THE ROLE OF SOUTHWESTERN ONTARIO MID-SIZED CITIES IN A REGIONAL AND RURAL BROADBAND PARTNERSHIP

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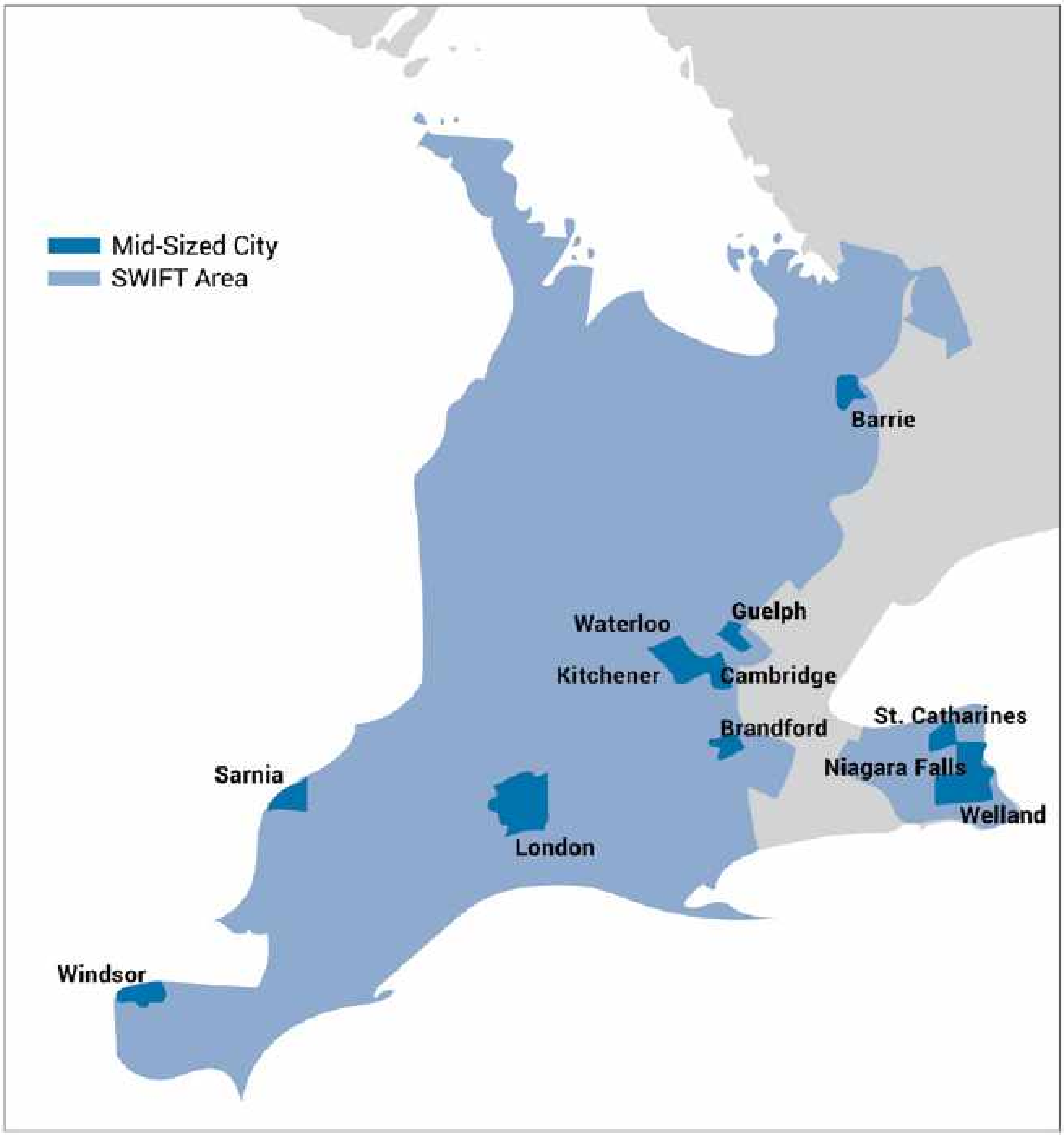
EVERGREEN



INTRODUCTION

Digital technologies, including the internet, have created a new age of regional economic development in Canada. Ultra-high-speed connections link mid-sized cities to one another—and more importantly, as we argue in this paper, to surrounding areas. The 2018 report *How to be Smart(er) in Mid-Size Cities in Ontario* prepared by Evergreen and Code for Canada sets the broader context for this discussion, but we will focus our findings around the first dimension of "smart cities": networking and telecommunications infrastructure, and more specifically broadband.[1]

[1] https://www.evergreen.ca/downloads/pdfs/2018/tech-and-data-msc.pdf

The term MSCs is used here descriptively to include urban areas within municipal boundaries that have a population of between 50,000 and 500,000 residents. We recognize that cities such as Sarnia and Guelph do not meet the Census Metropolitan Areas (CMA) criteria (>225,000 population). "Rural" is a descriptive term used in the paper to refer to areas outside urban areas, including smaller towns, villages, and hamlets. In Southwestern Ontario, First Nations communities also border MSCs. Rural areas are less densely populated and include zones of environmental and agricultural significance.

The objective of this paper is to examine the role of MSCs in regional and rural broadband initiatives. Drawing on data collected by the broadband investment program known as the SouthWestern Integrated Fibre Technology Inc. (SWIFT) network, this paper considers the importance of MSCs within the overall architecture of SWIFT, and the opportunities and challenges for MSCs in expanded networking and telecommunications infrastructure across Southwestern Ontario, Niagara, and Caledon (herein shortened to SW Ontario).

This paper first provides an overview of literature on understanding the role of MSCs in regional and rural broadband. Subsequently, we present the case of SWIFT to examine MSCs as they relate to broadband infrastructure, economic outcomes, and social benefits. This case study highlights apparent opportunities and challenges for the role of MSCs in regional and rural broadband connectivity. Finally, the paper concludes by identifying key research-related recommendations.

REGIONAL INFORMATICS FOR INNOVATION

We employ literature from two fields to examine the role of MSCs in creating inclusive, socioeconomically beneficial digital infrastructure: (i) community informatics, and (ii) innovation studies. Combined, they are what we refer to here as "regional informatics for innovation," and they aim to inform an ongoing analysis of MSCs as they relate to regional and rural broadband networks.

> Although gaps exist between broadband haves and have-nots, it is not the case that one possesses information and/or the ability to communicate, and one does not. Instead, there is significant variability in access to digital assets.

COMMUNITY INFORMATICS

The spread of faster internet connections (typically referred to as "broadband") has completely changed the way many people live, work, and network. This phenomenon can be described as the "triple revolution," referring to the proliferation of the internet, virtual social networks, and connectivity afforded by ultra-high-speed technologies (Rainie and Wellman, 2012). Broadband has fostered a vast range of digital technologies that creates not only connectivity, but hyper-connectivity (Quan-Hasse & Wellman, 2006). Fast-moving information, knowledge, and action makes synchronized communication and networked actions the "new normal" way of doing things. Not all individuals and organizations, however, get fully connected at the same time or in the same ways. Considerable attention has therefore been placed on what students of the socioeconomic impact of information and communication technology (ICT) refer to as the "digital divide," or the gap between those who have access and ability to use digital technologies to pursue their socio-economic interests, and those who do

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not (Castells, 1998). Some critical theorists such as Warshauer (2003) discourage the use of the term digital divide to represent what is, in fact, digital inequality. Although gaps exist between broadband haves and have-nots, it is not the case that one possesses information and/or the ability to communicate, and one does not. Instead, there is significant variability in access to digital assets. For instance, urban areas have different types of connections, such as cable (e.g., fibre, DSL, copper) than peripheral area networks (e.g., fixed wireless, satellite). Therefore, digital equality is very much based on what an individual, community, or region possesses, as well as on the modes of access and use of the assets.

To be an internet user on what could be considered the "have less" side of digital connectivity is to experience the limitations of living with gaps of information, knowledge, and communication, and, ultimately, without fully networked modes of economic, political, and social opportunity. We can say that users experiencing digital gaps have associated risks that can limit the achievement of their practical and strategic needs for housing, healthcare, employment, education, and legal rights or justice. Not all digitally excluded individuals suffer due to location or distance from connectivity. We do not consider, in the scope of this paper, inequality among users who experience digital exclusion due to socially constructed ability or identity.[2] The digital inequality addressed in this paper is locational, with emphasis on internet users who are in the intermediate and "last mile" of broadband connectivity (or the "end of the line" connection from a broadband point of premise to the individual premise [Paisley & Richardson, 1998]). There are still many communities, as Michael Gurstein (2003) reminds us, which experience

> systematic exclusions of locationally identifiable groups who, for whatever reason, are unable to make effective use of information and communication infrastructures- that is to go beyond simple access to ensure that the ICTs are useable, useful and being used- in support of personal and community objectives. (Gurstein, 2012:37)

The reasons behind locational digital exclusion are numerous and context-specific, but the predominant reason is that building and maintaining high-capacity telecommunications infrastructure is expensive, and peripheral internet quality of service is often compromised by distance from the core (fibre) network. The prevailing market logic of private sector and even public-private sector partnerships in telecommunications works in more densely-populated communi-

[2] For a sense of the scope of digital inclusion policy discussions and Ontario's recent summit, see: https://www.digitalinclusion.ca/

ties, but dispersed, less dense populations have been equated to relatively low user demand which is met with less competition and few options for service. Generally, rural/remote residential dwellings experience inferior speeds, or, at best, costly one-time connection fees with relatively higher monthly-recurring costs. Inadequate quality of service, particularly on older technologies such as copper telephone lines, is widely reported by groups such as the Rural Ontario Institute (ROI, 2018). In terms of socioeconomic opportunities, underserved areas generally compare poorly to locations with more competitive telecommunications options (Pant & Hambly, 2016). Generally speaking, there is longstanding policy-level awareness of the persistence of connectivity gaps in many rural and remote communities across Canada.[3]

After decades of statements issued from all levels of government seeking to close digital divides, in December of 2016 the Canadian Radio and Telecommunications Commission (CRTC) determined that 100% of Canadians will have access to reliable, world-class mobile and fixed unlimited data internet services with an unlimited data option (CRTC, 2016). Telecom Regulatory Policy CRTC 2016-496 states in Paragraph 21 of the ruling that “the latest generally deployed mobile wireless technology should be available not only in Canadian homes and businesses, but on as many major transportation roads as possible in Canada.” Furthermore, Paragraph 110 of the ruling states that quality of service is expected to “reflect the objective that broadband internet access services in rural and remote areas be of similar high-quality as those in urban areas.”

[3] As recently as this month (April 2018), in the 1st Session of the 42nd Parliament, the Report of the Standing Committee on Industry, Science and Technology was presented to the House of Commons by Chair Dan Ruimy. The report reinforced the need to close the digital gap in rural Canada.

As the data discussed below indicates, many users in non-urban SW Ontario do not experience such high-quality internet access services. CRTC's 2017 Communications Monitoring Report states that by the end of 2016, 84% of Canadians had access to download speeds of at least 50 megabits per second (Mbps) and upload speeds of at least 10 Mbps on fixed broadband internet services. CRTC has committed to 91% of Canadians reaching this target by 2021. As this paper will explain, service at the 50/10 Mbps threshold is far from ubiquitous within and across communities. As the data indicated below suggests, download and upload speeds may be lower and monthly costs can be significantly higher than averages reported by CRTC (2016).[4] Assessing internet service quality and understanding locational digital exclusion requires longitudinal analysis and system-level action.

Community informatics has an action-oriented approach to examining broadband, emphasizing the socio-technical linkages undertaken by user groups and communities to overcome digital inequalities. From community hackathons to business section hotspots, or from the home-grown establishment of wireless mesh networks to municipally-owned internet service providers, there is no shortage of examples of interventions. Many celebrated initiatives to overcome digital exclusion are, however, operating at the community network level (Clement et al, 2012). Scaling up community informatics to the system level may not be the main focus of the initiatives, and where it has been anticipated, it has not been as easy to achieve or sustain without linking the "soft system" elements of individual and organizational trust, active relationships, collaboration, and participation to the up-scaled technical or "hard system" elements of infrastructure (Dobrov et al, 1979; Simpson, 2005).

Understanding that community informatics initiatives are often challenged by scaling up to wider system-level change helps draw attention to the need for capacity building within and across communities. As an example, members of the Keewaytin-Okimakanaak First Nations council have created an active community of practice by re-framing broadband challenges as "first mile" community-led initiatives and not "last mile" connections (McMahon et al, 2010; Beaton and Campbell, 2014; Beaton, Siebel and Thomas, 2017).

With community-led, community-to-community cooperation efforts there are opportunities for regional innovation to overcome digital divides. This would require taking the community informatics approach to building not just a community network, but an aggregated regional network with capacity for connective actions to ensure broadband access for all.

Understanding that community informatics initiatives are often challenged by scaling up to wider system-level change helps draw attention to the need for capacity building within and across communities.

[4] According to data from CRTC (2016), the average minimum price for broadband in rural Canada is about $52 per month. Monthly prices in rural Ontario range from $30–$93, compared to $53 in urban Ontario.

ENABLING REGIONAL INNOVATION

In their seminal 1977 essay, *In Search of Useful Theory of Innovation*, authors Nelson and Winter explained that purposeful acts of investment are an important element of the dynamic processes of innovation. Innovation anticipates a dynamic, complex, and distinctly non-linear relationship between technology, institutions, and social change (Lundvall et al, 2002). Innovation is envisioned as social learning processes that implicate social networks and techno-institutional interactions. Within a Regional Innovation System (RIS), organizations, including firms, networks, and knowledge partners such as scientists are the crucial interacting elements of innovation. Although some literature posits that metropolitan areas are the primary sites for regional innovation, more recent research has proven the opposite. As Doloreux & Gomez explain, based on their review of 20 years of regional innovation literature,

> One key ambiguity is that RIS research has been problematized and theorized around stylized facts and the general belief that RIS can develop more easily in (metropolitan) regions that have built their competitive advantage from particular kinds of localized learning, which are functionally integrated in Marshallian agglomeration economies. This belief has led RIS research to fail to take into account newer approaches that acknowledge the diversity of pathways that can be adopted by non-metropolitan regions, and in particular approaches that seek to make sense of growth paths in peripheral and rural regions (Doloreux & Gomez, 2016:381).

From the perspective of RIS, focused investments leverage innovation arising from the complex linkage between technology, institutions, and social change. Whereas a neoclassical economics perspective posits that policy intervention is only legitimate and needed in the context of market failure. Innovation theory goes further to suggest that

> public intervention is legitimate and needed not only if the complex interactions that take place among the different organizations and institutions involved in innovation do not function effectively, but basically to promote a dynamic, innovation-based competitiveness trajectory or what is often referred to as a 'high road strategy' of competition (Coenen et al, 2017:603).

Public dollars spent on building fixed and mobile telecommunications infrastructure can be precisely described as the consequence of failed market forces (Rajabuin & Middleton, 2013). Indeed, since the 1990s, hundreds of millions of dollars from federal, provincial, and local governments have been spent to subsidize broadband infrastructure in SW Ontario. Broadband networks, and public investment in them, therefore become a relevant context in which to explore regional innovation. This is not regional development from the perspective of past agglomeration theories on regional clusters and the role of industrial districts; rather, it's a more evolutionary perspective. The latter involves facilitating change in the community's conditions through diversified economies, social learning, networked and communicative action involving stakeholder dialogue, and wide community engagement. Such evidence-based, process-intensive models of "transactive planning" are a distinct departure from the decades-old rational comprehensive planning models (Douglas, 2010). More interactive, iterative models of regional development interventions are needed to be able to respond to dynamic community conditions and process-based systems of regional innovation.

By linking concepts from regional innovation systems thinking and community informatics, there is an opportunity to scale up community-led action alongside public investment to leverage regional innovation that benefits the entire system.

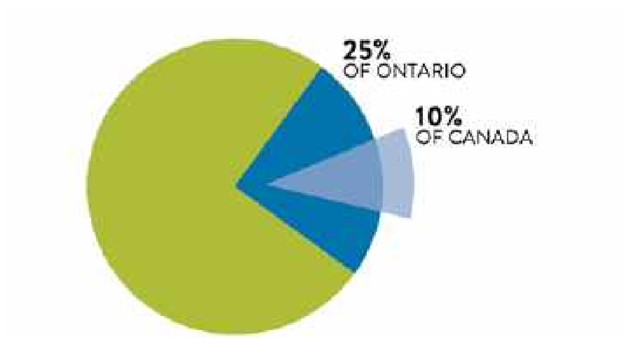
Therefore, we believe that by linking concepts from regional innovation systems thinking and community informatics, there is an opportunity to scale up community-led action alongside public investment to leverage regional innovation that benefits the entire system. In practice, purposeful acts of investment and public intervention can disrupt the status quo and even stimulate a more competitive trajectory for broadband. Broadband connectivity is essential and now a defensible right that holds not just private net benefit, but wider social benefit. We need to conduct empirical analysis to identify such benefits.

Therefore, to test these arguments, we present the case of the SouthWestern Integrated Fibre Technology Inc. (SWIFT)—a collective broadband initiative that is funding the construction of an affordable, open-access, ultra-high-speed fibre-optic regional broadband network for everyone in Southwestern Ontario, Caledon, and the Niagara Region. There are only a few recent empirical studies conducted on broadband for regional innovation in Ontario (Pant & Hambly, 2016; Ivus & Boland, 2015; Rajabuin & Middleon, 2013). None of the literature specifically focuses on the role of MSCs. This case study therefore concentrates on the role of MSCs as members of SWIFT as a collective broadband initiative designed to support dynamic innovation trajectories that close the digital divide across the region.

SOUTHWESTERN INTEGRATED FIBRE TECHNOLOGY INC. (SWIFT)

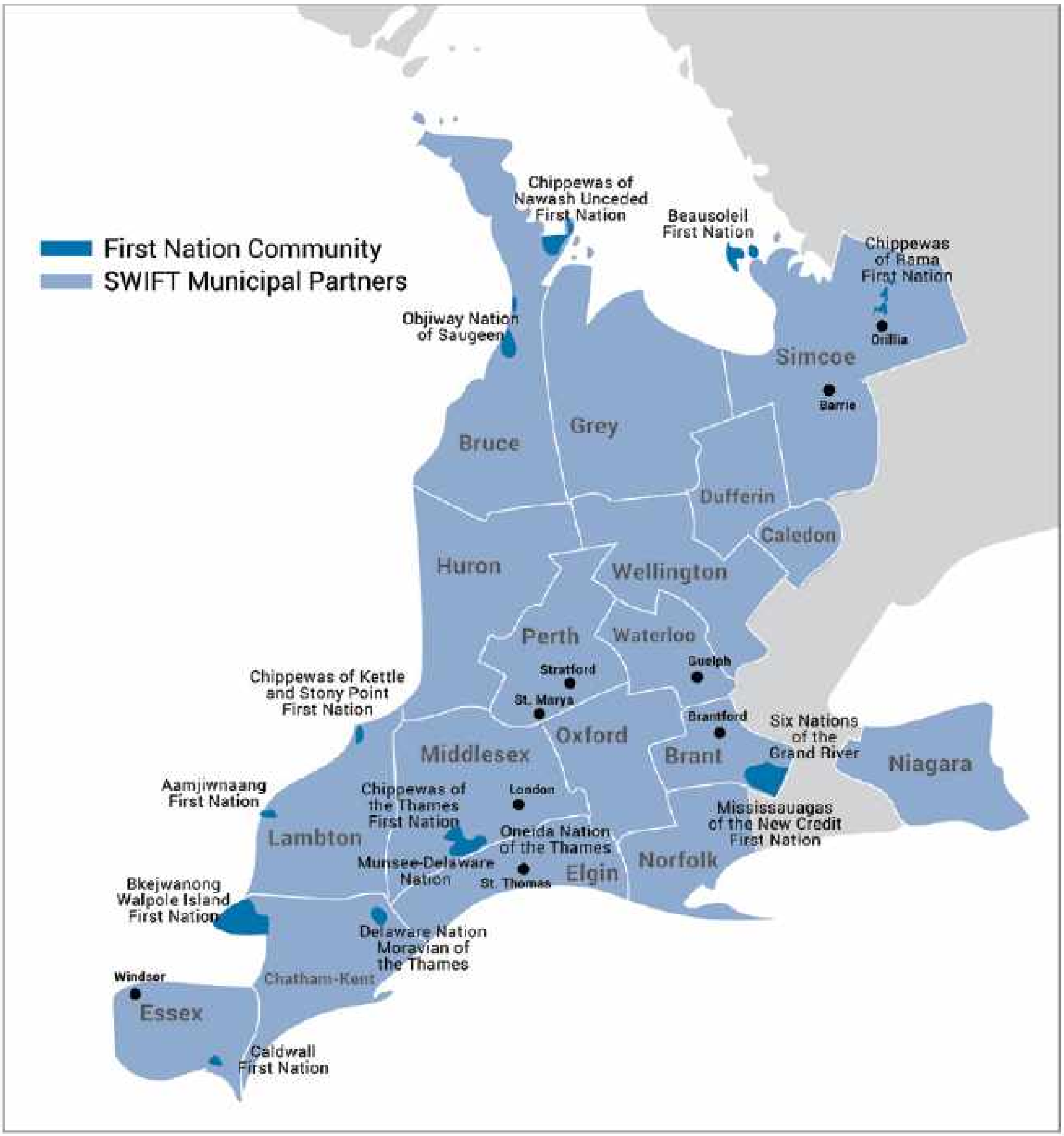
Strictly speaking, SWIFT is more than a region (using the administrative definition of the term). Here we will refer to SWIFT as "regional" in that its public investment and public-private partnership function as a regional innovation system (RIS). As of its first phase in 2016, SWIFT's area of concentration encompasses **42,000 km²** with over 3.5 million people; **this represents 25% of Ontario's population or 10% of Canada's population**. In July 2016, SWIFT was initiated with $180 million in combined investments from the federal and provincial governments and received an additional $17 million in investments by member municipalities.

SWIFT's area of concentration



From its roots in a Feasibility Study released in 2014, SWIFT currently represents the combined connectivity interests of all 15 members of the Western Ontario Wardens' Caucus (WOWC), Caledon, Niagara Region and several First Nations (see Figure 1).

Figure 1: SWIFT Membership



The overall architecture of SWIFT's investment in regional broadband infrastructure is structured by two major components which will go to scale in three phases: (1) the NetCo, or core network of fibre-optic technology (also referred to as the "backbone"), (2) the OpCo, or access network agreements (the operational intermediate technology), and (3) the building of the network with a funding mechanism to build ongoing connections which may be fibre to the premise or fixed wireless connections as far as the "last mile" (See Table 1).

Table 1: Three Phases of SWIFT Project

PHASE 1
Provider Consultations (Ongoing)
NetCo (Core) RFP Released (January 3, 2018)
NetCo design finalized
NetCo awarded and build begins (2018)
OpCo (Access) member consultations
PHASE 2
OpCo RFP's released and awarded
Master Service Agreements (MSAs) signed with providers
PHASE 3
Build Network (construction begins early 2018)
Broadband Development Fund (BDF) collects funds and provides ongoing subsidies for future builds

Source: SWIFT (2018)

While seeming to be "hard" infrastructure, there is, in fact, a combination of deep consultation and competitive processes (the SWIFT "orgware") at each step of the project. The hard and soft aspects of SWIFT's systems implement a set of SWIFT Board-approved strategic principles that direct public investment to stimulate private-sector Telecommunication Service Providers (TSPs) to build, own, and maintain the regional and rural broadband network (Box 1). The public investment by funders and members of SWIFT involves new or significantly improved open access broadband infrastructure (Guiding Principle #3). The location and amount of fibre-optic infrastructure built in each community are determined by the final overall evidence-based design of the project, as informed by the competitive process.

Box 1: SWIFT Guiding Principles

SWIFT GUIDING PRINCIPLES

SWIFT IS BASED ON SEVEN GUIDING PRINCIPLES:

1. **Standards-based architecture:** the system will interoperate with all other systems and will be easy to support;

2. **High availability and scalability:** SWIFT will be available at any moment in time, whenever users need it and it will scale to tens of millions of user connections and applications dynamically without requiring any additional capital outlays or causing system delays;

3. **Neutrality and open access:** there will be no barriers to entry for users and providers to access the network, levelling the playing field and ensuring that contractual mechanisms and oversight are in place to ensure the network is open and accessible to all;

4 **Ubiquity and equitability:** the network will be physically accessible to everyone and everyone will face similar costs to provide applications and services over the system or use applications and services on the system, regardless of geographic point of ingress/egress;

5 **Competition and affordability:** SWIFT will promote competition in services and applications by providing open access, high-availability, and a differentiated system that is affordable to users regardless of population density;

6 **Broad public-sector user participation:** SWIFT has received broad public-sector support from county level and municipal governments, post-secondary educational institutions, health care institutions, community networks, and other 'MUSH' sector organizations. The support of all Ontario Public Service (OPS) and Broader Public Sector (BPS) users are critical, as these organizations are 'anchor tenants' to the system and create the underlying foundation that makes it feasible to extend service to private enterprises, small and medium sized business, farmers and residents;

7 **Sustainability:** all users will pay fees to access the network, which will be published and publicly available to ensure transparency. These fees will provide the cash flow sustainability required to support ongoing operating and capital costs, and ensure that the network will not be dependent on taxpayer subsidies in the future. After Phase 1 is complete and the network is operational SWIFT will collect a small percentage of revenue from the successful Telecom Service Providers (TSPs) from each service sold to consumers over the SWIFT Network. The residuals will be added to SWIFT's Broadband Development Fund (BDF) along with sponsorship funds and more upper level government funding. SWIFT's Board of Directors will use the BDF to continue to subsidize providers to build fibre-optic infrastructure until the entire region has access to fibre-based broadband.

Source: SWIFT (2018)

SWIFT's Guiding Principles establish the key linkages to ensure that regional innovation is possible. The scaling (Guiding Principle #2) of SWIFT is in-built and reinforced by neutrality and open access (Guiding Principle #3). Furthermore, SWIFT is incorporated as a not-for-profit which, once the network is operational, will collect a small residual from the successful TSPs. In the Broadband Development Fund (Guiding Principle #7), residuals will be combined with additional funding from government, where available, to enable the network to accelerate increasingly deeper broadband connections across the region until SWIFT realizes its mission of "broadband for everyone" (SWIFT, 2018).

While still in its preliminary phase, the network architecture proposes optical transport network (OTN) configurations that link up MSCs to the fibre-optic backbone. One OTN is envisioned for Western Ontario and another for the Niagara Region; these OTNs ensure that the role of MSCs is embedded within the SWIFT architecture. With the combined power of over 2200 member sites, SWIFT offers MSCs, and all members, aggregated benefits from the broad coalition of public sector organizations which are anchor tenants on the network.

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> We need every possible partner in the region on board to make sure we can build an efficient, effective, and economical network. Urban cores are undoubtedly better connected than our most rural and remote communities – but having urban centres involved helps increase our market influence, makes the project attractive to service providers, and ensures important geographic and economic hubs are connected not only to each other but to smaller markets. Also, economically challenged neighbourhoods with urban centres are generally not as well served as more affluent neighbourhoods (SWIFT, 2017).[5]

We now turn to look more specifically at how the role of MSCs in the fibre-optic backbone network can be expected to generate benefits of scaled-up broadband connectivity as a regional innovation system.

SWIFT DATA

In this study, we draw on a preliminary dataset based on residential/farm internet user surveys collected by SWIFT as part of its baseline data collection. The SWIFT user-needs analysis dates back to the feasibility stage, and user surveys were re-released in July 2017. SWIFT collects information about internet usage at three main premises: municipal organizations or utilities, schools, and hospitals (MUSH); businesses; and residential/farm premises within the SWIFT region. This final category is the focus of our analysis.

SWIFT residential/farm surveys are distributed online and in hard copy.[6] They ask various sociodemographic and technical questions, involving types and costs of internet service, average download and upload speeds, and latency rate of current internet use at premise. The surveys also have questions about user applications and more specific socioeconomic benefit questions related to activities such as home-based business internet use and telecommuting. The SWIFT surveys are ongoing throughout the duration of the investment program in order to create longitudinal datasets for outcome analysis. Such analysis has not been achieved in any previous regional and rural broadband investment project in Ontario. For the purposes of this study, the dataset includes preliminary analysis of data from nearly 4000 SWIFT residential/farm surveys as of November 2017.

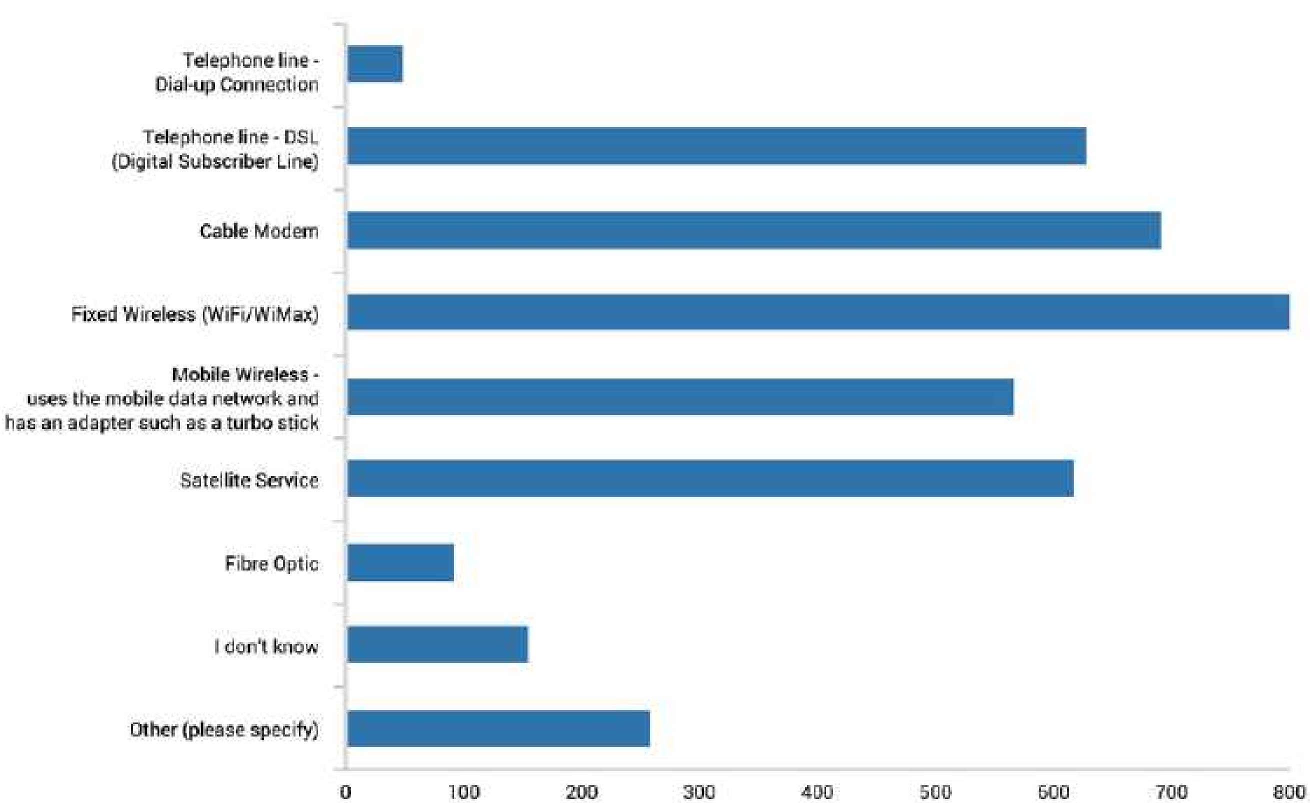
MSCS AND URBAN CONNECTIVITY

SWIFT represents a long-term plan to help SW Ontario develop networking and telecommunications infrastructure to keep pace in a changing digital world and support regional innovation. Connectivity varies substantially across SW Ontario primarily due to the type of connection (fibre/cable modem, fixed wireless and mobile technologies). Whereas MSCs have access to DSL, cable modem, and fibre-optic connections, most surrounding rural areas access the internet through fixed wireless and mobile technologies.

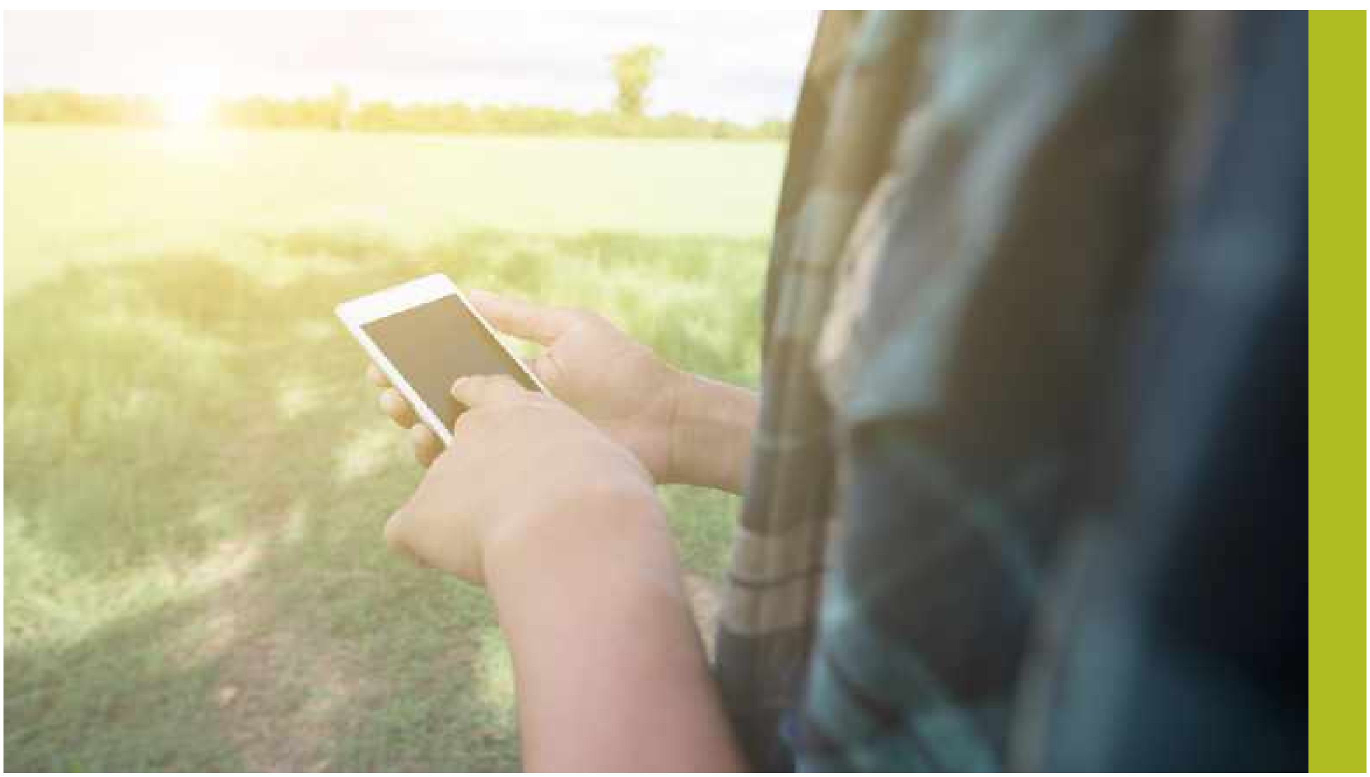
[5] http://swiftnetwork.ca/faq/

[6] http://swiftnetwork.ca/survey/

Figure 2: Type of connection at primary (most used) Internet service at (residential/farm) premise



Source: SWIFT Residential/Farm Surveys



As Table 2 summarizes, internet price and speed among the average residential/farm premise in the SWIFT area varies by dwelling type. The data includes full-time residences that are also farms or home-based businesses. We note that residences that are also farms are paying approximately the same monthly cost for lower internet speeds.

Table 2: Average Internet Price and Internet Speed for all SWIFT User Survey Sample by Dwelling Type

	PRICE (MEASURED IN 2017 CDN DOLLARS)	**DOWNLOAD SPEED** (MBPS)	**UPLOAD SPEED** (MBPS)
Home and Primary Residence (2899)	84.6	12.7	8.18
Farm and Residence (624)	85.1	6.52	6.25
Business and Residence (310)	107.2	9.11	6.14
Secondary or Seasonal Residence (77)	79.8	9.19	5.58

Source: SWIFT Residential/Farm Surveys

Note: *Number in parenthesis is the sample size. However, this number does not represent the total number of observations used to calculate the columns. This is because some respondents did not answer all the survey questions.*

In comparison, average connectivity in MSCs in SW Ontario is substantially higher. In Table 3 we summarize current data from three MSCs: London, Sarnia, and Orillia. Sarnia has higher costs for lower speeds. London and Orillia compare more favourably in price, but not in speeds, with London experiencing much higher internet speeds. Aside from variation among MSCs for connectivity, the data suggests that compared to the overall region which includes more areas surrounding MSCs, internet prices are generally lower and substantially faster (download and upload) as compared to the overall region.

Table 3: Average Internet Price and Internet Speed for Sarnia, London, Orillia and Others*

	PRICE (MEASURED IN 2017 DOLLARS)	**DOWNLOAD SPEED** (MBPS)	**UPLOAD SPEED** (MBPS)
London	73.6 (34)	45.1 (27)	11.7 (27)
Orillia	73.8 (59)	24.7 (40)	6.8 (40)
Sarnia	77.6 (225)	20.9 (139)	6.3 (137)
Others*	72.1 (96)	35.9 (71)	9.3 (70)

Source: SWIFT Residential/Farm Surveys

Note: *Number in parenthesis is the sample size. * Cities included in 'Others' are: Barrie (10), Brantford (10), Cambridge (3), Guelph (10), Kitchener (17), Niagara Falls (25), St. Catharine's (14), Waterloo (6), and Windsor (7)*

Residential dwellings within urban MSC areas that are members of SWIFT, such as Sarnia and Orillia, are likely going to benefit individually from network aggregation opportunities. As the data capture from SWIFT surveys increases, and in combination with the MUSH and business user survey data, there will be more in-depth analysis of this preliminary trend.

MSCS AND REGIONAL CONNECTIVITY

Broadband has become an essential part of community infrastructure for **promoting** economic growth **and for providing efficient and effective public services** in the modern era. The SWIFT data suggests connectivity is used to drive many of the modern applications of globally-competitive regions (see Table 4).

Table 4: Internet Use/Applications at Premise

INTERNET USE/APPLICATION	% OF RESPONSES	NO. OF RESPONSES
Email/webmail	88.4	3658
Social media	70.7	3295
Information gathering / internet searches	87.8	3566
Streaming content – voice over internet / TV/ entertainment	83.6	2745
Cloud-based applications – personal use	70.7	1752
Cloud-based applications business use – e.g., connecting to my company's network to access work files	86.5	1009
E-commerce: Online purchasing of products and/or services	74.9	2755
E-business – Customer and/or supply chain communication and service provision	84.8	578
Precision agriculture technologies – data collection/storage/analytics	86.6	223
Adult (not children/teens) e-learning and e-training (e.g. continuing education, online courses, webinars)	76.7	1210
Online education / homework by school-age children/teens	86.6	1197
Access to government / public services	75.1	2782

Source: SWIFT Residential/Farm Surveys

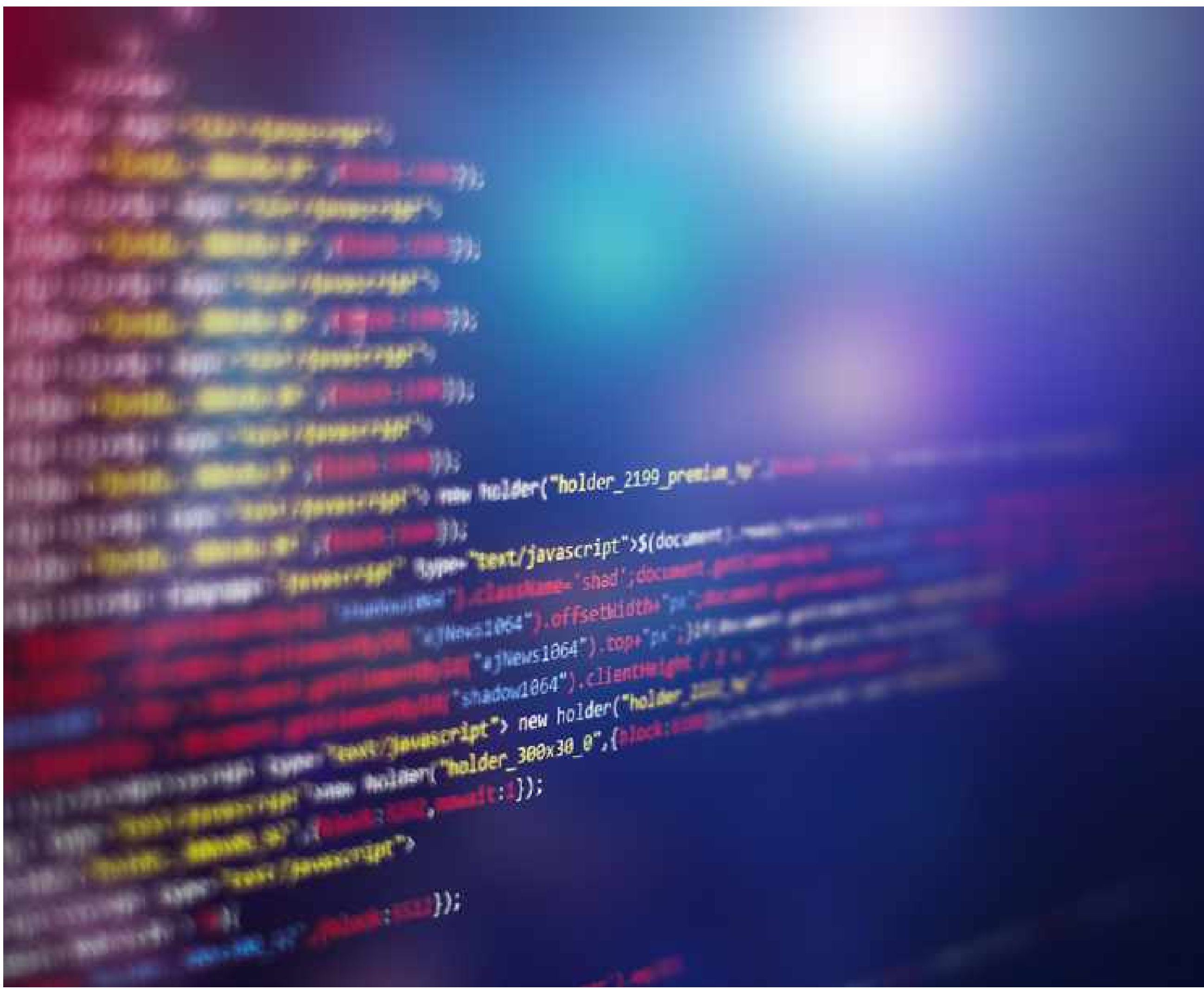
For the purposes of this paper, SWIFT residential/farm survey data suggests connectivity provides immense benefits in terms of telecommuting. For this analysis we refer to the results of a more in-depth econometric analysis presented in a forthcoming paper (Hambly & Lee, 2018). In this recent paper we calculated the typical savings to a telecommuter within the SWIFT area. We found that telecommuters achieve a significant annual surplus of $13,512 to $20,568, depending on the number of days telecommuted and the dwelling type (residential, farm, or seasonal dwelling). For dwellings in SW Ontario with more than one telecommuter, the typical savings of the first respondent telecommuting three days a week ranged from $13,956 to $17,278 per year; the second telecommuter saved $13,512 to $20,568 (again, these results vary depending on the dwelling type). In our final analysis we hypothesize that, as more remote residents and farms as well as seasonal dwellings gain improved access to broadband, the telecommuter surplus will increase.

MSCs will be able to benefit from the range of internet uses. Further analysis of the SWIFT data is needed to establish the relevance of specific applications to net private benefits and social benefits realized within the regional innovation system.

FINAL DISCUSSION AND CONCLUSION

In a preliminary manner, this paper finds that SWIFT is integral to a strong regional innovation where uptake of digital applications underlies social, economic, and environmental well-being. The findings point to a degree of digital inequality between the MSCs and surrounding areas of SW Ontario. The gaps are defined by connection types and based not only on internet speeds, but also on monthly cost of service and user applications enabled by accessible quality of service.

The case of SWIFT suggests that MSCs have an important role within the architecture of a regional broadband network. In regional broadband networks, MSCs may gain distinct membership benefits from connected actions with communities around them. As members, MSCs realize cost-efficiencies as anchor tenants on an aggregated optical transport network. They may also benefit as local economies, since spending the private net surpluses locally (such as the one created by telecommuting) creates surplus elsewhere (such as in the profits made in local retail businesses). Net benefits may



also be realized, for example, reduction in the costs of going over your data plan when unlimited plans become available or more affordable. From the analysis of SWIFT survey data collected from January to April 2018, we found that 58% of residential/farm internet users have a data plan and more than half of these users regularly exceed their monthly data limit. On average, this is an extra cost of $126 per month.

We believe there are more possible opportunities for connectivity to advance regional innovation. For example, telecommuting reduces the use of automobiles on the roads, resulting in less traffic congestion for other drivers for whom telecommuting is not an option. How then might broadband connectivity be aligned with investments in high-speed train service planned in the region? Furthermore, home-based businesses across the region frequently depend on ultra-high-speed connectivity. Aside from knowing that home-based business' use of internet services is important, we need to know more about how activities such as telecommuting support the start-up of new businesses located in nearby MSCs and across the region.

Therefore, we recommend further research on regional innovation enabled through broadband connectivity in SW Ontario, particularly as MSCs begin to realize the benefits of rural connectivity improving across the region. Our findings do not yet include metrics for worker productivity and firm profitability. Links between connectivity and regional public services (e.g., transit, telehealth) are relevant considerations, especially since the economic outcomes for regional innovation could be much higher. Other economic and social benefits for MSC businesses are likely to be realized. Our findings support recent policy dialogues that identify positive impacts of MSCs on Ontario's overall economy.

In conclusion, as the SWIFT initiative continues to bring connectivity to one of Canada's most densely populated regions, we expect MSCs will continue to feature prominently in SW Ontario broadband partnerships.

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