Designed for Work, But Not From Here: Rural and Remote Perspectives on Networked Technology

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ABSTRACT
While workers in an urban environment typically enjoy full speed, always available, broadband access, those in rural and remote environments do not necessarily have access to the same level of service. In this paper we describe insights from a qualitative study examining the benefits and continued challenges of using networked technologies for work purposes in rural and remote communities. Our findings indicate that work in these areas increasingly depends on networked technology to support in-situ and geographically distributed work practices, and to ameliorate health and safety issues, but that participants experience significant challenges in obtaining signal access and stability. We discuss implications for design and future research that arise from our findings.

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H5.m. Information interfaces and presentation (e.g., HCI): Miscellaneous.

INTRODUCTION
In an urban environment, people have become accustomed to 'always on', easily accessible internet connections. Given the substantial infrastructure in place, nobody is ever far from networked technology. Often this technology is used for social purposes; however, networked technology also plays a critical role in supporting work practices, such as providing the ability to contact vendors, customers and co-workers, and to research new products and developments.

High-quality networked technology is ubiquitous in urban centers. Despite the numerous potential benefits [28], the same cannot be said of rural and remote regions, even those found within western, highly industrialized nations. For example, according to a report issued in 2010 by the Canadian Radio-television and Telecommunications Commission (CRTC), in Canada, 16% of individuals living outside of urban centers are without broadband access [6]. At 40% without broadband, rural residents in the northern part of the country are the most underserviced [6]. In contrast, 100% of Canadians in urban centers have access to broadband [6]. Even when broadband is available in rural regions, this does not necessarily mean access to high-quality services, since the CRTC classifies any 'always on' internet connection with speed over 1 Mbps as broadband, a low threshold compared to the 100 Mbps typical in an urban workplace [7]. Furthermore, in rural areas, high speed or broadband is often provided over wireless-based technologies, which can be impacted by weather and other environmental factors, limiting the 'always on' ability.

Unfortunately, the situation in rural regions is not likely to improve in the near future. A 2009 Federal Communications Commission (FCC) report indicated that 16,000 towers would need to be added to support wireless broadband in rural regions in the United States [13]. The report compares this type of infrastructure to the creation of roads, bridges and electrical power grids. In their 2011 update, the FCC concludes that implementing this infrastructure is a "task of significant cost and complexity that will require continuation of […] efforts" [14].

Given the discrepancy between urban and rural connectivity levels and challenges associated with reducing this gap, our work seeks to understand the impact of currently available connectivity on rural individuals' use and perceptions of networked technology. We focus our investigation on the use of networked technology in work practices critical to these regions, such as farming, construction and tourism. In particular, through interviews with 15 participants located in rural and remote Western Canada, we examine work practices in these environments, the role that networked technology plays in these work practices and any impacts of lack of or poor connectivity. While our work targets rural regions in Canada, our findings and their implications are applicable to many westernized nations.

Our findings reveal the following key themes:

1) While many participants expressed negative sentiments towards the status of their connectivity, technology supports the *geographically distributed* nature of their work that tends to frequently occur *outside of*

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traditional office settings and hours. Networked technology also provides a means of communicating information essential to maintaining *community health and safety*.

2) Service interruptions are frequent and disruptive, often forcing participants to *drive to areas of better service*.
3) *Stability of service* is often seen as more important than connection speed.
4) Improving connectivity is something of a *Catch 22* situation. Without sufficient connectivity, attracting enough business and residents to an area is challenging. Yet without the customer base, it is difficult to convince service providers to build and maintain the infrastructure required for connectivity.

Given the challenges associated with obtaining sufficient connectivity and the importance of networked technology in rural work environments, our findings highlight the need to design for poor or intermittent connectivity.

The remainder of the paper is structured as follows. We begin by reviewing related work. This is followed by a description of our study method and findings. Based on these findings, we then describe a number of implications for design and promising areas of future work.

RELATED WORK

Our review of related work focuses on the intersection of networked technology and rural use. Studies in this area have tended to fall into four broad categories: (1) tool deployment in rural, developing areas; (2) the use of the internet for social purposes in rural communities; (3) technology penetration in rural/remote environments and (4) technology use in rural/remote environments.

Tool Deployment in Rural Developing Areas

Much of the rural-themed HCI research has taken place in developing areas, where researchers have deployed tools, often with an educational focus, and have examined the issues surrounding their use. Valderrama Bahamondez *et al.* [34] studied the impact of introducing mobile tools into Panama schools. They found that mobile tools were welcome additions to the classroom in part because rural students were much less likely to have access to personal computers than their urban counterparts. Kumar *et al.* [24] introduced mobile phone tools in rural India, but found that limited access to electricity impeded their use. Finally, Cervantes *et al.* [9] examined use of One Laptop Per Student (OLPS) computers in Mexican schools. They found that socio-economic status had an impact on schools' ability to support students' laptop use and noted the importance of considering *context of use* in design.

In the domain of healthcare, Chetty *et al.* [10] took a participatory approach to designing a telemedical tool. They found logistics a challenge in not only the product but the design process itself. Ramachandran *et al.* [32] used mobile devices for storytelling to help motivate rural health workers to gain training. The health care workers used cell phones to distribute videos among each other, sharing knowledge in a very organic manor. Frohlich *et al.* [17] also developed a system for digital storytelling, but for more social purposes. Their system allowed residents of a village in India to use cellular phones to create digital video stories for playback in their community, with infrastructure challenges forcing a change in their design. Finally, Bidwell *et al.* [5] studied digital storytelling in rural Africa, stressing the importance of understanding cultural and environmental context of use.

Social Internet Use in Rural Areas

Networked technology enables new methods of making social connections. While there are many studies of social media in HCI in recent years (e.g., [25]) there are few that relate to rural and remote communities. One exception is Gilbert *et al.*'s [18] empirical analysis of MySpace profiles, which focused on how people living in rural US communities interacted with social media. They compared rural and urban user profiles over a wide range of demographics finding that, for example, rural users tended to keep their profiles more private and had geographically closer contacts than urban users. Larson [26] studied social use of the internet by rural residents in Kansas, finding that rural people had high expectations for the internet being able to connect them to resources, be it material goods, social contacts, or reference information. At the same time, many participants expressed reluctance to fully engage with technology stemming from intimidation, or the awkwardness of the different social structure.

Penetration of Networked Technology in Rural/Remote Environments

Other work has focused on quantifying technology uptake and penetration in rural and remote regions (e.g., [19, 20, 21, 35]). Examinations of access to broadband and user uptake in rural North America (in particular the United Sates) include those by Glasmeier *et al.* [19], Wolff *et al.* [35] and Glass and Stefanova [20]. These quantitative studies of broadband use have found that communities in rural areas use networked technologies to a much lesser extent than those in urban areas. However, as the above studies admit, and Frieden [16] suggests, FCC reports and the National Broadband Map [15] might be over-estimating the availability of broadband because of the manner in which postal codes are grouped. A single town within a postal code with good connectivity can skew the data for the area. Our study uses qualitative methods to gain more detailed insight into users' day-to-day experiences in rural areas.

Technology Use in Rural/Remote Environment

In contrast to studies on technology penetration, relatively few studies have taken an in-depth look at technology use in rural environments or at how existing connectivity levels impact users' perceptions of technology.

Bakardjieva [3] conducted a focus group with rural residents of Alberta, Canada regarding their experiences with networked technologies. Participants felt they needed the same level of access to networked technology experienced by their urban counterparts, and at a similar cost. At the time (2008), many participants still used dial-up internet access and were eagerly anticipating wireless-based broadband technology at an affordable price. In their 2010 paper, Bakardjieva and Williams [4] describe impressions of residents and policy makers following the initial implementation of Alberta's SuperNet broadband access. They found that government and media promotion was not as linked to broadband use as practical uses grounded in everyday practices of rural residents.

Richards [33] compiled an overview of studies of information technology (IT) penetration and involvement in rural development with a focus on what forms of promotion resulted in increased uptake. Similar to the study described above, they found that promotional campaigns were less likely to increase uptake of IT than suggestions from trusted family and friends. They also found that perceived usefulness of IT by rural business was less than expected. The reasons for these perceptions were not discussed.

McCallum and Papandrea [27] studied technology use in Australian remote aboriginal communities and found that people had very little access to networked technology and typically underused the internet to a great degree. Underuse was also found by Oreglia *et al.* [30] who studied technology use by farm families in rural China. The authors found that while many used mobile devices for phone calls, farmers continued to rely heavily on face-to-face communication. While this is one of the few examples to take a detailed look at technology use in rural regions for work purposes, the authors did not explore issues relating to network connectivity and the cultural and political differences between that area of the world and rural Canada are also significant.

In summarizing the above related work, we note that no one has looked at the intersection of (i) rural perspectives of networked technology use in western, developed nations with a focus on *work* needs and (ii) technology/non technology choices rural users make and why. Our work also seeks to understand how technology can be designed to mitigate infrastructure challenges as opposed to focusing on policy recommendations.

METHOD

To understand the role of networked technology in rural and remote work practices, and perceptions of available connectivity, we conducted a series of semi-structured interviews with 15 participants (9 females and 6 males) who work in remote or rural locations in Manitoba (located in Western Canada). Participants were recruited through snowball sampling, beginning with the authors' personal contacts. Table 1 describes each participant's occupation, location within the region and current connection type. Four participants were interviewed in pairs since they work closely together (denoted P1(1)/P1(2) and P8(1)/P8(2)). Table 1 illustrates the diversity of participants' occupations, including farmers, teachers, and a commodities trader. Our participants also represented a range of ages (mid 20s to late 50s) and areas within the region.

During the interviews, we asked participants to describe the nature of their work and the corresponding role of networked technology. We asked for specific cases of interaction with customers, vendors, or others they identified they communicated with to ground the data. When possible, interviews took place in the rural workspace of the participant where photos and notes could be taken about the environment. Owing to traveling constraints, four interviews took place over the phone. The interviews lasted 20-45 minutes. Data was collected via audio recordings, which were later transcribed.

Interview Questions and Data Analysis

Our interviews sought to answer the following questions:

- What types of networked technology do workers in rural and remote areas use and for what purposes?
- Who do workers in these areas need to communicate with and how does this communication take place?
- How do currently available levels of connectivity support or hinder their work?

Data from the interview transcripts were analyzed by creating affinity diagrams using a bottom-up inductive approach. From these affinity diagrams, we extracted commonalities and themes relating to work practices, technology use and perceptions of available connectivity.

FINDINGS

Our findings are organized as follows. To provide context, we begin by describing a cross section of our participants work practices. We then describe some of the ways in which networked technology is supporting their work practices. This is followed by a discussion of open issues for networked technology use in these communities.

Working in Rural and Remote Areas

We begin by describing the types of work that occur in the rural and remote environments examined as part of this research, which tended to fit within four categories: resource-based business and related construction, tourism/hospitality, urban work transplanted, and public service. To illustrate each type of work, we describe specific practices of four participants (using pseudonyms).

P	Age	Gender	Type of Work	Area within Manitoba	Distance from Urban Centre	Connection Type
1(1) / 1(2)	45-55	F,M	Organic Farmers	South Central	150 km	Was dial up, is now a G4 stick
2	45-55	F	Newspaper Owner	South Central	240 km	DSL
3	40-50	M	Beef Farmer	South Central	235 km	Radio Freq.
4	55-65	M	Seed Marketer	Traveling	Various	Cellular
5	20-30	M	Carpenter/contractor	Various	Up to 820 km	Satellite, Cellular
6	45-55	F	Construction Project Administrator	North	1100 km	PAX line & others
7	55-65	F	Medical Software Distributor	Throughout	Up to 770 km	Radio Freq.
8(1) / 8(2)	50-60	F,F	Teachers at Adult Education Centre	South	100 km	DSL
9	40-50	M	Landscape product Distributor and Commodities Trader	South	100 km	Radio Freq.
10	50-60	F	Owner of Bed and Breakfast	West	250 km	DSL
11	30-40	F	Hunting and Fishing Guide and Epicure Distributor	North	670 km	Satellite
12	25-30	M	Grain Farmer	South	240 km	Satellite
13	25-30	F	Homemaker	South	240 km	Satellite

Table 1 Participant demographics, occupations, geographic locations and connection types.

Resource-Based Business

P1, Mary and Sam, are a married couple who together run an organic farm. Sam works long hours in the yard and in the field and is not able to contact people during business hours. In addition to growing grains on their farm, they also grind them into flour and rolled oats. To this end, they share flour shed with a partner farm on a property several miles away from their home. Mary works at the flour shed several days a week grinding and milling grain and filling orders. On other days, Sam and Mary load their truck and travel to make deliveries both in the countryside and in the city several hours drive away. They also ship to customers in other parts of the country. Since they switched from a dial-up connection to G4 cellular based internet access, Mary is able to bring her laptop computer into the shed and on the road to aid with deliveries and processing customer orders.

Tourism

P11, Tina, works with her husband Randy, a guide for hunters and fishers from outside the province. Tina and Randy maintain and run a camp during hunting season. For client safety, Randy carries a satellite phone, a cell phone, and a two-way radio to ensure signal in the remote location. Randy and Tina prepare successful catch for transport including gathering required customs paperwork. To operate their business, they access government agencies from their home, where they have Satellite internet access. In the off-season, Tina works as an Epicure distributor, using the internet to order for her friends and family, many of whom are geographically distant.

Urban Work Transplanted

P9, Ed works as a landscape product distributer and as a commodity trader. For the former, Ed works with his wife Sally in her Landscape Product Distribution company, which they run from their rural acreage. Since logistics and customer service are core to this business, communication technologies are essential.

Ed is able to work with his wife because his other work trading commodities can, in theory, be done from "anywhere" now instead of on a trading floor. Ed monitors real-time charts on his computer, in his home office, and decides when to make trades. This requires that he constantly get up-to-date information and that he does not lose his connection.

Public Service

P8, Kim and Anita, are teachers at an adult education centre that serves clients from a moderately large rural area surrounding the small town where the centre is located. In addition to in-centre education services, they provide distance education via both traditional and online delivery options. The centre enjoys a dedicated high-speed line, so when students come to the centre they have full speed access to the internet. Since students may be located anywhere in the province, there are varying levels of connectivity in their homes and offices, which can make aiding certain students difficult.

Summarizing Work Characteristics

Examining our participants work practices revealed a number of commonalities. Distance is a frequent theme for the rural work experience, with even near neighbours distant as compared to those in an urban area. In particular, customers and vendors are often located far away from the work location. Either due to the nature of the work, or due to this distance, workers rarely spend much time in an office. There is heavy reliance on connectivity in most participants' work and in many cases, maintaining a consistent, stable connection is important. In the next section we delve further into the primary roles of networked technology in our participants work practices.

Role of Networked Technology

When we asked participants about the use of technology in their community, participants were often hesitant, which appeared to stem from cultural expectations. For example, in the quotes below P3 and P10 indicate that many old-fashioned individuals in rural communities and farmers tend to avoid technology:

> *Most farmers don't handle high tech at all, and cattle farmers even less so […], if they can't put their hands on it it's not real. – P3*

> *There's a lot of old fashioned people out there, still like the telephone. – P10*

Yet, our participants described using technology on a regular basis, in ways that were integral to their work practices. For example, P10, described herself as someone who was not technically inclined, but then proceeded to describe a series of encounters with customers at her Bed and Breakfast who exposed her to various online applications. She ended the interview with the following:

> *I'm getting more appreciative of my computer than I ever was. –P10*

When participants spoke using networked technology, the most dominant advantage raised was the ability to complete tasks efficiently and the importance of efficiency to their work. In the following quote, P9 describes how a combination of different technologies (an on-line shipping system and e-mail) enables him to send and receive landscaping supplies with very little time delay:

> *Once you enter a shipment [into the computer] it triggers something within [the vendor's] system where it notifies that their driver that there's a pickup to be made at our company […]. And also there's one of the drivers that we have his email address and he has a blackberry so we just email and say ok we've got a pickup today for you. – P9*

Networked technologies have also opened doors to allowing new industries into certain rural areas:

> *[Before], in order to have some of the access that you do today, you'd have to be physically there at the trading [floor], at the commodity exchange, or the stock exchange […]. And now with the advent of electronic trading and the age of the internet, it's evolved to the point where it's very sophisticated and it's all done electronically so […]as long as you've got high speed internet you can do it from anywhere – P9*

One of the dominant technologies used by our participants is email, as a large part of their work involves communication with relevant stakeholders (e.g., customers, vendors, employees, government, contractors, clients and students). P11, who has run a newspaper for many years, describes how she accepts submissions for articles and advertisements from various community members:

> *Email has made my life so much easier, people used to do... they'd call me up and they'd say 'I've got this picture I want to send you, and it has to be for this week, and a certain week... can I fax it?' and I'd say 'no... a picture you can't fax', now I say' just email it'. –P11*

We found that in addition to generally improving efficiency, networked technology plays a critical role in the following areas key to working in rural/remote environments: (1) supporting in-situ 'workstations', (2) enabling reliance on distribution work groups and (3) promoting community health and safety.

Reliance on of In-Situ 'Workstations'

Likely typical of many industries in rural and remote areas, the majority of our participants work outside of a traditional office setting. Participants commented on mobile networked technologies enabling them to use technology in-situ and the value that this mobility brings. We learnt that as farm equipment becomes more technologically sophisticated, farmers are able to do more and more office type work from the tractor. For example, some tractors come equipped with GPS and auto steering, enabling farmers to both work their fields and keep in contact with vendors, markets, and partners. P4, a seed marketer, described receiving lots of text messages from his farm contacts during seeding in recent years:

> *[the] Biggest frequency of contact with producers, farmers, is during seeding, which historically, is no, but they all have auto steering, […] so I'll get phone calls from people, I'll get text messages […] I'll get dozens of texts every day from guys in the field. They're doing something and they want something, and before they'd never do that ever. So they're tuned in to what's going on. – P4*

These farmers can combine their day-to-day operations with the communications and management needs of their farm, tasks formerly confined to early morning or later evening hours and done back at the office. When cellular connectivity is sufficient, there is a wealth of social media and applications waiting for farmers to use, as described in an edition of Farm Credit Canada AgriSuccess [12] provided to us by P4. According to the magazine, farmers in areas with good connectivity are heavy users of email and other networked technology, which P4 backs up with experience.

P1(1), a farmer, talked about being able to work on her laptop while traveling to deliveries, and P10, a bed and

breakfast owner, about being able to access community and weather information from her kitchen or living room.

Reliance on Distributed Work Groups

Geographically distributed work groups have been enabled in these areas by increasingly better networked technologies. The small businesses that we talked to had clients across Western Canada and the education facility in which P8(1) and P8(2) work services clients all over the province. They routinely rely on remote communication with their clients/students and use networked technology to access shipping, banking and government services.

Participants also described time-distributed work practices that are supported by networked technology. These participants spend long work days away from their desks, in industries such as farming and construction. Having the ability to communicate with government, vendor, and client offices outside of regular business hours is very important and only plausible by accessing on-line services:

> *'cause [government officers] are done at 4 and I'm not done until 10 or so and when they send forms over the line, online it's a lot easier too – P1(2)*

Health and Safety

Use of and availability of internet in rural areas has an impact on health and safety for both our participants and those beyond the local area. Our participants spoke of the ability to check for hazardous driving conditions and the ability to contain contagious illnesses:

> *With all the flooding in Souris [...] There's an update website -- I'm always checking the weather - P10*
>
> *what roads were closed, where not to drive - P10*
>
> *We had the first case of H1N1 in a confined camp [...] getting our message out, getting it out quickly, getting it out accurately was optimum. If it wasn't for email -- on that day that we got confirmation from health Canada we emailed all of the contractors, who emailed all of their staff that they could –P6*

The use of technology in P6's experience with the H1N1 virus prevented its wider spread by keeping exposed staff from traveling to other areas.

P3 spoke of how on-line auctions have allowed cattle farmers to view livestock without the animals leaving their home farm. These on-line auctions have the efficiency advantage of not requiring the farmers to travel, but more importantly, they are safer for the animals themselves:

> *They can take a picture of the feeder cattle and you can go and take a look at those cattle without having to be there. Then they actually don't leave the farm that they come from until you buy them and then they come directly. Instead of actually going through an auction ring, that's where they pick up diseases and things and stress. The animals get stressed the more they're handled and stuff. –P3*

Service Type	Availability – According to Provider	Availability – according to participants
Dial Up	Anywhere with a phone line	Provider is accurate
DSL	Select towns, provider shows list	Provider is accurate
Cellular 4G 'Stick' (2 ISP)	Relative to tower locations, provider shows map	4G does not reach all locations indicated on the map
Cable	Select towns, provider shows list	Provider is accurate
Satellite	Relatively universal	Weather impedes access
WiMax and/or other radio frequencies	Relative to tower locations, provider shows map	Provider does a site survey to determine case by case access

Table 2 - Available Internet Service Provider Types

A safer food supply for consumers and better protected investment for farmers is possible if the farm owners have access to a good enough internet connection for the online auction technology to work consistently.

Open Issues: Rural/Remote Networked Technology

While the vast majority of the quotes we collected about the use of networked technology were actually positive, when we first approached participants, a typical response was "oh you want to talk about how terrible our internet is?" In this section we describe some of the reasons for these lasting negative perceptions and challenges that remain for improving service in these areas. We begin by describing the type of services that are available in these areas.

Service Availability

Table 2 lists the service provider types we encountered during our interviews. As table 2 indicates, these services are not necessarily available to all we interviewed, depending on where they are located.

Participants spoke of the situations where the environment, either geography or climate, has limited their options and access to broadband internet:

> *We had the other one, that was tower to tower, but we're out of sight from the towers here, we're kind of in a hole here so that one didn't work either, satellite was the only option we did have. – P1*
>
> *The wrong trees or something in the road and it wouldn't get the strength strong enough to get it. –P3*
>
> *Cloud cover, snow storm, rain storm, thunderstorm [cause problems] same as your satellite TV –P3*
>
> *You've got to do your online banking on the sunny days – P5*
>
> *If [the connection] doesn't work, or the internet goes off, I look outside, 'ok it's raining or its thunderstorm'. –P11*

Importance of Stability

Participants also spoke of the importance of stability of service and considered it to be a key business resource:

> *If we're down for a day or two, I mean that really affects your business quite a bit because you communicate with your customers. You want to make sure you're there all the time. - P1(2)*

Participant P9 noted that his work involving commodity trading depends on consistent high-speed internet. P9 was adamant that it did not have to be the fastest connection available, but it needed to be extremely consistent; he could not afford to miss a moment of real-time data. He indicated that dial-up is too slow, and that satellite would be too inconsistent for his needs. For him, missing a few minutes would be a problem.

Several participants described frustrating incidents of trying to accomplish tasks and being interrupted by inconsistent network access. For P5, the frustration became so great he has simply quit using the internet until he can get a new provider.

> *But [with this ISP], you have to sign a 2 year contract, so I'm basically stuck with it. As soon as that's done, it's gone. [...] Whenever I can cancel it I will. – P5*

Frustration with Multimedia

Participants did not make use of networked technologies when the available connection was insufficient. In particular, video-based media is difficult for participants to access with current network speeds. P3 gives an example of what it is like dealing with streaming video:

> *[the video] wasn't one you could stop it and let it download and then play it. As soon as you click it to stop, it started the thing all over again. So it doesn't help. [...] Yeah you get a couple seconds at a time. – P3 [using wireless broadband]*

Since multimedia is a large portion of the content found on the web, participants' frustration with this format may be a major contributor to the overall negative impression that many have towards networked technologies.

Unsustainable Coping Strategies

The previous sections reveal that not all of our participants have a consistent, good enough, internet connection. Out of necessity, our participants all noted alternative communication methods they depended on when connectivity was unavailable, or sub-par. For some, this involved using text messaging and e-mail rather than relying on cellular technology for phone calls:

> *Cell phones work so poorly here, so if people really need him, he tells them to email him, because that will get through when a call won't. – P2*

Others commented on having to rely on two practices that have environmental implications. The first involves printing and faxing documents. They described needing to print documents to take with them, having to request to receive large documents via fax, or needing to send faxes to communicate with groups in underserviced areas:

> *If we knew they were sending a big file we'd tell them to send a fax or put it in the mail or whatever instead of emailing to us depending on what it was. – P1*

P1 describes how a more reliable mobile internet connection immediately reduced her need to rely on the less sustainable practices.

> *Yeah [the G4 stick] saves a few miles. And when I've got my computer at the flour shed I don't have to carry the papers, so I'm not printing everything out all the time. [...]It's a little easier on the trees. – P1*

Unfortunately, G4 connections are not available to all rural participants. More cellular towers would be needed in places where there may not be the customer base deemed economically necessary by the cellular providers.

Participants also talked about traveling to get a better connection and traveling for face-to-face communication, when their connection was not good enough.

> *I generally had to drive 6 miles to get any service at all. - P6*

> *Basically, I don't work from home if the connection isn't good. If I have to go to town, or head back into the city, often it will be because I need a more solid connection. – P7*

Improving Service: A Catch 22

While the lack of quality service is disruptive to our participants, creating the right financial incentives to increase service levels in rural and remote regions is something of a 'Catch 22' situation. Participants in rural areas with larger communities (e.g., P2, P8, and P10) were able to access wired broadband. As P6 and P5 describe, however, it is less economically feasible for providers to service less densely populated areas:

> *These are untouched areas [...] everything's based on numbers, based on amount of users. – P6*

> *I got them to put me on a list 'cause, if they get enough customers, they're going to put another tower up, somewhere around here. – P5*

But lack of or poor service makes it difficult for people to live and work in these communities. Industries in rural and remote areas are also run more and more efficiently:

> *[the] farm hasn't changed much in size, but there are less of us doing the same amount of work. [...] Better machinery and we've changed to different methods to streamline things so there isn't as much work that has to be done. – P3*

Ironically, greater efficiency means that fewer people have to live in these areas, making it difficult for those who remain to get access to the internet and cellular services they want.

While there are many sections of the country with poor service, it is the north that is faced with the biggest connectivity challenges. Northern Manitoba is the most

poorly serviced area in the province according to the 2010 reports [6], and provider maps [23]. Participants sited areas that had no cell service at all and no internet that they were aware of. P6 described an incentive program created by the government to increase the number of jobs for aboriginal people in the community that was unable to fill its positions due to difficulties communicating with interested parties:

> *One of our greatest difficulties is reaching the people, [is] getting the message to them. Many aboriginal communities [are] without cell phone service, without internet service, many homes do not have phones, they don't have running water, so to expect them to have phones or that sort of thing makes it difficult. – P6*

These areas are far from cities, difficult to access, and often sparsely populated. P6 describes how convincing an Internet Service Provider to provide service requires cooperation of multiple parties:

> *The only way we could have a cell tower in, was to have [a government owned utility company] partner with aboriginal groups to say that they would utilize it. [The utility company] would provide the hardware, the information, the location, a lot of the service. But you need to have [one of the big service providers] also bring in their equipment and stuff to sustain it […]" –P6*

The quote above describes how access to service depends on the utility company building the tower, creating the road and providing access for the service provider to get their equipment to the tower. It depends on the aboriginal groups agreeing to long-term use of the services and on the service provider agreeing to provide hardware and service. Without cooperation of all three groups neither the utility company nor the aboriginal group has access.

DISCUSSION

Access to networked technology in rural and remote areas is improving and people are taking advantage of this, but lack of stability and poor support for multimedia applications leave a negative lasting impression. Distributed work groups, over both time and distance, are particularly important constructs for people in rural and remote areas due to the long hours worked in many industries and long distances between communities. The wireless satellite-based broadband service common in remote areas is not as consistent or fast as the wired broadband used in urban areas, accounting for users' negative perceptions.

Our study suggests that the importance of rural and remote connectivity reaches beyond the residents of these regions. For example, government agencies and large companies need to service constituents/customers in a widely distributed service area. Since some of these customers cannot access multimedia content, these companies and agencies have three options: restrict all customer communications to non multimedia, ignore rural customers, or create a two-tiered communication system. With each option, both the customers and the company loose out via either higher cost or poorer communication mode.

The health of everyone is improved by better rural access to network connectivity. We learned from a participant that online auctions are improving the health of livestock, which improves the safety and consistency of our food supply. Tracking contagions can slow the spread of outbreaks and this requires a network connection between the location of the person who is sick and health officials. Health connectivity keeps people healthier, and saves money in the health care system and all businesses via reduced lost work.

Reliable connectivity in rural and remote areas also plays a role in keeping people safe. Rural and remote highway systems are used for transportation of goods and resources, and access to parks and recreation areas as well as for connecting various urban areas. Reliable connectivity in these areas would allow for faster emergency response to auto accidents and preventing movement of dangerous goods down closed roads due to things like flooding. Good connectivity can also help stop wild fires early and provide easier reporting and publicizing of severe weather and natural disasters. If good connectivity is available in rural and remote areas, safety issues can be reported early, before they reach more populated areas.

IMPLICATIONS FOR DESIGN

Given that sufficient connectivity in rural and remote regions is likely to remain an issue for years to come, we turn to the role of design in developing and supporting technologies for these environments. We look at the following design considerations: 1) networked technology as a part of a larger system, 2) taking advantage of connectivity maps and GPS, and 3) accounting for environment in design and testing.

Networked Technology as Part of a Larger System

Given the slow and unreliable nature of connectivity in rural and remote regions, providing users with the ability to work asynchronously is a must. Our participants' frustration with multimedia was one of the main reasons for their negative feelings towards their network connectivity. Parikh and Lazowska's [31] proposed architecture for supporting mobile users in rural developing areas included such things as asynchronous capabilities in mobile applications. Our findings suggest that these kinds of considerations apply to various situations.

Another issue is that of environment awareness. There is a need for tools that can help users monitor and understand the health of their connections. The Kermit tool [11], which allows users to monitor connections speeds within a local area network, would aid rural users a great deal in identifying when they are having a connection issue. Augmenting such a tool to provide information about the health of the external connection would be helpful for users of wireless broadband.

That same environment awareness can allow interactive applications to adjust the way they behave. An application

that streams immediately in an urban high speed network, can switch to extra buffering when an inconsistent connection is detected. Including connectivity feedback to users allows them to consider waiting until they are at a location with a better connection, such as a public high-speed hotspot.

Our study highlights that networked technology is rarely used in isolation, but rather is used as part of larger system of users' work and communication with relevant stakeholders. Therefore, rather than competing with other forms of communication, there is an opportunity for technology to take advantage of input from different sources of information (stored, user provided, etc.) to provide the best overall user experience possible.

Taking Advantage of Connectivity Maps and GPS

Internet Service Providers include maps on their websites to show where their services are available [23]. This is particularly useful for wireless services; however, the question is whether these maps show the whole picture. Often the answer is no, since wireless provider maps indicate a best-case situation for their tower network. These do not let users know what sort of hardware you require for the level of service they indicate, nor do they include any private service boosters that might be available. In the UK there are at least two crowd-sourced connectivity map projects [1, 29]. These applications allow users to provide data on their signal to a central database and in turn access data about connectivity provided by others who use the application. This more accurate and detailed information would be very beneficial to rural and remote workers, letting them see where to go for better connectivity.

Mobile operating systems able to tap into a map of surrounding connectivity (available asynchronously) could adjust their behaviour accordingly, for example, by waiting to poll for a connection until the GPS indicates nearness to a known signal-rich area. Only polling for email when a good signal is available would significantly save battery life and ensure better road safety in remote areas.

Accounting for Environment in Design and Testing

Designers and developers cannot change the connectivity situation, and while they can advocate for full broadband for everyone, the political situation is complicated. In the interim, designers and developers should consider the broad spectrum of connectivity situations in choosing methods of content delivery. For example, designers should carefully consider the use of large images and video, particularly streaming videos. It is also important to continue examining ways to allow users to get the meaning of large content prior to a full download, through, for example, selective pixel loading in large images [22].

Another potential area of focus is tools for testing applications that simulate varying connection speeds. One such example is the loband simulator by Aptivate [8]. Their tool allows the testers to input a webpage and connection speed, and then experience the use of that page at the selected speed. Such tools would allow quality assurance practitioners to target different demographics, which could be particularly important if the website in question is selling farm equipment, or construction trucks, among others.

SUMMARY AND FUTURE WORK

Connectivity is improving for rural and remote areas and is leading to networked technology forming an integral role in work practices. Despite these positive advances, our study indicates that challenges remain. For example, not all residents have access to enough speed and stability for streaming multimedia. As a result, rural residents sometimes resort to inefficient workarounds, such as driving great distances to areas of better services.

There are a number of promising directions for future work. The first involves exploring implications for design that have arisen from this work, including design of connection- and environment-aware applications, user-friendly connectivity feedback, and systems that are tolerant of connection instability. A second avenue of future work involves embedded participatory research (e.g., [8]) with residents in the Northern parts of the country where both infrastructural and cultural factors appear to be impacting networked technology use the most. The areas are furthest from urban centers and dramatically effected by severe climate change and global economic issues. Broader understandings of factors impacting networked technology use in rural/remote regions, and tools that support these practices are necessary to ensure greater inclusivity.

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