Building Wi-Fi Networks for Communities: Three Canadian Cases

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Abstract: This paper explores three Canadian wireless network projects that demonstrate that Wi-Fi technologies, like landline telephones, radio, and hydro, can be used to bring services to local communities. It is our position that despite the strengths and weaknesses of Fredericton's eZone, Montréal's Île Sans Fil, and the Lac Seul network in Northern Ontario, these three highlighted Wi-Fi networks demonstrate that a public information utilities model is still a useful lens through which to understand the development and implementation of telecommunications in Canada. Through our case studies, we have observed that in order for municipally based and community Wi-Fi networks to successfully take root in a community, it is advantageous to build on existing technological infrastructure. Moreover, municipal and community needs must be considered in the project. Finally, a cohort of interested advocates from the region is needed.

Keywords: Wi-Fi Networks, Wireless Technologies, Community Wireless, Municipalities, K-Net, Fredericton eZone, and Île Sans Fil

Résumé : Cet article explore trois projets canadiens de réseau sans fil qui démontrent qu'on peut utiliser les technologies Wi-Fi à la manière du téléphone traditionnel, de la radio ou du système hydraulique pour servir les communautés. Selon nous, les réseaux Wi-Fi eZone de Frédéricton, Île sans fil de Montréal et Lac Seul du nord de l'Ontario, quels que soient leurs qualités et défauts, démontrent que le modèle d'un service d'information au public demeure utile pour comprendre le développement et l'établissement des télécommunications au Canada. Au moyen de nos études de cas, nous avons remarqué qu'il est avantageux de se fonder sur l'infrastructure technologique existante pour établir avec succès des réseaux Wi-Fi municipaux et communautaires. Par surcroît, il faut tenir compte des besoins municipaux et communautaires dans un projet. En outre, il est nécessaire d'avoir une cohorte de défenseurs provenant de la région impliquée.

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Introduction

In the past 10 years, there has been a growing interest in sponsoring the development of public wireless communication networks that allow users to have immediate access to the Internet via their own personal computer or hand-held device in a variety of locations. Community groups in San Francisco (Bay Area Wireless User Group, 2000); Seattle (SeattleWireless, 2008); British Columbia (BC Wireless Network, 2002); Champaign-Urbana, Illinois (Champaign-Urbana Wireless Project, 2002); New York (NYCWireless, 2001); and London (Priest, 2004) were among the first to use wireless technologies (e.g., the IEEE 802.11b standard known as Wi-Fi) to "build community owned and operated networks and collaborative user spaces" (FreeNetworks, 2001), providing local citizens with free access to the Internet and to local information. Cities such as Taipei, Taiwan (Ho, 2005); Tallinn, Estonia (WiFi.ee, 2003); Albuquerque, New Mexico (City of Albuquerque, 2004); and Fredericton, New Brunswick (Richard, 2004) were among the early municipal leaders in developing Wi-Fi infrastructures to provide citizens with broadband Internet access in public places.

Much has been written about the development of municipal wireless networks in the U.S. (see, for example, the 2006 special issue of *Government Information Quarterly* focusing on wireless broadband networks: Strover & Mun, 2006), but less attention has been paid to the Canadian experience. Powell and Shade (2006) provide an overview of community and municipal wireless projects in Canada, Cho (2008) offers insights into the developers of the Wireless Toronto network, and Wong (2008) discusses the Toronto co-op wireless provider, Wireless Nomad. With a focus on three Canadian wireless network projects—the Fredericton eZone ("Fred-eZone"), Montréal's Île Sans Fil (ISF), and the Lac Seul network in Northern Ontario—this article supplements previous work and adds to an understanding of community and municipal wireless networking initiatives in Canada. It highlights the accomplishments of these projects, drawing on an historical perspective on the development of information utilities (Sackman & Nie, 1970) to highlight the unique aspects of each case. While each of the networks provides real benefits and services within its community, there are potential benefits that remain unrealized and potential users who are not served by the current network deployments.

The cases discussed in this paper indicate how unlicensed or licence-exempt spectrum can be deployed by communities and municipalities to develop fairly robust Wi-Fi networks that support a variety of communications purposes in a local region. However, simply having the funds to build the technical infrastructure for a Wi-Fi network is not enough. In each case, Wi-Fi is perceived as a fundamental service for the community, but the conceptualizations of Wi-Fi, technological strategies, and servicing of the Wi-Fi networks are fundamentally different. For the municipally driven service (eZone), Wi-Fi is viewed as part of the municipality's economic development strategy, with the Wi-Fi network considered city infrastructure much like sidewalks and sewers. The city takes respon-

sibility for providing Wi-Fi connectivity, but it does not guarantee quality of service. As an organization, Île Sans Fil is interested not only in providing a Wi-Fi network, but also in "promoting interaction between users, showing new media art, and providing geographically and community-relevant information" (Île Sans Fil, 2008a). To attend to this, Île Sans Fil has developed its own open source software tools for managing community hotspots and is working to make explicit the social relevance of Wi-Fi. The Lac Seul network is supported by K-Net, which relies on numerous local, provincial, and federal funding bodies to provide a telecommunications infrastructure to Aboriginal communities in Northern Canada in the most challenging physical environment of all our case studies. K-Net's focus has been on developing and implementing a digital infrastructure for and by First Nations people.

Wireless networking

The wireless networks of interest in this paper are *public* wireless networks. Developed with the public interest in mind and/or to serve a public need, public wireless networks are distinct from for-profit wireless offerings (from companies such as Boingo, http://www.boingo.com; T-Mobile, http://hotspot.t-mobile.com; The Cloud, http://www.thecloud.net/About-us; and other broadband providers). As noted above, these public wireless networks are usually developed by community groups or municipalities (see Fuentes-Bautista & Inagaki, 2006, and Middleton, Longford, Clement, Potter, & Crow, 2006, for more detailed discussions of public wireless networks). Many provide free or low-cost network access to anyone within defined service areas, and they may facilitate access to local community content. Some networks provide connectivity to support the delivery of municipal services.

The first and most widespread type of public wireless network is the municipal network, found in cities around the world. These Wi-Fi infrastructures provide citizens with broadband Internet access in public places (e.g., parks, community centres, government offices) and in some cases serve individuals in their homes. Municipal networks can also be used to support municipal operations (e.g., meter reading, mobile access to municipal data, and remote monitoring), with the City of Westminster (in central London, see Smith, 2003) and Corpus Christi, Texas (Tropos Networks, 2007), among the early adopters. By 2005, the "municipal wireless" movement was in full swing, with one report showing almost 100 networks planned or deployed in the U.S. and 65 international projects already in operation (Vos, 2005). Ambitious plans for citywide Wi-Fi networks were developed for Boston (Wireless Task Force, 2006), Philadelphia (Wireless Philadelphia Executive Committee, 2005), San Francisco (City and County of San Francisco, 2005), and many other locations. By 2007, there were 200 operational wireless networks in cities and counties around the U.S., with an additional 215 in the planning stages (Vos, 2007).

Despite the focus on providing public infrastructure, it was common for municipal projects in the U.S. to adopt a private-consortium approach to develop their wireless networks (Civitium, 2005). Companies such as EarthLink offered municipalities free or low-cost broadband access for certain groups (e.g., government employees, low-income citizens)—thereby creating the public-infrastruc-

ture component of the network—in exchange for access to city-owned infrastructure on which to deploy their wireless networks. The agreement would allow the private-sector provider to profit from deals with "anchor tenants" to purchase network access (see Jain, Mandviwalla, & Banker, 2007, for a description of this approach in the City of Philadelphia), and through the sale of wireless Internet access to residents in the communities the provider served (in competition with other Internet service providers). But by the summer of 2007, it became clear that this model was not viable in many instances (Weinschenk, 2007). Subscriber rates were low (likely because of the availability of better options for broadband connectivity in many locations), municipalities were not interested in being "anchor tenants" on the terms providers wanted, and it became evident that providers could not get a good return on their investments in municipal wireless infrastructures. By mid-2008, EarthLink and MetroFi (a provider operating networks in the Silicon Valley and Portland, Oregon) had announced plans to withdraw completely from the municipal wireless sector and to sell or shut down their networks (Cheng, 2008; LaVallee, 2008; Urbina, 2008).

The decline of the municipal wireless marketplace in the U.S. is outlined in detail in Civitium's report on the future of municipal broadband (Civitium, 2008), which effectively concludes that there is no future for the private-consortium approach to providing municipal wireless networks. However, a review of recent industry news coverage at MuniWireless (http://www.muniwireless.com) shows that many projects are still going ahead, but with different business models and a reduced focus on providing wireless Internet access to residents in areas that are already well served with broadband connectivity.

The second type of public wireless network is the community wireless network. The Institute of Electrical and Electronics Engineers (IEEE) ratified the 802.11b (Wi-Fi) standard in 1999 ("A brief history of Wi-Fi," 2004), enabling technically minded individuals to use the Wi-Fi platform to share their personal Internet connections. Soon there were community efforts to build and/or share Internet connections to meet the needs of local communities in cities all over the world (Cha, 2000; Forlano, 2008; Nielsen, 2007; Powell & Shade, 2006). These volunteer-led community wireless networking groups worked independently of municipalities to develop wireless broadband networks for use within their own communities, often with an explicit agenda of developing community-based alternatives to commercial Internet service provision (Sandvig, 2004) and/or challenging regulatory policies and practices that favoured the commercial sector (Meinrath, 2005).

Community Wi-Fi developers pride themselves on sharing applications, strategies, and software for delivering bandwidth in unlicensed spectrum (e.g., at the International Summit for Community Wireless Networks; see http://www.wirelesssummit.org), making it easy and cost-effective for local groups to build and administer their own networks. These networks have been developed and delivered largely by groups of volunteers who are either self-taught or have existing professional knowledge of computer coding and software applications (Powell & Shade, 2006). From a community perspective, the benefits of developing wireless networks include fostering a sense of community and

encouraging civic engagement, as well as facilitating innovation. It is noted that the community wireless movement has been influenced by earlier instances of community media-building, including rural co-operative phones (Winseck, 1995) and ham radios (Coe, 1996; Radio Amateurs of Canada, 2008). A variety of community wireless initiatives are discussed in a recent special issue of the *Journal of Community Informatics* (see Powell & Meinrath, 2008).

Wireless networks as information utilities

The concept of an "information utility" has been a topic of interest to researchers and policymakers since at least the late 1960s (Sackman & Nie, 1970). This "utility" was understood as some sort of appliance or device that would allow people in their homes to access information from a remote source, using some kind of communication network. Today, computers connected to the Internet and telephones provide this functionality, but for many years it was unclear how the goal of providing citizens with information access could be achieved and what the impacts would be. Early discussions examined technical questions of how to reach citizens in their homes (with Dunlop, 1970, among others, suggesting that the cable television network offered the most viable option) and attempted to articulate the social implications of developing an information utility (Bengelsdorf, 1970; Licklider, 1970). One topic of particular interest was the democratizing potential of the information utility, which was (and continues to be) seen as a way to open up the political process to a much wider group of participants (Dahlberg, 2001; Parker, 1972).

It is beyond the scope of this paper to provide a detailed history of the evolution of information utilities over the past four decades (see Dutton, Blumler, & Kraemer, 1987, for an overview of developments up to the mid-1980s). However, an understanding of some aspects of the journey from the imagined information utility of the late 1960s and early 1970s to today's reality of home and mobile Internet access is relevant here, as current community and municipal initiatives for developing wireless Internet infrastructures have some roots in these earlier projects. Wi-Fi networks can be seen as part of a set of long-term initiatives by citizens and some levels of government and industry to provide people with basic telecommunications infrastructure and information services. While the advent of wireless and mobile technologies has allowed access to occur in public spaces outside the home, as well as inside, the basic goals of providing infrastructure and enabling access to information remain unchanged. As such, it is instructive to review the motivations for developing information utilities over the past decades, as a means of understanding and assessing the outcomes of current wireless network deployments.

Private enterprise has been interested in developing ways to provide consumers with information access in their homes. In the United States and Canada, cable companies were the leaders on the commercial side, running trials of what became known as "interactive" cable systems, which offered upgraded cable infrastructure to provide selected consumers with a choice of programming and on-demand access to information (Davidge, 1987; Mundorf, Kolbe, & Brenner, 1997). Although interactive cable was popular with some consumers and advanced the concept of an information utility, the trials were not commercial

successes (Becker, 1987; Blahut, Nichols, Schell, Story, & Szurkowski, 1995; Carey, 1997). The trials were discontinued by the mid-1990s, as it became evident that the Internet, rather than closed, proprietary systems, could become a mechanism for providing citizens with access to information in their homes. Cable and telephone companies then quickly established themselves as commercial Internet service providers (Shelanski, 1999).

Community and municipal wireless networks are not operated on a commercial basis. Rather, they are much closer to what Guthrie & Dutton (1992) described as "public information utilities." These were "designed to facilitate access to community information and dialogue" (p. 574) and sought to achieve civic goals (Sullivan, Borgida, Jackson, Riedel, Oxendine, & Gangl, 2002), with an explicit focus on "electronically connect[ing] individuals who also share common geographic space" (Virnoche, 1998, p. 85). Predating widespread citizen use of the Internet, community networks such as Santa Monica, California's Public Electronic Network (PEN) aimed to assist in the delivery of city services, enable communication among citizens, familiarize residents with electronic communication technologies, and help ensure access to electronic resources for the socioeconomically disadvantaged (Guthrie, Schmitz, Ryu, Harris, Rogers, & Dutton, 1990; Rogers, Collins-Jarvis, & Schmitz, 1994). Residents could access PEN through public access terminals or their own home computers, but the project did not develop the access infrastructure.

While community networks such as PEN focused on developing information services, others, including the Blacksburg Electronic Village (BEV) in Virginia (Blacksburg Electronic Village, 2001; 2008) and "freenets" such as Ottawa's National Capital FreeNet (Patrick, 1997) and the Cleveland Freenet (2008), also addressed infrastructure needs by assisting residents in connecting to networks from their homes. Moll and Shade (2001) emphasize that community networks were distinct from other services because of their clear focus on local issues, their commitment to providing free or affordable network access, and a belief that community networking could foster social change and community development. But over time, it became clear that the communications infrastructure of choice for citizens who wanted to connect themselves with each other and with their communities would be the Internet. As it became easier for citizens to get Internet connections on their own, community networks became less actively involved in developing infrastructure, and freenets disappeared (Featherly, 2003).

Community groups were not the only ones developing communications infrastructure. In the U.S. (and to a lesser degree in Canada), many municipalities became broadband service providers. The expertise of municipal utilities in delivering services, their access to municipally owned infrastructure on which to install equipment, and their existing relationships with community members positioned them well to develop broadband networks (Carlson, 1999; Feld, Rose, Cooper, & Scott, 2005; Gillett, Lehr, & Osorio, 2004). Some municipalities first developed broadband infrastructure for their own use and later made access available to local businesses and citizens (Gillett, Lehr, & Osorio, 2004). Municipal broadband networks that offer residential services typically provide high-quality Internet access at affordable prices, and they may also offer telephone and cable

service (Kelley, 2003; Mitchell, 2007). Municipal objectives for developing broadband infrastructure include fostering economic development, improving the efficiency of government services, and providing service to citizens and businesses that are not well served by commercial providers. But prior to the deployment of wireless broadband, the number of municipalities actually providing Internet connectivity to residents was quite low (Gillett, Lehr, & Osorio, 2004).

To summarize the evolution of the "information utility" over the past few decades, it is noted that commercial entities, communities, and municipalities have all been involved in developing the information services and communications infrastructures that allow citizens to connect with communities, governments, businesses, and each other, initially using various local networks and more recently through the Internet. In the context of the wireless broadband initiatives of interest in this paper, it is the community and municipal efforts that are most relevant. Central to the "information services" component of the community networking movement was the desire to connect local citizens with local information sources and to provide access to informational content generated by local governments as well as by other citizens within the same geographic location. Community networks could also foster democracy and social change, for example, by encouraging local residents to participate in online discussion forums. With respect to the "infrastructure provision" aspect of the information utility, as the Internet became established, community groups withdrew from infrastructure provision. Municipalities built on existing expertise to develop broadband infrastructures, motivated by prospects of fostering economic development, providing service to underserved groups, and capitalizing on efficiencies in service provision.

As noted above, in the past decade, *wireless* networks have been used by community groups and municipalities to develop new broadband infrastructure and to provide a platform to encourage community networking. As Gillett (2006) observes, "Wireless technology is unique in its low barriers to entry. Little public disruption is required (generally, streets do not have to be dug up), and, when unlicensed spectrum is available, the transmission medium is free" (p. 592). Although developing robust, reliable wireless infrastructure is not as simple as Gillett's comments might imply, the relative ease of deployment and lack of entry barriers (such as acquisition of spectrum) have encouraged many municipalities and communities to take a role in providing information infrastructure. But as the case studies below show, some current deployments of wireless networks do not provide the full set of benefits and services that earlier iterations of public information utilities have aimed to deliver.

Public wireless networks in Canada: Methodology and case studies

For many decades, a number of researchers on the Community Wireless Infrastructure Research Project (CWIRP, http://www.cwirp.ca), of which we are members, have been involved with social movements and digital technologies.[1] We were aware of a number of Wi-Fi developments from our activist and research practices and from reviewing the literature on Wi-Fi networks. In 2005, as part of the development of CWIRP, we identified four Wi-Fi networks in Canada that had each been in operation for a minimum of one year and served a local community in a unique way. These networks were the municipally funded and gov-

erned Wi-Fi network in Fredericton, New Brunswick (Fred-eZone); the Lac Seul First Nation wireless network, affiliated with the Keewaytinook Okimakanak Nation; Wireless Nomad, a volunteer-run co-operative offering free Wi-Fi and a pay-for-service network in Toronto; and finally, Île Sans Fil, a community wireless network in Montréal. We sought explicitly to develop working relations and partnerships with these organizations, providing funding for partner research, seeking their input on interviews and survey materials, and convening a workshop to share experiences across organizations. We had wanted to work closely with Toronto Hydro Telecom to learn more about the One Zone project (http://www.onezone.ca—a for-profit network serving downtown Toronto), but they declined to participate.

The primary researchers visited all of the sites in 2006. This provided each of us with an opportunity to meet the individuals responsible for the networks, to see the infrastructure, and to gain material experience of each location. After each site visit, the researchers made notes and recorded initial impressions of each site. We then used these impressions to shape further data collection to facilitate our understanding of how these networks operated. One principal researcher, with a number of graduate students, was then responsible for each individual site. Each researcher conducted interviews with constituents such as policymakers, developers, and users at each site and reviewed local newspaper coverage, policy documents, and academic articles pertaining to the development and implementation of each Wi-Fi network.

The following research questions guided our investigation of each of the sites: When was the project started? Who initiated the project? Why was the project initiated? Who were the key players in establishing this project? Are they still involved? If not, who are the key players now? What were the challenges in getting the project established? Was there resistance to establishing this infrastructure? What are the major ambitions for this project? How have they changed over its course? What do you consider to be your most notable accomplishments so far? What are the most significant setbacks or disappointments so far? In order to enhance and nuance an understanding of each site's history, we then asked a series of questions pertaining to users, economics, technologies, ownership, content and services of network, and policy. These results were then mapped, and we created detailed case studies available at http://www.cwirp.ca. Wireless Nomad is not discussed in this paper, but a description of its efforts to enable citizens to share their Wi-Fi networks is provided by Wong (2008).

In the next section, we provide a brief description of each network and the context in which it was developed. We outline challenges inherent in developing each network and identify each organization's successes. The descriptions are followed by a synthesis of the benefits and services provided by each network, using a framework derived from the literature on public information utilities discussed earlier.

Fredericton eZone

Fredericton is the capital city of New Brunswick, with a population of about 85,000 (census agglomeration, Statistics Canada, 2006a). There are two universities in the city, and major employers include the government and institutional sectors, as well as knowledge industries (information technologies, life sciences, consulting engi-

neering, and e-learning) (Team Fredericton, 2008a). Access to good-quality information and communications technology infrastructure is essential to the citizens and businesses of Fredericton, and the municipal government has played a major role in developing this infrastructure for Fredericton.

In 1999, to promote and support economic development through innovation, and in response to concerns about the high costs of Internet access for local businesses, the city established E-Novations, a city-owned company that created and manages the Fredericton Community Network. Much effort was needed to gain the support of municipal politicians and to overcome the resistance of the largest telecommunications carrier in the province, but E-Novations persevered and created a fibre optic network that provides bandwidth to local businesses on a wholesale basis, as well as serving the needs of local government. This co-operative model of infrastructure development reduced the costs of Internet access significantly and also resulted in increased competition in Internet provision in Fredericton. As of 2007, the community broadband network managed 60 km of fibre and served 35 "tenants," who each saved up to $600 per month on the cost of broadband connectivity (Powell, 2008).

In 2003, with the support of the city council, E-Novations created the Fred-eZone, the city's public wireless network. The eZone Wi-Fi network was not originally part of the city's telecommunications infrastructure plan, but it was possible to provide this peripheral communications service once the fibre was in place. The Fred-eZone is owned by the City of Fredericton and supported by public funding (with each proposed expansion approved by the city council). It uses surplus capacity from the community broadband network to provide bandwidth for anyone within the network's range to connect to the Internet using Wi-Fi. Fred-eZone currently offers over 100 access points, with most concentrated in the downtown core and available at municipally funded institutions such as the public library. The eZone also serves the shopping mall, the truck stop on the highway near town, and the airport, and it offers online access to webcams providing various views of the city (http://www.fred-ezone.com/webcams) as the city is not interested in being an Internet service provider (recognizing that being an ISP requires a commitment to a certain level of service), the network is not designed to provide service to individual residences.

E-Novations manages the network, using a mix of licensed and unlicensed spectrum for "backhaul" connection to the community fibre network. The network uses Motorola and Cisco equipment, and Cisco has used the Fred-eZone to promote its products (Team Fredericton, 2008b, 2008c). Given Fredericton's relatively small size and its location, what is most important regarding the choice of technology vendors is that local support is available. The eZone is not afraid to reject technologies and solutions that do not work in Fredericton, and it is happy to promote the ones that do.

Fredericton established itself as the first municipality in Canada to offer Wi-Fi to its residents, and the Fred-eZone represents one of Canada's Wi-Fi success stories. The efforts of Maurice Gallant (E-Novations CEO and CIO of the City of Fredericton), Mike Richard (E-Novations VP Operations and City of Fredericton IT Manager), and Don Fitzgerald (Executive Director of Team Fredericton) have

been central to the success of the community network and the Fred-eZone, and they continue to share the Fredericton broadband story with audiences around the world. Their work earned the city an economic innovation award in 2004 (Canadian Information Productivity Awards, 2004). Promotion for the eZone emphasizes the role that broadband infrastructure plays in economic development and in encouraging industry to come to their city, although such effects are difficult to assess.

The innovators and players behind eZone view their Wi-Fi network as public infrastructure akin to sidewalks. They have significantly reduced the telecommunication costs for business and government agencies in their city, they have brought national and international attention to the city, and they have generously shared their process with countless municipalities. Interestingly, the eZone approach has not been replicated widely. Few other municipalities have the combination of success factors present in Fredericton: strong local champions, support for development of a locally owned fibre network, favourable city finances, and a supportive local council.

Île Sans Fil

Montréal is the second-largest city in Canada, with a population of about 3.6 million (census metropolitan area, Statistics Canada, 2006b). It is a culturally rich, bilingual city with the highest number of cultural producers in the country. Montréal has the highest average earnings of artists as a percentage of average local labour force earnings and the second-highest population of artists after the City of Toronto (Hill Strategies, 2006). Montréal's cultural richness, as well as its long history of engagement with sustainability issues and national independence, have influenced the development of the Île Sans Fil community Wi-Fi network.

While eZone advocates were municipal employees, ISF is a group made up of about 20 core volunteers, with more than 500 additional volunteers keeping up with the project through their mailing list. As a non-profit group, ISF is committed to providing free public wireless Internet access in public spaces in Montréal. The high number of artists and self-employed individuals in Montréal has partially sustained a strong public café culture, providing an ideal environment for deployment of wireless hotspots. ISF implemented its first free hotspot in July 2003 at Café Laika—centrally located in what is considered to be a funky and hip neighbourhood, the Plateau. The Café serves as a beacon site and is one of ISF's most frequented and longstanding free hotspots.

Run by volunteers who describe themselves as "computer hackers (the geeky-but-cool kind), system administrators, 'hands-on' academics, web designers, idealists, engineers and more" (Île Sans Fil, 2008b), ISF has implemented about 160 free hotspots in cafés and other public places (e.g., parks, local businesses) and has registered 30,000 users. Two individuals, Michael Lenczner (one of the few Anglophones in the group) and Benoit Grégoire, were key to the technological development and implementation of the network. Its approach is a simple one. ISF enables local businesses and community organizations to extend their existing Internet connections by creating hotspots on their premises. The hotspot "host" pays a small fee to ISF and in return gets the hardware necessary to create a hotspot, some technical support, and a listing in ISF's directory (Île

Sans Fil, 2008a). As one of its founders commented, "[I]t's more the importance of having decentralizing players offering access; offering it wirelessly, not getting stopped by regulations or other non-business obstacles" (Benoit Grégoire, Île Sans Fil, Montréal, interview, June 7, 2006).

Who offers Wi-Fi and how it is offered has been critical to ISF, given its commitment to open source software and politics. In late 2005, there was some discussion that various levels of government and telecommunication companies might be interested in developing a citywide municipal network in Montréal. As a result, ISF made a concerted effort to increase its number of hotspots. ISF felt that this increased presence could play a role in opening up discussions about public and free networks. To date, neither government- nor telecommunication company–owned Wi-Fi networks have materialized. However, the municipal governments in both Montréal and Québec City are now offering a small, but sustaining, budget for ISF and ZAP Québec (another community wireless network and spin-off from ISF) to increase their community networks to cover public parks and city-core areas (Péloquin, 2007).

What makes Île Sans Fil unique in the larger international context of community Wi-Fi networks is its commitment to making the network not only seamless and transparent (for example, through use of open source software), but also a site for community engagement and interaction:

> We believe that technology can be used to bring people together and foster a sense of community. In pursuit of that goal, Île Sans Fil uses its free public access points to promote interaction between users, show new media art, and provide geographically- and community-relevant information. (Île Sans Fil, 2008a), ISF's founding members have been committed to free public wireless and initially privileged the technical delivery of Wi-Fi. "[Our] main goal to start off with . . . was free public wireless, free wireless in public spaces, and using the technology to create and support local community" (Michael Lenczner, Île Sans Fil, Montréal, interview, June 7, 2006).

However, they soon realized that the maxim "Build it and they will come" did not work and that their own political agendas were not evident to those who used their services.

It is important to acknowledge that different groups have different ways of engaging with Wi-Fi. As other community wireless groups were fledging, such as LondonWireless and NYCwireless, ISF wanted to take up its own place and context more specifically. To do this, the team developed an application called "Wifidog" (an alternative to "NoCatAuth"—see http://nocat.net) to manage user access to ISF hotspots and to establish meaningful contact with cultural producers in Montréal to provide community content at each hotspot. Wifidog is both "a gateway per hotspot running a client process and a Web-based central server" (Lenczner, 2005, p. 8). As a captive portal, all users are required to log in and are taken to an ISF Web page (or redirected to a portal page where the site is located). This application allows hotspot "hosts" to create and manage their own location-specific content. ISF also developed extended features that allow users to upload and download text, images, and sound through HAL (Hubs des Artistes Locaux,

http://www.ilesansfil.org/tiki-index.php?page=HAL&bl=y), (Charest, Lenczner, & Marceau, 2007), although these are not currently active. A user profile section allows users to see who is online, where users may be located, and information (disclosed solely by the user) about particular users currently online. To date, this application has been taken up in four continents and by over 30 groups, and Île Sans Fil has made usage data collected through Wifidog available to the international research community at the CRAWDAD archive (Community Resource for Archiving Wireless Data at Dartmouth, 2007). Finally, ISF has also collaborated with the artists working with the Mobile Digital Commons Network (MDCN) and other local artists to display their work (Powell, 2006).

ISF has been one of the most successful community Wi-Fi networks in Canada. Montréal's long history of community activism and advocacy for communication networks (Powell & Shade, 2006) and the place of the café in street culture in Montréal are significant factors in sustaining an environment for Wi-Fi. Most recently, ISF has entered into an agreement with the City of Montréal to cover the downtown core with ISF's network. ISF's network was built by a community of largely young, White, and highly skilled Francophones to provide themselves with Internet access outside of their places of residence. These young men, largely employed as freelance workers, wanted to be able to connect with others in a community. Many ISF users confirmed this important use as well, wanting to get out of their residences and be "part of something."

Relying entirely upon volunteers, ISF has been able to implement a large number of hotspots, has enjoyed significant positive media coverage, and has partnered with numerous academic and community projects to provide initial and sustaining funds (Powell, in press). ISF has developed software not just to deliver network use, but also to apprise users of various community, artistic, and political local events. However, ISF also faces the challenge of how to mentor and sustain its volunteer network. Many of the initial core volunteers have become less interested in the network as it has become more self-sustaining. As well, at some level, the network reflects its designers. While many people can appreciate free access to the Internet in cafés, fewer women, communities of colour, and people with disabilities have the same leisure time, equipment, skill set, and/or mobility to avail themselves of and/or maintain these services. In conclusion, despite the network reflecting its designers' overt needs, ISF has been a tremendous success in the development and deployment of community Wi-Fi. The group has set new standards for user integration through its social software applications and has been generous in transferring skills and knowledge to other community Wi-Fi groups around the world.

Keewaytinook Okimakanak K-Net

The Kuh-ke-nah Network (K-Net) is an initiative of Keewaytinook Okimakanak (KO), a non-profit tribal council in Northwestern Ontario. K-Net is one of the first Aboriginal networks created, developed, and maintained mostly by First Nations peoples in Canada (Beaton, 2004; Ramírez, Aitkin, Jamieson, & Richardson, 2004). Established in 1994, K-Net operates and manages a community broadband network, providing services and applications (e.g., teleconferencing, telehealth, education, community e-centres, and economic development) to

the Nishnawbe Aski First Nations (see http://smart.knet.ca/fednor_video_list.html for more info on K-Net). K-Net is "a regional network of more than 60 aboriginal communities and related points of presence, clustered around Northern Ontario and Québec. 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" (Fiser, Clement, & Walmark, 2005, p. 3). It also serves as the Regional Management Organization for First Nations Schoolnet programs across Ontario and operates telemedicine services in 24 communities. K-Net servers now host over 30,000 Web pages and 70,000 email accounts, and they receive over 80 million hits per month.

CWIRP's relationship with this community was built on a pre-existing one through the Canadian Research Alliance for Community Innovation and Networking (CRACIN; http://www.cracin.ca). Andrew Clement and Adam Fiser had been working with this community and asked whether they could bring the interests of CWIRP to the community as well. Of particular relevance to CWIRP was the wireless network deployed by the Lac Seul First Nation to bring connectivity to three small remote communities. This network infrastructure is owned by the Lac Seul First Nation with K-Net Services (http://knet.ca/info/knet) acting as its Internet service provider as well as providing for applications such as video conferencing and telehealth.

Of the three cases profiled in this paper, K-Net operates in the most rural and most challenging physical landscape. The deployment of the Lac Seul Wi-Fi network was difficult, given the need to attend to the climate, user uptake, technical training, and sustainability. Although these particular Nations have been very successful in seeking out and managing a number of provincial and federal grants to build and develop their network (Fiser, 2007), the grants have also dictated the priority they need to give to certain broadband and Wi-Fi activities and deliverables. K-Net has had to be strategic in terms of delivering on grant promises and determining how to best serve its wide-ranging communities. Like Fredericton's eZone and ISF, the Lac Seul network was also enabled through the hard work and persistence of local supporters, including K-Net's Brian Beaton and the Chief and Band Council of the Lac Seul First Nation.

The Lac Seul First Nation is a 90-minute drive from the closest town (population of 5,000), followed by a boat ride for those who live on the lake. In the wintertime when the ice is thick enough, residents use skidoos to access the main road to town. Children are schooled in the local community until grade eight, when they are sent to an Aboriginal school with boarding facilities. On our first visit to the Lac Seul region, we were shown the wireless network connecting three First Nations communities: Frenchman's Head (population 425), Kejick Bay (population 426), and Whitefish Bay (population 98). Some of the initial funding for the project (e.g., for the communication tower and equipment) was provided directly by the band council. The network provides the connectivity to the communities, as no fibre optic link was in place. It consists of smartBridges Wi-Fi radios for public wireless access, with Aperto transceivers (operating on licensed spectrum) pro-

viding a backhaul connection to Sioux Lookout and enabling quality of service (QoS) applications such as telehealth and video conferencing.

Using licensed spectrum to guarantee QoS, the Lac Seul wireless network serves band offices and community centres, local nursing stations and health clinics, and local police. Residents can access the free Wi-Fi network in their homes if they have a computer with a network card and line-of-sight access to the network, and if the network is operational. Access is also provided at the community centres, where people can connect to the Internet and view local community information on the K-Net website and "MyKnet" personal homepages. Although the advent of Facebook has decreased its popularity recently, MyKnet.org gets more than 20,000 daily visits (though these are not all from the Lac Seul community, they show the popularity of this network across the K-Net community).

On the day we arrived at Kejick Bay, the wireless tower was not working and the community had been without service for over a week due to a recent thunderstorm, a common occurrence in the region. As a result of various agreements between service providers and the Lac Seul Band Council, there were several misunderstandings about who owned the equipment and who was supposed to service it. As the receiving dish was on a telecommunications tower, only network technicians from certified "tower crews" were allowed to replace the broken receiver. There can be a significant wait for these trained climbers, as they must be brought in from either Winnipeg (almost 800 km) or Thunder Bay (over 400 km) (Fiser, 2007). Hence, it may be that the communities have problems finding and keeping technical staff as a result of these kinds of situations and perceived lack of support. As well, the computer technician the Band had hired to maintain and service the broadband and Wi-Fi network argued that he was not being paid enough to manage the Internet services for these communities and resigned from his position.

On one hand, K-Net has been tremendously successful in the development and provision of broadband network services by and for Aboriginal peoples. To date, there have been few other Aboriginal communities that have attempted to build their own infrastructure. Millions of dollars have been raised and spent to develop and maintain this telecommunications infrastructure (see Fiser, 2007, for a detailed analysis of the expenditures for the Lac Seul network). On the other hand, efforts to develop the wireless network to extend service into the remote Lac Seul community resulted in a number of challenges. These included unpredictable climate conditions, a mixed infrastructure of stakeholders and technologies, and limited technical support.

Concluding Remarks

These three case studies illustrate a range of diffusion and adoption of Wi-Fi in Canadian communities. Each of these sites has mobilized a range of different players to supply and service Wi-Fi access for communities, providing benefits through infrastructure provision and encouraging the development of local communities. Each of them reveals the importance of public network access, and collectively, the cases show a range of ways to provide such networks at the local level.

In returning to the literature on information utilities, we are reminded of the

benefits they sought to deliver. From the perspective of providing information services, these earlier projects aimed to link local citizens to local community information. The focus of the public information utilities was on enabling community within specific geographic locations, rather than on extending community beyond local boundaries.

In our case studies, ISF has done this well, although the individuals who have developed and implemented the network applications could limit their definition of community—i.e., the ISF network was largely designed to provide network access for a certain group of people (young, White, freelance, males). Fredericton has done very little to explicitly develop community and has significant potential to do more, while K-Net has strongly encouraged community development and has explicitly linked its network with political autonomy. The Lac Seul wireless network, combined with K-Net's content and infrastructure, does the best job of delivering services and benefits to its community. The combination of infrastructure provision in Lac Seul and information content developed elsewhere in the community does support attempts to bridge the digital divide and to foster community and economic development. However, K-Net is unique among First Nations communities and to date their extensive accomplishments in providing reliable infrastructure and community support to a large remote area have not been replicated.

Hence, what is missing from the public information utilities literature, and seen in our case studies, is a desire to build community beyond the local (i.e., people in all locations using the Internet to reach beyond local community to other communities of interest, friends, and family). As well, there was little recognition in the utilities literature that networks could be used for non-utilitarian purposes. For example, building on the utilities model, both ISF and K-Net have developed, facilitated, and provided important and rich value to users and citizens through their applications and mandates to enhance community.

The eZone case is a fascinating story about three individuals who saw an opportunity to provide telecommunications access at a lower rate than an incumbent telecommunications company. What makes this situation unique is that the municipality owns and manages the network and that these three individuals continue to play a key role in advocating and developing the Wi-Fi network. Fredericton is not reliant on other levels of government funding and/or telecommunications companies to provide it with legitimate autonomy in how to pursue and use its network. The Wi-Fi network was a "no-brainer" for the city. Given the buildings that the city owned, it was straightforward to put up antennae and enable the network. While eZone has an FAQ page on how to set up a network and is working hard to provide coverage to the whole of the city, the network is viewed largely as infrastructure. Little consideration has been given to other ways this network could facilitate more civic and user engagement in the city and whether the eZone could bring in other "advocates" to develop this realm of the network.

ISF has been very influential in the community wireless space, providing technical information, consulting with other organizations developing their own networks, and sharing their software. ISF's commitment to providing applica-

tions such as "Wifidog" and "HAL" has made it easier for other groups to enable community representation on portal sites. These applications are an attempt to bring meaning to virtual communities and link them back to the place where users live and work.

However, ISF is a volunteer organization, and its growth and sustainability is limited by its reliance upon volunteers. Fielding numerous requests for assistance setting up community Wi-Fi networks, building and maintaining its own network, and developing user/community applications have been very demanding for this organization. ISF has had to turn down requests for assistance in the implementation of other networks. Providing software solutions to make it easier to start up networks has not been enough to generate similar networks—manuals are needed; people are needed to build, share, set up, and manage the networks; and knowledge about local infrastructure and municipal bylaws is helpful to setting up community networks. However, the passion generated by the ISF volunteers to implement something they needed is equally important. Presently, ISF is trying to reflect on and consider more long-term implications of their technical and community work.

Finally, K-Net builds on other autonomous media practices of First Nations communities such as Aboriginal Peoples Television Network (APTN) and First Nations Broadcasting radio (Roth, 2005). This particular region has deftly managed numerous funding agencies and project-driven grants to provide broadband networks to support telehealth and video conferencing capabilities. The rural landscape and its wilderness have presented significant physical challenges to Wi-Fi networks that do not present remedies as easily as urban spaces. As well, the region does not have the same population of amateur and professional computer scientists and engineers to support, maintain, and champion Wi-Fi initiatives.

In all of these models, key factors that have not been made central to the networks are sustainability and user integration. While each of these sites has had a small group of individuals serving as advocates for the Wi-Fi networks, ultimately, it has been quite astounding to see the incredible good will, time, and energy that these small groups of individuals have put into play to develop and maintain these networks. One of the challenges will now be to mentor other individuals to keep this work going as well as to diversify the group of people doing it. At present, it is mainly men who are involved in developing these networks. While this is understandable in terms of the demographics of computer science and engineering students in Canada (see Canadian Women in Computing, 2008; Galpin, 2002), their commitment to transferring these skills, particularly at ISF, can play a role in changing the power dynamics and also influence the types of content and future users for these networks. (For example, see some of the exciting work being done by Studio XX in Montréal: http://www.studioxx.org.)

Finally, in terms of the policy context, the 2006 Telecommunications Policy Review Report awaits parliamentary review and implementation. The recommendations of this report state quite clearly that markets should determine development of telecommunications and that federal governments should be committed to facilitating rural access to telecommunications (Telecommunications Policy Review Panel, 2006). These case studies not only defy the recommendations of

the report and demonstrate ways in which local communities can provide public information utilities outside of market forces, but also make a case for the continued importance and need for public information utilities.

These cases demonstrate that municipalities and communities can make use of licence-exempt spectrum to provide useful infrastructure and content to local residents. However, they are also a patchwork of broadband delivery and access and are not always duplicated easily. What we do know is that individual champions, technical expertise, and opportunities are important ingredients. The latest challenges for these networks are how this technology will work with other mobile devices, the fate of unlicensed spectrum, and quality assurance for services available to users.

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Note

1. Principal investigator: Catherine Middleton. Co-investigators: Andrew Clement, Barbara Crow, and Graham Longford.

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Île Sans Fil: www.ilesansfil.org

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