blueprint:

To explain the principles and planning behind K-Net's emergence, we now turn to examine the origins of this ten-year old network. Can a recurring pattern be deduced from the early activities behind K-Net? We believe the answer lies with the founding of

[8] Fort William provides an interesting contrast to K-Net's remote community partners. It is a thriving urban reserve with prosperous industries, including power generation and the Bowater Sawmill. Fort William acts as a hub for numerous satellite First Nations communities.

Northern Chiefs. In 1992, six First Nations bands from remote northwestern Ontario formed Keewaytinook Okimakanak tribal council (an Oji-Cree term for Northern Chiefs). The First Nations of Deer Lake, Fort Severn, McDowell Lake, Keewaywin, North Spirit Lake, and Poplar Hill desired to modernize their respective public infrastructures. They wanted electricity, improved telecommunications, improved septic and water systems, and better housing. They wanted better options for their families in education, health, and business, local options that could dissuade young people and families from leaving. They wanted a clearer future for their communities, one that felt sustainable and could be achieved on their own terms and at their own pace. They wanted to overcome the isolation of life in remote communities and find affordable technology solutions for their common high cost serving area.

The six First Nations considered a tribal council to be their best option. In Canada, a tribal council is a voluntary organization that assists and advises its member First Nations. A tribal council employs expert staff in areas such as finance, administration, public works, health, education, and outreach. It assists and advises at the discretion of its members. Its board of directors consists of the members' elected Chiefs who make final decisions. It therefore does not co-manage or take over the affairs of local band government but enables its member First Nations to 1) pool their resources, to 2) share expertise, and to 3) strive for projects beyond their individual abilities, while maintaining local autonomy.

To analysts unfamiliar with Canada's First Nations, it may seem elaborate to address the origins of a tribal council when the subject is a broadband network. Our objective is not to embellish details but to convey the role the network plays in its unique

environment. K-Net did not emerge as part of a telecommunications experiment divorced from the socio-economic and cultural life of its environment. It grew as a complementary branch within the existing organizational structure that Northern Chiefs had established as a foundation in 1992. K-Net Services carefully planned and maintained network growth to coincide with the actions of its counterpart branches in health and education to improve the socio-economic needs of First Nations communities in the region. Its project proposals and eventual project evaluations included their staff and contacts as project leaders and champions. Moreover, the tribal council blueprint of pooled resources, of shared expertise, and of autonomous First Nations, directed how K-Net continued to evolve. This is evident from our examination of education and health applications.

In 1994 the 'Stay in School' BBS resulted from extensive consultations between the Northern Chiefs' education advisory service, community champions, local education authorities, families, the Sioux Lookout Aboriginal Area Management Board (which contributed CAD$80K), and district tribal councils. This critical mass was in place before the idea of a BBS had emerged. It was an outcome of the Northern Chiefs' extensive outreach work throughout the district. The tribal council was able to tap the pooled resources and expertise of these district groups because it respected their local autonomy, and allowed each partner to contribute their best assets: Families and students brought their strong desire to communicate, community champions created a welcoming online environment, SLAAMB brought seed capital, and local education authorities facilitated usage, while the Northern Chiefs coordinated the project, and so forth.

Northern Chiefs orchestrated the BBS's rapid uptake by the communities. However, without the further enticement of external partners there would not have been enough financial support at the grassroots district level for rapid uptake to materialize. Partnerships with federal and provincial governments, and local incumbent telcos were required, especially if K-Net was going to expand to Internet Service Provision, or become a Wide Area Network. The requirement of external partnerships also created tension in K-Net's development process.

With external partnerships funding K-Net's capital costs and over half of its ongoing operating costs, the grassroots values may appear to be compromised. Who owns K-Net if external funders paid the majority of capital costs, and continue to pay for a substantial portion of services? Expanding K-Net's resource pool to external partners therefore creates obligations that appear to counter the Northern Chiefs' tendency to decentralize. Northern Chiefs wants to distribute resources, knowledge, and control to the grassroots, to the local First Nations communities. But if communities cannot afford the costs of development, as is the case in the Sioux Lookout district, then the balance of resources, knowledge, and control has to be reallocated elsewhere, according to the demands of those who can afford to split the costs. External partners such as Industry Canada, Health Canada, Bell Canada, Telesat, and so forth will want a K-Net development process that harmonizes with their internal operations. Should those operations fail to harmonize with the grassroots, what is Northern Chiefs to do?

Despite the seeming impasse, Northern Chiefs pushed straight ahead. Instead of giving up a future network to insurmountable costs, or diving headlong into the arms of a local incumbent, the tribal council took an opportunistic route. As early as 1996 the

Northern Chiefs had learned how to tap resource pools from provincial and federal sources (e.g., through partnerships with Indian and Northern Affairs Canada, and First Nations SchoolNet). It was on its way to becoming an indispensable regional liaison for high cost serving areas.

But there is also more to the story than dogged determination. It must be acknowledged that the ability to leverage funds to the tune of CAD$50M in total capital costs, over the span of less than a decade, has also been a product of serendipity, of being in the right policy frame at the right time. As the 1990s escalated a number of parallel events coincided for the benefit of remote public telecommunications. The federal "Connecting Canadians agenda" was coming to maturation at around the same time as K-Net, and looking for aboriginal partners. The province of Ontario was upgrading telecom services to remote regions and willing to support the federal government's agenda. The Canadian Radio-Television and Telecommunications Commission was set to declare basic services for high cost serving areas that included touch tone phone service and toll-free access to the Internet. This would constrain local incumbents to lay fibre and offer reduced rates to community aggregates. Telesat had donated 18 MHz of transponder space to Industry Canada for public benefits, thus creating opportunities for "affordable" broadband satellite services. Situations such as these formed a constellation of good fortune that Northern Chiefs' was prepared to exploit. Preparedness is key to downplay any notions that Northern Chiefs was simply lucky. None of the aforementioned partners and benefactors was about to go into the communities and build up the infrastructure or develop the services and applications for the communities. Northern Chiefs had to lobby the CRTC in 1998. It had to lobby Industry Canada for a piece of Telesat's transponder

space. It had to convince Fednor and the Northern Ontario Heritage Fund that its BBS network was ready to expand. It had to demonstrate that the problems of Sioux Lookout district's high cost serving area were too great for external agencies to undertake development without the support, local knowledge, and grassroots mobilization of the district's constituents.

Northern Chiefs therefore had the right blueprint in place to mobilize a grass roots response to the agendas of external funders. External funds would be accepted only if community autonomy was respected. This meant community ownership of local loops, investment in local employment, and community driven applications. Technical knowledge also had to be shared at the community level to help build an indigenous IT sector. In return, external funders required that grassroots developments speak to their respective policy frames (e.g., use their evaluation methods, metaphors, conferences); and more importantly, pool local resources to ensure a viable market in the high cost serving area.

Throughout the 1990s, education was the medium that clothed ICT development in a language of social needs. This manifested internally through the Northern Chiefs' efforts with the BBS. It also manifested externally, as a dominant trope of the federal government's "Connecting Canadians Agenda", which had begun in 1994. When Canada's first aboriginal focused connectivity program First Nations SchoolNet (FNS) appeared in 1996, K-Net Services was looking for just such an opportunity to expand and improve connectivity to district schools. When K-Net won its partnership with FNS it did not have to adjust its language to help the program articulate its mandated policy goals (e.g., to subsidize connectivity in First Nations schools). When more external

funds for connectivity became available in the late 1990s and early 2000, through K-Net Services' partnership with FedNor and later SMART, new ways of articulating social needs and the agendas of external funders arose, this time with regards to broadband applications and health.

Once again, K-Net was poised to act out a similar story of development, this time to articulate the emergence of broadband, through health applications. In 1998, the Northern Chiefs board of directors witnessed a telehealth demonstration at the Ottawa Heart Institute. They watched attentively as readings from a cardiograph in Greenland were broadcast over a high-speed network to Ottawa. The demonstration convinced them to remake K-Net into a broadband network in order to alter the coarse of health services delivery in the district. The Northern Chiefs ran pilot projects in telepsychiatry from 1999 to 2001. These tests coincided with its bid to become a SMART Demonstration project. They also served as practical evaluations of videoconferencing tools, the medium for telepsychiatric therapy.

The idea for telepsychiatry emerged from Northern Chiefs health services, but it also depended on the assumption that K-Net was an emergent Wide Area Network on the verge of becoming a deliverer of broadband services. The latter assumption was becoming realized through incremental partnerships with FedNor, the Northern Ontario Heritage Fund, Human Resources Development Canada, Indian and Northern Affairs Canada, Bell Canada, and others. These partners were putting their investments towards infrastructure upgrades, preparing K-Net for broadband. But they lacked a trope that would bring external funders and community constituents in alignment. The promise of high-speed service was not enough without applications. It needed to be tangible. Thus

it was K-Net's grassroots telehealth applications, first for telepsychiatry, which provided the tangible impact statements that could justify their investments, not only to funders but to the residents of the communities as well.

Northern Chiefs' health services staff had firsthand experience of the waiting periods and travel costs that weighed on the district health system and mental health patients from remote communities in the Sioux Lookout district. Thus when K-Net services began to plan for higher bandwidth telecom services in the communities, health services staff saw an opportunity to create telehealth applications. They reached out to the district, enrolled a local nursing station, band council, and a psychiatrist from Winnepeg. They coordinated with Health Canada to establish inroads for further development capital. The pilot projects lead to community consultations, town hall meetings, and planning sessions for future telehealth applications at the grassroots.

As with the BBS, the project established a link to emerging themes at the federal government level. The SMART communities projects of the millennium were framed by a policy that e-government services could help government cut costs in high cost serving areas. While education became a federal, provincial, and local trope for connectivity in the early 1990s, the new trope for SMART broadband applications was telehealth. Cost savings for both governments and residents were tangible. Once again, K-Net was poised to accept the mantle of innovation, and broadband services ensued.

In his book the Digital Nation (2004), Anthony G. Wilhelm proposes a "new liaison role" to support emerging information societies. Wilhelm enumerates four key functions (2004: 132): 1) The liaison helps to coordinate and leverage existing projects; 2) the liaison serves a critical public relations role, spearheading popular campaigns,

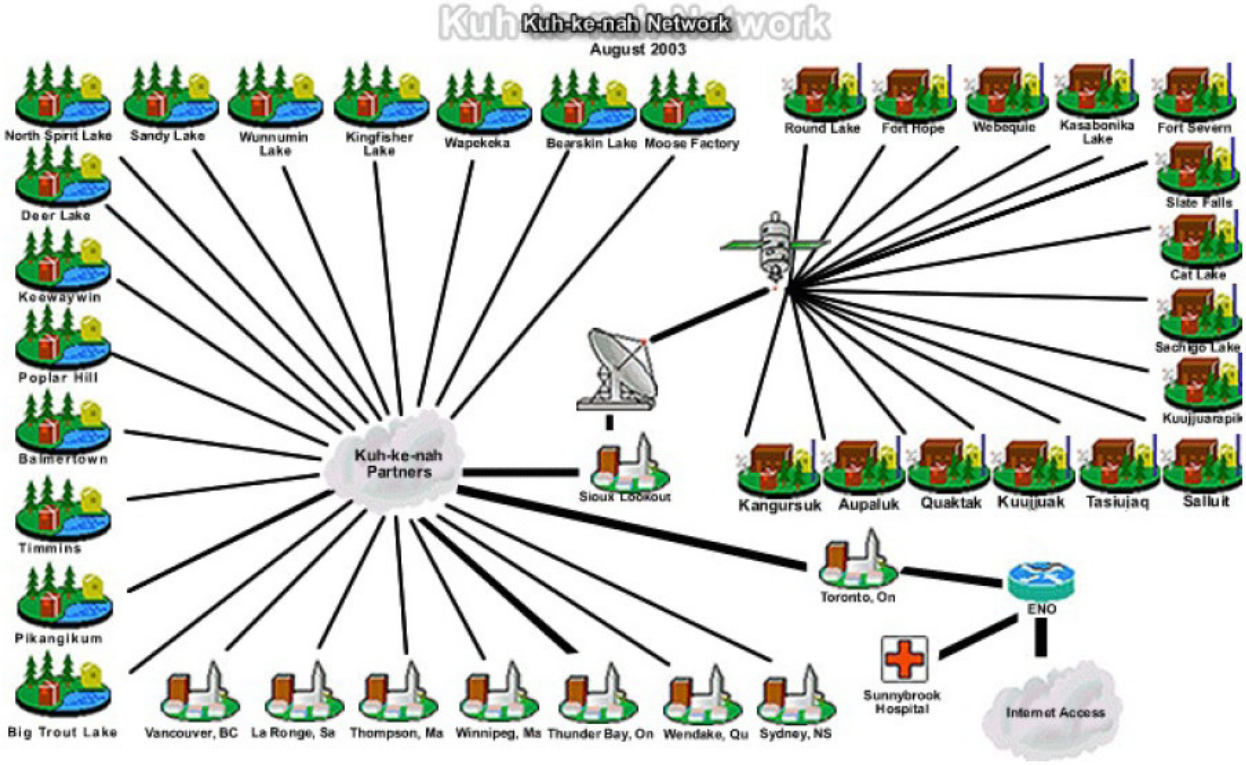
conducting town hall meetings, and the like; 3) the liaison would be a champion of a Digital Nation platform in government; 4) the liaison would commission research and development to explore next-generation ICT. Northern Chiefs has exemplified all of these qualities throughout its development process. We believe they help clarify the role it had to play in order to balance the decentralizing tendencies of its tribal council blueprint with the policy frames of external funders.

In terms of the tribal council blueprint we see a number of recurring patterns that overlap with Wilhelm's "liaison role". First, in both the education and health examples Northern Chiefs coordinated projects that served the social needs of its constituents. Through its services and network of champions Northern Chiefs served a critical public relations role. While it lobbied extensively at the grassroots, it also helped articulate the policy frames of its external funders. K-Net's rising capital costs required external partners beyond the Sioux Lookout district. These partners would not be willing to take a risk on longer term benefits, if Northern Chiefs was not willing to champion their joint platform of broadband and e-government services. The external partners also needed to trust in the local capacities of the district to be assured that an aggregated business model could be achieved in a high cost serving area. To this end Northern Chiefs provided a liaising role. Its extensive ties with communities and agencies throughout the district enabled it to rally the right people, community champions, to mobilize action in the communities and build a sustainable case for ongoing telecom services and applications delivery that resonated with the tropes of its external partners.

We can only cautiously predict what the future tropes will be in K-Net's development process. The following are a few scenarios we will be watching for.

Recent expansions in 2005 of Voice Over IP indicate that K-Net is poised to become a competitive regional carrier of voice and data. This is not exactly news given that K-Net has had VOIP capabilities since becoming a SMART demonstration project in 2001. But the recent (and currently incomplete) expansion of VOIP to residents presents a significant challenge to the local incumbent. How this will affect K-Net's relationship with Bell remains to be seen. Moreover K-Net is part of an emerging national aboriginal network. We predict that the services and applications that arise from the collaboration of regional aboriginal networks will help shape the coming vision of aboriginal societies in Canada.

The question of education and its role in the future of K-Net is another research theme to watch. As communities and external partners come to invest more funds in e-learning and vocational studies, they will suggest a greater emphasis on lifelong learning. However, a grade gap continues to exist in the Sioux Lookout district. Innovative solutions will be required to turn ICT to the advantage of students with special needs.



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