Waiting to Connect

The Expert Panel on High-Throughput Networks for Rural and Remote Communities in Canada

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The project that is the subject of this report was undertaken with the approval of the Board of Directors of the Council of Canadian Academies (CCA). Board members are drawn from the Royal Society of Canada (RSC), the Canadian Academy of Engineering (CAE), and the Canadian Academy of Health Sciences (CAHS), as well as from the general public. The members of the expert panel responsible for the report were selected by CCA for their special competencies and with regard for appropriate balance.

This report was prepared for the National Research Council of Canada (NRC). Any opinions, findings, or conclusions expressed in this publication are those of the authors, the Expert Panel on High-Throughput Networks for Rural and Remote Communities in Canada, and do not necessarily represent the views of their organizations of affiliation or employment, or the sponsoring organization, the NRC.

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The Expert Panel on High-Throughput Networks for Rural and Remote Communities in Canada (the Panel) would like to acknowledge all the First Nations, Inuit, and Métis people who have and continue to be stewards of the land, water, and air in Canada. Panel members carried out the work for this assessment remotely from their homes and offices across the country using digital technologies. The report was completed on the ancestral, unceded, and ceded† territories of many different Indigenous nations, whose people often do not have access to the connectivity and technologies afforded to non-Indigenous people in Canada. The Panel also recognizes that this work was made possible by the airwaves that enable data-sharing and communication in Canada.

The Council of Canadian Academies (CCA) acknowledges that our Ottawa offices are located in the unceded, unsurrendered ancestral home of the Anishinaabe Algonquin Nation, which has historically nurtured the land, water, and air of this territory and continues to do so today. Though our offices are in one place, our work to support evidence-informed decision-making has broad potential benefits and can hopefully contribute to collective action to address long-standing inequities and injustices impacting Indigenous people. We are committed to drawing on a range of knowledges and experiences to inform policies that will build a stronger, more equitable, and more just society.

† Ceded territories refer to those lands for which there is a treaty or land claims agreement between an Indigenous nation and the Crown that includes the language of "cede" or "ceded" in reference to Indigenous claims, rights, titles, and interests (e.g., Gwich'in Comprehensive Land Claim Agreement, Nunavut Land Claims Agreement).

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The Expert Panel on High-Throughput Networks for Rural and Remote Communities in Canada

Under the guidance of its Scientific Advisory Committee, Board of Directors, and founding Academies, the CCA assembled the **Expert Panel on High-Throughput Networks for Rural and Remote Communities in Canada** to undertake this project. Each expert was selected for their knowledge, experience, and demonstrated leadership in fields relevant to this assessment.

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Denise Williams, Chief Executive Officer, First Nations Technology Council (Vancouver, BC)

Halim Yanikomeroglu, FCAE, Professor, Department of Systems and Computer Engineering, Carleton University (Ottawa, ON)

Message from the President and CEO

From online banking to remote working to virtual healthcare appointments, access to a high-quality broadband connection has become essential to many aspects of modern life. Unfortunately, these connections are not available to everyone in Canada. While this has long been the case, the COVID-19 pandemic has highlighted the disparity in broadband access and quality among some households, businesses, communities, and others.

Broadband connectivity in rural and remote communities is generally slower, less available, and more expensive compared to urban centres. For those living in regions that lack reliable, high-speed, and affordable internet, the result is not only fewer choices but limitations on social and economic opportunities. Lack of access to essential services such as education and healthcare can lead to harmful outcomes. But suboptimal access also affects people's ability to participate in the labour market and contribute to the ever-evolving digital world, to say nothing about the importance of staying in touch with friends and family. Filling the connectivity gap is particularly important for Indigenous people, as high-quality broadband plays a critical role in supporting Indigenous self-determination and the ability to fully participate in and contribute to the digital world.

Many countries face similar issues and are developing responses. The National Research Council of Canada (NRC) has developed the High-throughput and Secure Networks Challenge program, aimed at developing innovative technologies to enable the provision of ultra-fast broadband in rural and remote communities. In support of the program, the NRC asked the CCA to assess the multiple challenges that limit deploying and adopting these technologies in rural and remote communities.

In response, the CCA assembled an eight-member expert panel, one with expertise in telecommunications policy, human geography, law, and engineering, as well as direct experience in bringing technology to underserved communities. The Expert Panel drew on a range of evidence, including peer-reviewed literature, government data, grey literature, the work of other review panels, and media articles. The final report highlights statistics, data, and lived experiences related to underservice.

Waiting to Connect considers the benefits of high-speed broadband connectivity, the challenges in achieving these benefits, and the barriers that have limited the rollout of broadband in rural and remote regions. The report also includes examples of place-based promising practices and certain guiding principles that can help achieve equitable connectivity.

I'd like to thank the Expert Panel, under the leadership of Chair Karen Barnes, for its work on this report. As always, the CCA's Board of Directors, Scientific Advisory Committee, and three founding Academies — the Royal Society of Canada, the Canadian Academy of Engineering, and the Canadian Academy of Health Sciences — provided key guidance and oversight during the assessment process.

Eric M. Meslin, PhD, FRSC, FCAHS
President and CEO, Council of Canadian Academies

Message from the Chair

The importance of high-quality internet to modern life in Canada cannot be overstated. Connectivity underservice to rural and remote regions has been a problem for decades, and the harms of the connectivity gap are growing more severe as more and more aspects of day-to-day life move online. Broadband connectivity is not simply used to navigate the internet; it is integral to communications and commerce, as well as the delivery of education, healthcare, and other vital services. Furthermore, connectivity in Indigenous communities supports self-determination and elevates Indigenous participation and leadership in the economy. People in rural and remote communities who lack access to affordable, high-quality networks, or who do not have the devices or digital literacy needed to take advantage of them, are being left behind.

The COVID-19 pandemic has brought the harms of the connectivity gap into sharp focus. In communities served only by low-quality broadband or without equitable access, employees have been unable to participate in work that moved to virtual spaces, students have been shut out of education, and patients have been unable to access healthcare. At the same time, by exposing the severity of the problem, the pandemic has the potential to spur or accelerate change by demonstrating the urgent need for improved connectivity across rural and remote Canada.

The Expert Panel was asked to examine the legal, ethical, social, and policy issues associated with bringing ultra-fast broadband connectivity to rural and remote regions in Canada. Early in its deliberations, however, its members recognized that many lingering challenges will not be eliminated by the introduction of faster technologies. In some cases, new technology may even intensify the problem by improving connectivity only for those communities and people with the resources to take advantage of it. For these reasons, *Waiting to Connect* examines the systemic issues that have consistently led to connectivity underservice for millions of people living in rural and remote regions in Canada. The report pays particular attention to those communities that are most adversely affected — namely, remote regions and Indigenous communities. This includes an examination of challenges related to funding, governance, adoption, and infrastructure deployment, as well as some promising practices to overcome these challenges. Central focuses include the importance of considering the local needs and contexts of communities, as well as building and empowering local capacity and knowledge.

An exceptional group of panellists brought considerable expertise and knowledge from relevant disciplines and sectors to work on this project. Some panel members contributed their on-the-ground experience in trying to bring high-speed internet to rural and remote communities, including Indigenous communities, all while working from underserviced regions themselves. I would like to thank each of the panellists for their impressive work and sustained engagement throughout the process despite the challenges of an entirely virtual assessment. The thorough discussions were always enlightening and led to an important, timely, and comprehensive report.

On behalf of the Panel, I would also like to thank the peer reviewers who provided comprehensive and constructive feedback. These reviews led to a stronger report. Lastly, I would like to thank the CCA staff for their guidance and support throughout this process. The final report is an important synthesis of evidence that could serve as a guide for the decisions and policy actions needed to address Canada's persistent and damaging connectivity gap.

Karen Barnes, EdD
Chair, The Expert Panel on High-Throughput Networks for Rural and Remote Communities in Canada

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Peer Review

This report was reviewed in draft form by a group of reviewers selected by the CCA for their diverse perspectives and areas of expertise. The reviewers assessed the objectivity and quality of the report. Their confidential submissions were considered in full by the Panel, and many of their suggestions were incorporated into the report. They were not asked to endorse the conclusions, nor did they see the final draft of the report before its release. Responsibility for the final content of this report rests entirely with the authoring Panel and the CCA.

The CCA wishes to thank the following experts for their review of this report:

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The peer review process was monitored on behalf of the CCA's Board of Directors and Scientific Advisory Committee by **Gilles Patry, FRSC**, Executive Director, U15 – Group of Canadian Research Universities. The role of the peer review monitor is to ensure that the Panel gives full and fair consideration to the submissions of the peer reviewers. The Board of the CCA authorizes public release of an expert panel report only after the peer review monitor confirms that the CCA's peer review requirements have been satisfied. The CCA thanks Dr. Patry for his diligent contribution as peer review monitor.

Executive Summary

Canada's population is divided between those with digital privilege — that is, able to access services, choices, and opportunities that depend on high-quality broadband connectivity — and those without. The implications of this connectivity gap are severe; they are also growing as society is increasingly built around the assumption that everyone has access to high-quality connectivity and the devices and digital literacy needed to take advantage of it. Overwhelmingly, those most negatively affected by underservice live in rural areas, and particularly in remote regions and/or Indigenous communities.

The COVID-19 pandemic has brought into sharp focus the substantial disparities resulting from the lack of high-quality broadband connectivity in many parts of the country. Those living in underserved regions (i.e., having no connectivity, or only low-quality broadband that does not meet connectivity needs) have long known they are being held back. More than a year of lockdowns and physical distancing has made this difficult to ignore as people living in regions with slow, unreliable, unstable, high-latency, and expensive internet have been particularly hard hit by the pandemic. Students have been unable to attend school, patients have not had access to medical care, and workers have been unable to do their jobs, among many other challenges. The pandemic has the potential to accelerate change by demonstrating the urgency for improved connectivity, especially in rural and remote areas of Canada.

The National Research Council of Canada (NRC) has launched an initiative to address the connectivity gaps between urban and rural areas of Canada. Its High-throughput and Secure Networks Challenge program seeks to develop new technologies to support the deployment of high-throughput secure networks (HTSN) (i.e., ultra-fast broadband networks) in rural and remote communities in Canada. These potential innovations include new photonic technologies for satellite connectivity, fixed wireless access, and fibre optic communications with up to 1 gigabit per second (Gbps) symmetrical upload/download speeds. Recognizing that providing such speeds to rural and remote communities is not only limited by technological challenges, the NRC (the Sponsor) asked the Council of Canadian Academies (CCA) to assess the non-technical factors specific to the deployment and adoption of these technologies in rural and remote communities. Specifically, the Sponsor asked:

What are the legal, regulatory, ethical, social, and economic policy challenges associated with the deployment and use of high throughput secure networks (HTSN) for rural and remote communities, including Indigenous communities, in Canada?

To answer the charge, the CCA assembled the eight-member Expert Panel on High-Throughput Networks for Rural and Remote Communities in Canada (the Panel). Panel members were selected for their knowledge of telecommunications policy, human geography, law, and engineering, as well as their experience in bringing (or trying to bring) high-quality broadband connectivity to underserved communities in Canada.

Though the charge asks about the legal/regulatory, ethical, economic, social, and policy (LESP) issues associated with ultra-fast (1 Gbps) broadband connectivity specifically, the Panel notes that the key LESP challenges are independent of technology or speed. Underservice in broadband connectivity in rural and remote communities, including Indigenous communities, is not only a technology problem. Indeed, there is technology available that could substantially improve the quality of connectivity in rural and remote communities, including Indigenous communities, and some rural communities already have access to ultra-fast speeds. In some cases, the introduction of new technologies may exacerbate existing disparities. If a new technology or funding program is offered without consideration of long-standing LESP challenges, it will only improve connectivity for those with the resources to take advantage of it, leaving the most underserved communities further behind. This is true for low Earth orbit (LEO) satellites, which have the potential to transform the Canadian telecommunications market. For this reason, the Panel chose to focus on the systemic challenges that have consistently led to underservice for millions of people living in rural and remote regions in Canada.

Main Messages

Closing the connectivity gap means providing broadband in rural and remote communities comparable to that in urban centres in terms of speed, quality, and cost.

While speed is a key component of a high-quality network, internet connectivity must also be affordable, reliable, stable, possess low latency, and have redundancy — that is, have more than one network option in place (either fibre rings or multiple backhaul options) to avoid blackouts and spotty service. In regions without redundancy, a single problem (e.g., satellite outage, fibre cut) can be catastrophic, especially as more and more essential services and applications move exclusively online. In the past, extended outages have made it impossible for people to reach emergency services, get groceries, pay for gas, or travel by air (due to a loss of air traffic control capabilities). Symmetrical upload/download speeds are also growing in importance because they enable people to be active participants in education and work (e.g., videoconferencing), as well as create and share content and innovate. Without sufficient upload speeds, users are restricted to passive consumption of the internet.

Rural and remote communities in Canada are diverse and may be characterized by a combination of factors, including topography, population density, distance to urban centres, local economy, and access to other infrastructure services such as roads and reliable electricity. Furthermore, these communities are not always well represented by strict definitions of rural and remote. Variations in remote and rural communities (e.g., population density, demographics, income) mean that their classification as such may not be consistent across definitions, impacting subsequent policy decisions and funding opportunities.

The heterogeneity of rural and remote communities extends to the quality of broadband access. Having said this, compared to urban centres, connectivity in non-urban regions is generally slower, less available, and more expensive. As of 2019, 54% of rural households in Canada lacked access to broadband services meeting the Government of Canada's target speed of 50 megabits per second (Mbps) download and 10 Mbps upload (50/10) with unlimited monthly data transfer.[1] In comparison, that level of service was available to essentially every household in urban areas. Further, in many rural (and particularly remote) regions, data transfer limits (caps) severely increase the cost of using the internet and limit its applications. The connectivity gap is not primarily the result of technological limitations, as shown by there being rural communities in Canada and abroad that already have access to high-quality broadband.

1 The short-form 50/10 unlimited is used to refer to 50/10 speeds with unlimited data transfer.

The data on connectivity in Canada generally focus on speed availability, but this metric, in isolation, is an oversimplification that does not represent the quality of a network, or the services being offered. Furthermore, the Panel is of the view that the 50/10 targets are insufficient and will not meet the needs of rural and remote Canada by 2030 and beyond. Many applications already require faster download or upload speeds (e.g., some e-health services), and new innovations will continue to demand the fastest available speeds. Furthermore, the availability of 50/10 does not necessarily mean that those speeds are consistently achieved; average speeds are often lower, particularly during peak usage times. The benefits associated with connectivity are constantly evolving, and in response, connectivity must evolve as well. The Panel therefore emphasizes the importance of viewing connectivity standards as a fast-moving target, and thus the need for future-proofing broadband infrastructure. Rather than focusing on a particular speed, having internet in rural and remote regions comparable to urban centres in terms of quality and price is a more equitable and suitable goal.

The incremental approaches to addressing the connectivity gap have been unsuccessful at establishing universal connectivity in Canada.

The Government of Canada's efforts to bring high-speed internet to rural and remote communities have depended primarily on a market-based, private sector-led approach, with the additional assistance of government programs, subsidies, and regulations that aim to incentivize investments, competition, and service delivery. There are various government programs for improving connectivity in rural and remote regions in Canada. These have been put in place without a coordinated and overarching plan for meeting a goal of universal and equitable connectivity and lack transparent evaluation processes to determine if they were successful.

In 2019, the federal government released *High-Speed Access for All: Canada's Connectivity Strategy*, which committed to bringing 50/10 internet speeds to all communities by 2030. While the document includes aspirational targets and goals, it does not include an action plan or coordinated approach on how universal connectivity will be achieved, particularly in rural and remote areas. It also focuses on a fixed speed target (50/10), which the Panel notes is insufficient to meet needs of people in Canada and carries a risk of entrenching inequalities and inequities between urban centres and rural communities.

While funding to support broadband access is available, it is typically secured through a competitive, zero-sum proposal process — wherein available funds are awarded to a handful of projects, leaving the remaining projects unfunded. The current funding landscape in Canada creates challenges in accessing such funding, particularly for small businesses, not-for-profit organizations, and local or Indigenous communities. For example, the sheer number, variety, unique criteria, and complexity of funding programs constitute a barrier for small entrants to access the assistance they need. Funding application processes are often complex, requiring specialized skills and, in some cases, qualified consultants. As a result, internet service providers (ISPs) or other groups are often forced to assess whether it is worth investing a considerable amount of time and resources on funding applications; in some cases, this acts as a deterrent to applying. The zero-sum approach also lacks provisions to provide services in communities that do not obtain funding. The challenges created by a complex funding environment favour bigger companies and/or communities with the capacity and resources to benefit from government infrastructure funds.

The Government of Canada manages radio-frequency spectrum — a finite natural resource — through the department of Innovation, Science and Economic Development Canada (ISED). Difficulties in accessing spectrum have long been cited as a key challenge for rural and remote communities seeking to secure broadband connectivity. Spectrum licenses cover large geographic areas and are primarily held by big incumbent telecommunications providers, which can be slow to fully deploy services to all communities within licensed areas. Licence holders can sub-licence unused spectrum, but there is limited information about unused spectrum for potential buyers, and little business incentive to make it available. The Government of Canada has not set aside spectrum for Indigenous Nations, as have governments in Mexico, New Zealand, and the United States.

In Canada, there are critical knowledge and transparency gaps related to the availability, adoption rates, and economic benefits of broadband connectivity; these gaps create challenges for evaluation and limit accountability.

Several important knowledge gaps create challenges in evaluating the state of broadband connectivity in rural and remote regions. Currently, the information to fill these gaps is not collected systematically or in a timely and coordinated manner (e.g., it might be primarily based on applications for public funds during prior programs). This creates an incomplete picture — even to the government departments implementing connectivity programs. This makes it difficult to accurately determine which regions are currently underserved (in terms of both speed and reliability), and to monitor and assess connectivity strategies and programs in Canada. The absence of accurate, reliable, and up-to-date data can also create practical problems for those seeking to address connectivity gaps. For example, a lack of up-to-date connectivity mapping data has led to approval delays for those seeking funding.

A broadband connection can only provide benefits if it is used. For this reason, data and evidence related to adoption, along with availability, are important for evaluation. Government documents inconsistently report broadband availability and adoption data, making comparisons among programs challenging. While some of these data are collected, it is done infrequently and is not linked to specific programs. Along with adoption, there is limited monitoring of socio-economic indicators associated with broadband programs despite the emphasis on economic development as a justification for launching them.

A lack of transparency also hinders the accountability and evaluation of existing programs that support broadband connectivity in rural and remote regions. Companies receiving grants and/or subsidies are not always required to demonstrate that public funds have made the internet more reliable, stable, lower-latency, and affordable for customers. Consumers may not see the impact of public funds given to ISPs to subsidize connectivity, unlike many other subsidy programs. For example, the Nutrition North Canada program requires that retailers display the subsidy on customers' receipts and that companies provide evidence that the subsidies are being fully passed on to the customer. More broadly, there have been calls to increase accountability with respect to achieving the government's universal broadband objectives through annual reporting to Parliament by a single department, informed by robust and comprehensive data. These data would help coordinate broadband program design and public spending.

Communities without access to affordable, high-quality broadband connectivity are cut off from the key services and economic and cultural benefits enjoyed by better-connected communities. The problem is most severe for remote and Indigenous communities.

Many well-documented disadvantages are created when the broadband connectivity of rural and remote regions is not on par with urban centres. High-speed broadband access is essential for many aspects of daily life, and the inequitable and low-quality connectivity experienced by rural and remote communities, including Indigenous communities, severely limits economic, education, and healthcare opportunities.

Rural and remote communities in Canada have identified limited access to fast, reliable internet as their main barrier to achieving economic growth and have stated that the lack of connectivity restricts their ability to retain youth, attract new talent, develop or expand existing businesses, train workers, and adopt new technologies. Broadband connectivity has an overall net positive impact on the economy, correlated with increased labour productivity, trade, employment, foreign investment, GDP gains, and competitiveness levels. E-commerce has the potential to help rural retailers in Canada be more competitive (e.g., by accessing a wider range of markets), enable new entrepreneurs to establish themselves, and make it easier for those with limited mobility to access goods.

Appropriate planning and support can help mitigate potential unintended negative economic impacts on rural and remote economies due to connectivity. These challenges can include increased competition for local businesses and labour market disruptions. Changes brought about by increased automation — which depends on broadband connectivity — are also important considerations, particularly for rural and remote regions that depend on industries such as wholesale and retail, manufacturing, and natural resource extraction. The negative impacts of automation can be exacerbated in rural and remote communities by the difficulty of redistributing labour in these regions. Jobs held by Indigenous people are often more concentrated in industries with a higher risk of job loss due to automation than non-Indigenous people. It is important to consider the potential employment impacts of connectivity when rolling out high-speed networks. People will require job re-training as well as the resources and skills needed to use the internet to its fullest potential.

Low-quality connectivity severely limits choices and opportunities for rural and remote communities, especially related to education and healthcare. The benefits of having high-speed broadband connectivity in schools in Canada's remote regions include access to learning platforms, research tools, information for students, and tools for teachers. Poor connectivity also leads to negative impacts on healthcare, which increasingly depends on digital technologies to deliver services to rural and remote communities. Multiple benefits of telehealth applications are documented. These include expanding the delivery of, and access to, health services in remote regions; reducing waiting times; enabling earlier diagnosis so patients can get appropriate treatments sooner; increasing patient comfort by reducing travel time; and allowing patients to stay in their communities while receiving care. These benefits cannot be achieved, however, in regions with sub-par broadband connectivity.

The negative impacts of underservice on education and healthcare have been particularly severe during the COVID-19 pandemic. In many rural and remote regions, students have been unable to engage in any online learning when schools close, putting them at a considerable disadvantage compared to their connected peers. At the same time, many people in rural and remote regions were unable to access any healthcare services if in-person options were unavailable or unsafe.

Importantly, *availability* of a network is not sufficient — *adoption* is required. A low level of adoption does not indicate disinterest in using the internet; rather, it suggests that a network is not meeting people's needs, whether in terms of affordability, reliability, speed, or the skills and tools required to use it. The gap between potential and actual internet adopters is accentuated in rural and remote regions. The available evidence on internet adoption in rural and remote regions points to a series of socio-demographic considerations (e.g., age, income, education) that impact the needs of potential users, including challenges related to affordability and limited digital literacy. A lack of capacity to maintain networks and devices can also create challenges for adoption if there is no one in communities able to fix even minor problems when they arise.

High-quality broadband connectivity in Indigenous communities supports self-determination and Indigenous economic reconciliation by elevating Indigenous participation, innovation, and leadership in the economy. Current approaches to deliver broadband connectivity have left Indigenous communities in Canada at a disproportionate disadvantage.

Although the digital divide often refers to urban regions having better connectivity than rural and remote ones, there is also a substantial connectivity gap between Indigenous communities (in urban as well as rural and remote areas) and non-Indigenous communities. In 2017, 76% of households in Indigenous communities lacked access to 50/10 speeds. While more recent data on connectivity in Indigenous communities is lacking, as of 2019, 65% of households on First Nations reserves did not have access to 50/10 unlimited, compared to 54% of households in rural communities. While connectivity data related to Inuit communities are not available, as of 2019 no households in Nunavut had access to download speeds of 25 Mbps or greater (half of the federal government's target of 50 Mbps download speed).

This lack of connectivity exacerbates socio-economic inequities, including those related to business opportunities, employment, education, and physical and mental health. There have been some incremental programs put in place to address this connectivity gap, but the problem, and impacts, remain severe. Historical and current policies and approaches to broadband investments or service delivery have led to racist outcomes, while existing policies and programs have not addressed the long-standing discrepancies between the services and opportunities accessible to Indigenous people as compared to non-Indigenous people.

The Governments of Canada and British Columbia have approved legislation formalizing the adoption of the United Nations Declaration on the Rights of Indigenous Peoples (UNDRIP), which enshrines several rights for Indigenous Peoples, including the right to self-determination and the ability to pursue social, cultural, and economic development. Access to high-quality broadband connectivity is a critical component of upholding the rights outlined in UNDRIP for several reasons. Broadband connectivity can provide many critical benefits to Indigenous communities, including supporting self-determination and economic reconciliation whereby Indigenous people are able to fully participate in Canada's economies and contribute to the ever-evolving digital world. Further, connectivity allows Indigenous communities and governments to implement their cultural and economic priorities and effectively provide essential services, including safety and security, healthcare, and education. Internet connectivity is also vital for Indigenous people to share, preserve, develop, and celebrate their cultures, stay in touch with their communities, and innovate in the digital economy.

Poor connectivity in Indigenous communities in Canada limits the ability of Indigenous governments to provide necessary local services to their communities and engage in business opportunities across sectors, including telecommunications. Given the harms created by a lack of connectivity, ensuring access to equitable and high-quality broadband connectivity in Indigenous communities throughout Canada is necessary to advance reconciliation — including Indigenous economic reconciliation — and to respond to several of the Truth and Reconciliation Commission's Calls to Action.

The current digital divide discourse in Canada often portrays Indigenous people primarily as consumers, beneficiaries, and passive recipients of digital technologies; yet, they are innovators and creators driving change. Indigenous leadership and entrepreneurship are key components in shaping digital society and can be supported by governments and industry stakeholders. Strong partnerships are built on meaningful, respectful, and ongoing engagement with Indigenous people about how they can develop (on their own or with others) and undertake broadband initiatives in their communities and traditional territories. Currently, there are insufficient investments specifically earmarked for broadband connectivity projects in Indigenous communities. Indigenous self-determination also entails a commitment to Indigenous data sovereignty and applying Indigenous laws, practices, institutions, worldviews, values, and objectives to emerging technologies, including broadband connectivity. Furthermore, it is essential that any broadband project on Indigenous lands benefit the members of that community.

Airwaves, like water, are considered natural resources. Yet there is no mention or special consideration of Indigenous people in the Government of Canada's latest spectrum priorities. There have been calls for the reallocation and setting aside of dedicated spectrum for Indigenous Nations in their lands, so they may deploy wireless broadband to their communities. Doing so can be done on a priority basis, or on a licensed, unlicensed, or shared/secondary spectrum-use basis, particularly in areas within licensed allotments. Unused and returned spectrum could also be offered to Indigenous Nations. Similar proposals are at advanced stages in New Zealand and the United States, and at a small scale in Mexico. The New Zealand government recognizes that Māori have an interest in spectrum, so funding is provided for Māori-led programs to build commercial and technical capacity, and to have more equitable representation and participation by Māori in spectrum-related activities.

Some place-based ownership models and approaches — including community-based and hybrid approaches — have succeeded in bringing high-quality broadband connectivity to rural and remote regions in Canada and abroad.

The cost of deployment and maintenance, and the relatively small customer base in rural and remote regions, discourage investment from large telecommunications providers and are significant hurdles for other actors (e.g., small ISPs, not-for-profits, municipalities, Indigenous-owned companies) trying to serve their communities. The value proposition for investing in broadband networks is different for large and small ISPs, however, and even more so for municipalities, non-profits, and Indigenous ventures with broader metrics for success and other means of recouping investment costs. Different ownership models, with varying combinations of private and public ownership, have been successful. For example, communities can recuperate the invested costs of network infrastructure from service fees and taxes; save money through organizational efficiencies; benefit from personal and business development; and reduce prices by running at-cost. Whether connectivity is provided by for-profit or not-for-profit entities, rural and remote communities benefit directly from the business development, as well as healthcare and education improvements, provided by broadband. Estimates suggest that rural communities generally realize a full return on investment within five years.

As a result of the diversity of rural and remote communities, there is no single approach that will effectively bring high-speed connectivity to all rural and remote communities across the country. Place-based approaches move away from broadly applied government policy, and towards understanding specific community values and goals. Place-based policy centres location as the focus of policy development and design. This focus is particularly important in rural and remote regions, as community characteristics — including a strong sense of cultural identity and dependence on services that fulfill multiple functions — impact the effectiveness of public policy. This does not mean that each community needs a unique solution; place-based approaches can be implemented at community, regional, or other levels. What is important is that broadband connectivity programs are flexible and recognize the heterogeneity of rural and remote regions. Special consideration of the unique context of Indigenous communities is also needed, including how to support self-determination and reconciliation; this enables Indigenous communities to actively lead, participate, and partner in broadband deployment and delivery.

Conclusion

The connectivity gap between rural or remote communities and urban centres in Canada is substantial and continues to widen. The quality of broadband connectivity is particularly poor in Indigenous communities, contributing to socio-economic inequities and hindering self-determination and Indigenous economic reconciliation. There is considerable frustration over the persisting connectivity gap despite recognition of the inequities it has created and perpetuated.

The market-based system to fund, deploy, and govern internet connectivity has consistently failed to deliver high-quality internet service in rural and remote communities in Canada that is comparable to the service enjoyed in urban centres — this despite funding and subsidies by multiple orders of government. The incremental approaches taken in the past have failed to deliver universal connectivity across Canada, but there is a path forward. The evidence points to a set of proposed principles for addressing the challenges of bringing broadband connectivity to all rural and remote communities, including Indigenous communities, in Canada (Box 1).

Box 1 Proposed Principles for Equitable Connectivity

- **Equity:** The full integration of equity dimensions in the design of programs and policies — as an explicit goal — and the creation of provisions to guarantee connectivity services.
- **Universality:** Sufficient funding to provide universal service to all communities as opposed to a zero-sum, competition-based model, which is, by definition, not universal.
- **Future-proof technology:** Networks designed around current and future bandwidth needs.
- **Transparency:** Funding criteria, metrics, and more detailed connectivity data made easily available.
- **Accountability:** A single department consistently responsible for periodic reporting, especially if public funds are used.
- **Competition and redundancy:** More options and backup services for rural and remote regions.
- **Place-based and needs-based approaches:** Differentiated policies and programs built around the specific needs and potential of rural and remote communities.
- **Meaningful inclusion** of, and benefits for, Indigenous communities from the outset, including in program design.
- **Indigenous reconciliation,** including economic reconciliation through the elevation of Indigenous participation, innovation, and leadership in the economy.

People in rural and remote communities, including Indigenous people, are not simply consumers or beneficiaries of connectivity programs. They are innovators, creators, entrepreneurs, and leaders who will be drivers of change when empowered by access to the right tools. Through comprehensive, holistic, and flexible frameworks that recognize the heterogeneity of communities in Canada, there is an opportunity for fundamental change that would benefit all.

Abbreviations

BTLR	Broadcasting and Telecommunications Legislative Review
CRTC	Canadian Radio-television and Telecommunications Commission
FTTH	Fibre-to-the-home
ISED	Innovation, Science and Economic Development Canada
ISP	Internet service providers
LEO	Low Earth orbit
LESP	Legal, regulatory, ethical, economic, social, and policy
NGSO	Non-geostationary satellite systems
NRC	National Research Council Canada
TPRP	Telecommunications Policy Review Panel
TSP	Incumbent Telecommunication Service Providers
UN	United Nations
UNDRIP	United Nations Declaration on the Rights of Indigenous Peoples

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Introduction

1.1 The Charge
1.2 The Panel's Approach
1.3 Overview of the Report

The poor quality of broadband networks in rural and remote communities in Canada create barriers that limit the opportunities, choices, creativity, health, and quality of life for residents. High-speed internet is an essential service and, increasingly, society is being built around an assumption that everyone has access to high-quality connectivity, as well as the devices and digital literacy to take advantage of it. Underservice — characterized as having no connectivity, or only low-quality broadband that cannot meet connectivity needs — is not just a technological issue per se; technologies that could substantially improve the quality of connectivity for rural and remote communities exist, and some rural communities are already well served. Despite the availability of these network technologies, a persistent connectivity gap exists. Many people remain underserved while others experience digital privilege, which is characterized by access to the services and opportunities afforded by high-quality broadband connectivity.

This connectivity gap disproportionately affects Indigenous people, with substantially greater digital access and choices afforded to non-Indigenous people in rural Canada compared to Indigenous communities. This enduring gap has blocked the potential of Indigenous communities to innovate in the digital economy, and has resulted in significant harms, including impeding self-determination, decolonization efforts, and access to essential services such as health and education. The inequities brought on, or exacerbated by, poor connectivity reflect social policies that perpetuate colonial approaches and practices, and hinder reconciliation efforts. Despite calls for substantive change, the continued reliance on current policies and approaches to connectivity has led to racist outcomes, whereby Indigenous people do not have access to equivalent service levels, choices, and opportunities as non-Indigenous people in Canada.

The COVID-19 pandemic has brought into sharp focus the inequities resulting from a lack of connectivity. More than a year of lockdowns and physical distancing demonstrated that connectivity is essential for accessing education, health, and government services; participating in the labour market; keeping businesses afloat; buying food and other essentials; and maintaining contact with friends and family. While everyone in Canada has been affected by the pandemic, those living in regions with poor internet connectivity have been particularly hard hit — students were unable to attend school, patients were unable to get medical care, and workers were unable to do their jobs (Stewart, 2020; White, 2020). By bringing these inequities to light, the pandemic has the potential to act as an accelerator of change by demonstrating the urgent need for improved connectivity.

While COVID-19 has brought new attention to the issue, it has long been recognized that the current level of rural and remote connectivity in Canada is inadequate and puts these communities at a significant disadvantage. Past reviews of broadband connectivity in Canada stressed that providing reliable internet to rural, remote, and Indigenous communities is a critical issue (NBTF, 2001; TPRP, 2006; BTLR, 2020). In 2001, the National Broadband Task Force stated:

> *[T]he priority of the broadband deployment strategy should be to link all First Nation, Inuit, rural and remote communities to national broadband networks using appropriate technology. Further, access to broadband connectivity in First Nation, Inuit, rural and remote communities should be available at a price reasonably comparable to that for more densely populated areas.*
>
> NBTF, 2001

Little had changed almost 20 years later when the Broadcasting and Telecommunications Legislative Review Panel found that:

> *Significant disparities divide urban from rural and remote regions of Canada in terms of fixed-line broadband and mobile wireless penetration [...] The longer that these gaps continue, the further behind those living in northern and remote geographies become in terms of the communications infrastructure required to flourish in the 21st century.*
>
> BTLR, 2020

The inability of Canada's traditional market-based model to meet the connectivity needs of rural and remote areas has long been apparent, and there have been continued calls to identify different approaches to address this gap. In response, the Government of Canada has invested in a range of programs and organizations seeking to bring improved connectivity to rural and remote communities, including the Connect to Innovate program, the CRTC Broadband Fund, the Universal Broadband Fund, and selected programs of the Canada Infrastructure Bank. Several provincial/territorial, regional, and municipal programs have also been established to improve connectivity in those jurisdictions. While these programs have improved connectivity in some communities, broadband underservice to rural and remote communities relative to urban centres has persisted or worsened.

The limited success of past fragmented investments demonstrates that incrementalism without evaluation — this is, isolated initiatives created and implemented without clear action plans, data collection, or metrics for success — cannot close the connectivity gap. More fundamental change is warranted, urgently. By identifying the challenges preventing universal connectivity, decision-makers in Canada could enable transformative change based on holistic and flexible frameworks that recognize the heterogeneity of rural and remote regions, including Indigenous communities.

1.1 The Charge

The National Research Council of Canada (NRC) has launched a new program to address the connectivity gap between urban and rural or remote regions in Canada. Its High-throughput and Secure Networks Challenge program aims to develop innovative technologies that can enable high-throughput secure networks (HTSN) (i.e., ultra-fast broadband networks) in rural and remote communities. These potential innovations include new photonic technologies for satellite, fixed wireless access, and fibre optic communications with up to 1 gigabit per second (Gbps) symmetrical[1] speeds; to put that measurement in context, 1 Gbps is 20 times the current Government of Canada target for download speeds.

To support its new program, and in recognition that providing HTSN in rural and remote Canada is not limited to technological challenges, the NRC (the Sponsor) asked the Council of Canadian Academies (CCA) to assess the non-technical factors specific to the deployment and adoption of these technologies in rural and remote communities. Additional financial support was provided by Innovation, Science and Economic Development Canada. In particular, the CCA was asked to answer the following question and sub-questions:

What are the legal, regulatory, ethical, social, and economic policy challenges associated with the deployment and use of high-throughput secure networks (HTSN) for rural and remote communities, including Indigenous communities, in Canada?

- What are the potential challenges to deploying and maintaining network infrastructure (antenna, ground stations, 5G and later generation installations) in rural and remote communities, including in Indigenous communities?
- What are the challenges associated with the successful adoption and use of high-speed networks in rural and remote communities, including Indigenous communities?
- What models or practices, including business models, have been employed in support of the successful deployment and use of HTSN in rural and remote communities in Canadian and international jurisdictions?

1 Symmetrical broadband connections have equal upload and download speeds.

In order to answer the charge, the CCA assembled a multidisciplinary panel of eight experts (the Expert Panel on High-Throughput Networks for Rural and Remote Communities in Canada, hereafter the Panel). Panel members were selected for their knowledge of telecommunications policy, human geography, law, and engineering, as well as their experience in bringing technology to underserved communities. Each member served on the Panel as an informed individual rather than as a representative of a specific discipline, organization, region, or set of values. This report was also informed by a comprehensive peer review, whereby additional experts provided further evidence and guidance on the content.

The Panel met virtually over a period of nine months to collect and review evidence and deliberate on its charge. At the beginning of the assessment process, the Panel met with the Sponsor. This meeting allowed the Panel to acquire a full understanding of the charge and to establish the scope of the assessment.

1.2 The Panel's Approach

While the Panel was charged with looking at the legal/regulatory, ethical, economic, social, and policy (LESP) issues associated with ultra-fast (1 Gbps) broadband connectivity, it recognized that many past challenges (e.g., those relating to community capacity) would not be eliminated by the introduction of faster technologies. The technologies needed to substantially improve the quality of connectivity in rural and remote regions in Canada already exist but have not been deployed to many communities. The Panel notes that, in some cases, the introduction of new technologies may exacerbate existing disparities as opposed to reducing them. If a new technology is offered without consideration of long-standing LESP challenges, it will only improve connectivity for those with the resources to take advantage of it, while leaving the most underserved communities further behind. For these reasons, this report focuses on the systemic challenges that have led to millions of people in rural and remote regions being shut out of the benefits and services that depend on reliable, high-speed internet.

The report also considers future challenges that may stem from the deployment and adoption of novel broadband technologies. Low Earth orbit (LEO) satellites, in particular, have the potential to disrupt the Canadian telecommunications market and bring ultra-fast internet to Canada's most remote regions (along with creating new policy and regulation challenges). For this reason, the Panel paid particular focus to the issues surrounding satellite connectivity.

The Panel sought to focus its assessment on those who are underserved by broadband connectivity. The report highlights statistics, data, and lived experiences related to underservice, with a particular focus on those most negatively affected by the lack of connectivity. The Panel also sought to emphasize the heterogeneity of rural and remote communities in Canada throughout the report, to illustrate the diversity of connectivity needs and challenges across the country. The report moves beyond simple definitions of *rural and remote* based on a single metric (e.g., population density), since many factors affect connectivity, including population density, topography, distance to urban centres, and others. Lastly, since urban centres are not the focus of this charge, they receive little discussion in the report. The Panel notes that, in some cases, the challenges facing rural and remote communities extend to underserved communities within urban centres, particularly in the case of Indigenous communities.

The Sponsor considers HTSNs to be those that can deliver symmetrical speeds of 1 Gbps or faster to end-users. While this terminology may be suitable for a technical audience, it is not in common usage among the broader public. For this reason, the Panel has elected to use more widespread terminology throughout its report. *Broadband connectivity* (or broadband networks) describes the networks themselves, while *internet* describes how a person uses a high-speed broadband network. The Government of Canada defines *high-speed internet* as having minimum download speeds of 50 megabits per second (Mbps) and upload speeds of 10 Mbps (50/10) (ISED, 2019c). According to ISED (2019c), these are the speeds needed to "take full advantage of the opportunities offered by the modern internet." The Panel notes that this definition is short-sighted and incomplete. Many applications require increasingly faster upload/download speeds, and speed alone is insufficient for evaluating a network's quality. For these reasons, the Panel chose to focus on how best to achieve rural and remote broadband connectivity comparable to that provided in urban centres.

1.2.1 Sources of Evidence

The Panel's assessment is based on a review of various sources of evidence, drawn from peer-reviewed publications, publicly available government information and data, the work of other review panels, and other relevant grey literature[2] related to the challenges of high-speed connectivity in Canada. In several cases, media articles were also used as a source of evidence, particularly related to individual and community experiences and records of events (e.g., prolonged outages). The Panel notes that the need to rely on grey literature and media articles for this assessment illustrates the substantial gaps in the peer review literature related

2 "Grey literature stands for manifold document types produced on all levels of government, academics, business and industry in print and electronic formats that are protected by intellectual property rights, of sufficient quality to be collected and preserved by library holdings or institutional repositories, but not controlled by commercial publishers i.e., where publishing is not the primary activity of the producing body" (Schöpfel, 2010).

to issues around rural and remote connectivity in Canada. An initial, structured literature review was carried out to survey the landscape of published, peer-reviewed material on the LESP issues surrounding broadband connectivity, which identified ~200 relevant references. To inform its consideration of promising approaches, the Panel reviewed evidence from other jurisdictions that have successfully brought broadband connectivity to their rural and remote regions.

While the CCA does not carry out consultations, the Panel sought to include the experiences of individuals, communities, and businesses in the assessment. It reviewed submissions made to other expert panels or groups as a source of evidence, as well as media articles. The Panel notes that meaningful consultation with affected groups and users will be a critical component of bringing ultra-fast broadband networks to rural and remote communities across Canada.

1.3 Overview of the Report

Chapter 2 provides background on the policy context for rural and remote broadband connectivity in Canada, including a brief description of available technologies. Building on Chapter 2, Chapter 3 looks specifically at the relevant context for broadband connectivity in Indigenous communities, with a particular focus on the integral relationship between connectivity and self-determination. Chapter 4 then considers the impacts of high-speed broadband connectivity on rural and remote communities, focusing on the areas of economic development, education, healthcare, and culture, in particular. The chapter also includes a discussion of the challenges that limit the uptake of internet in these communities. Having laid out the importance and impact of high-speed internet for rural and remote Canada, including Indigenous communities, the report moves into an examination of the challenges that limit the rollout of broadband networks in these regions. This includes an examination of both deployment and maintenance challenges (Chapter 5), as well as those related to policy (Chapter 6). Both chapters also consider promising practices from Canada and abroad to overcome these impediments. Lastly, Chapter 7 presents a brief synthesis of how the Panel addressed the charge, and its final reflections on the topic.

2

Connecting Rural and Remote Communities: The Canadian Context

2.1 Defining Connectivity

2.2 Current State of Government Initiatives to Support Rural and Remote Connectivity

2.3 Current State of Connectivity in Rural and Remote Canada

2.4 Diversity and Policy Considerations in Rural and Remote Communities

2.5 Summary

Chapter Findings

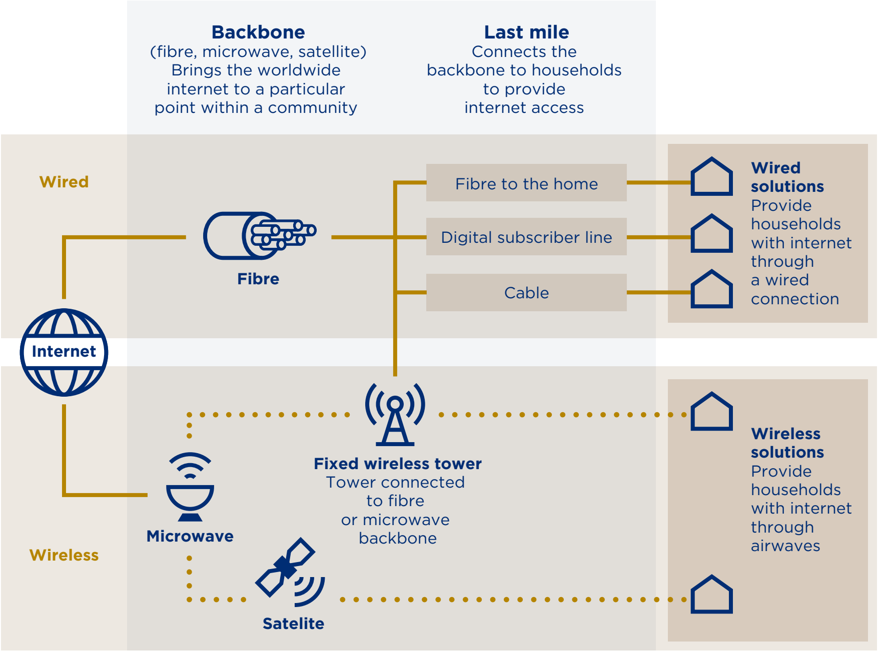
- Bringing high-speed broadband to rural and remote communities is not solely dependent on technological advancement.
- Speed is only one of the features that determine the quality of a broadband network. Redundancy, reliability, and symmetrical upload/download speeds are other technological factors that are needed for a broadband network to meet the needs of users.
- Government-led connectivity programs have been insufficient to narrow the connectivity gap between urban centres and rural or remote communities.
- Rural and remote communities in Canada may be defined through a combination of factors, including distance from urban centres, population density, topography, and accessibility. There is no one-size-fits-all solution to bringing connectivity to rural or remote areas; place-based policy considers this diversity when addressing issues of underservice, equity, and access.

The network technologies already exist to deliver ultra-fast broadband with speeds of 1 Gbps and beyond; however, it is not yet universally available or accessible across Canada. Indeed, in several regions, customers have been able to access services with speeds greater than 1 Gbps for some time, allowing for enhanced connectivity, along with new and improved data-intensive services. For many people across Canada, however, such speeds are a long way off, as is basic dependable broadband service. This chapter sets out what it means to have broadband in rural and remote regions, providing the policy context needed to understand the challenges that persist irrespective of broadband speed.

2.1 Defining Connectivity

A broadband network comprises two basic elements: the *backhaul (or backbone) network* that brings connectivity to a given community, and the *last-mile connection*, which links that network to the end-user (Figure 2.1). The backhaul can be wired (delivering data via a fibre optic cable) or wireless (delivering data via a microwave station to either a satellite or fixed wireless tower). The last-mile of connection that delivers data to homes using a wired backbone can be provided by fibre optic cable, digital subscriber line (DSL), or cable to or near the home — although in some cases it can also be a wireless connection. Satellite connectivity uses wireless last-mile connections through receivers on the ground, which may be located directly at the user site (e.g., home) or at a shared access point (Auditor General of Canada, 2018a). Both fixed wireless and mobile wireless broadband connectivity depend on access to radio-frequency spectrum (Box 2.1).

Rural and remote regions are served by both fixed and wireless connections depending on the location. The existence of a broadband network, however, does not automatically mean that a community will be able to realize the benefits of broadband connectivity. Similarly, access does not necessarily mean adoption (Section 4.5), and a network can only yield benefits for people if it is used. Furthermore, not all networks will provide the quality of connectivity needed to meet the needs of a community. In fact, many people living in rural and remote regions in Canada do not have access to high-speed internet of sufficient quality to achieve the benefits promised by universal connectivity (ISED, 2019c). People in these communities have slower and less reliable internet access than urban residents, resulting in a substantial connectivity gap (ISED, 2019c).



Adapted from: Auditor General of Canada (2018a)

Figure 2.1 Simplified Schematic of Methods of Providing Broadband Internet Access

The external methods of providing broadband internet connection to households are illustrated above. There may be challenges within households that affect quality of service (e.g., multiple WiFi-connected devices simultaneously).

Box 2.1 Radio-Frequency Spectrum

Fixed wireless and mobile wireless broadband connectivity use radio-frequency spectrum to transmit signal. Wireless service providers can use allocated bands of spectrum to allow users to send and receive data over the air on devices such as smartphones, tablets, and personal computers. Data can be transmitted at high or low frequencies, and the greater the bandwidth the greater potential speed. Low-frequency bands have a greater ability to travel long distances and penetrate through structures (e.g., buildings) as compared to high-frequency bands (ISED, 2018c). High-frequency bands transmit data over shorter distances and at lower latency[3] than low-frequency bands. Mid-frequency bands allows for a mixture of coverage and capacity (ISED, 2018c).

In Canada, spectrum is managed by Innovation, Science and Economic Development Canada (ISED) (GC, 1985), in recognition of the fact that radio-frequency spectrum is a finite resource. Prospective Canadian wireless service providers must register with ISED and obtain a licence for use of a specific spectrum frequency band within a defined geographic area (Industry Canada, 2011).[4] In its *Spectrum Outlook 2018 to 2022*, ISED implemented spectrum management policies with the goal of fostering improved deployment of fixed wireless and mobile broadband services in rural and remote areas (ISED, 2018c). These policies include designating bands of licence-exempt spectrum for fixed services and adopting an "all-come-all-served" approach to other bands where certain spectrum is licensed on a shared basis (Auditor General of Canada, 2018a; ISED, 2018c, 2021a). Several challenges related to spectrum allocation in Canada are discussed in Chapter 6.

Discussions of connectivity tend to centre on speed, with the focus generally on download speeds, but what constitutes "high" speed is a moving target. In the 2000s, 5 Mbps download was the target speed for broadband connections (CRTC, 2011; McNally *et al.*, 2017), but today this is far too slow for many modern applications. Furthermore, while current Government of Canada speed targets are 50/10, there are already many applications that require faster download or upload speeds (e.g., some e-health services). It is probable that new innovations will continue to be developed that take advantage of the fastest available speeds. As long as internet speeds in urban centres continue to be substantially faster than

3 Latency refers to the time required for data to travel from its source to destination (CRTC, 2021a)

4 Bluetooth and wireless local area network (WLAN) channels (often referred to as WiFi) use non-exclusive spectrum to send and receive data (BTLR, 2020).

those in rural communities, the latter will continue to be shut out from the benefits of the digital economy. Rather than focusing on a particular speed goal, it is more appropriate to strive for network access and adoption in rural and remote communities comparable to urban communities.

While speed is a key component of a good network, a continued focus only on a fixed speed goal — regardless of the exact number — can serve as a distraction from the other factors that define whether a connection will meet the needs of end-users. In the view of the Panel, redundancy, reliability, and symmetrical upload/download are equally important for ensuring high-quality connectivity.

2.1.1 Redundancy

Regardless of the type of network, it should be expected that the infrastructure will fail at some point, be it due to human error, weather, or an unexpected event. This means that redundancy (i.e., backup infrastructure) is needed to ensure that a community has uninterrupted broadband network coverage. Put simply, if a community does not have redundancy in its broadband network, it is at greater risk for a loss of network connectivity as compared to other communities. Redundancy is therefore an essential component of networks capable of consistently meeting the needs of residents.

The impact of an extended outage because of lack of redundancy can be severe and will only grow as more and more essential services and applications move exclusively online. A prolonged outage can be particularly problematic for institutions such as schools and hospitals, especially in regions where there are no alternatives for patient care (Enck & Reynolds, 2009; McNally, 2019). Box 2.2 describes two instances where the impairment of a single access point resulted in day-long outages. The examples provided are not isolated events; there have been several instances of lost connectivity due to a satellite error or a fibre cut.

There are multiple ways to provide redundancy to a given network. In the case of fibre, redundancy can easily be inserted into a network through the use of fibre rings, as opposed to a single fibre line (Cisco, 2018). Redundancy can also be achieved through having multiple backhaul types available (e.g., microwave stations in addition to satellite internet). Ensuring redundancy increases the cost of deploying (or maintaining) infrastructure, which can be particularly challenging in rural and remote communities (Fontaine, 2017) (Chapter 5). For instance, in its 2018 submission to the Standing Committee on Industry, Science and Technology, Northwestel (2018) noted that, in the past, "government funding programs have typically not invested directly in redundancy, most likely because redundancy does not explicitly result in faster-speed or higher bandwidth service offerings at lower prices to consumers."

Box 2.2 The Importance of Redundancy

Satellite Outage in the North – October 6, 2011

On October 6, 2011, Telesat Canada lost control of the Anik F2 satellite, which then experienced a loss of orientation (Nunatsiaq News, 2011). The error put the satellite out of service for over 16 hours, starting at approximately 6:30 AM ET. This meant that the satellite and all the services it supported were offline for an entire day, and every community in Nunavut, as well as some in Yukon, the Northwest Territories, northern Ontario, and Labrador, lost the ability to access the internet and make cellular or long-distance phone calls. The impacts of the outage extended well beyond an inability to check email. Commercial activities were heavily impacted when all debit and credit machines, as well as ATMs, were unusable. Air travel in Nunavut was delayed, stranding hundreds of passengers, as air traffic control in the territory was entirely dependent on satellite connectivity. The outage necessitated the Government of Nunavut to take on emergency measures; CBC radio was used to communicate with residents and institutions, including RCMP detachments outside Iqaluit (Nunatsiaq News, 2011).

Fibre Cut in Northern British Columbia – August 1, 2016

A lack of redundancy with fibre can also be problematic, as illustrated by the many outages that have occurred has a result of a single severed cable (CBC News, 2016). When a construction company accidentally severed a fibre line in northern British Columbia in August 2016, thousands of customers across Yukon, as well as some in the Northwest Territories and Nunavut, lost internet, long-distance, and cellular service for most of the day. The fibre line was the only one linking Yukon to southern Canada. The outage meant that people were unable to do any shopping, including buying groceries, as payment systems were down. Furthermore, according to CBC News (2016), "[t]he local and territorial governments were advising residents who needed emergency assistance but couldn't access 911 to send someone to a fire hall or RCMP detachment, where they could radio for help."

2.1.2 Reliability

Even in cases where there is not a full, prolonged loss of service, unreliable networks have limited utility for users. An unreliable network is one that has occasional or frequent loss of service, or reduced quality of service (i.e., slow upload and download speeds). While concerns over reliability are not unique to rural and remote communities, the risks posed by unreliable networks are often greater in these regions than in urban centres, because upload and download speeds are lower to begin with, and there are fewer (and sometimes no) alternative methods of connectivity.

"ISPs were technically meeting the CRTC's upload/download standards (50/10) in these communities, but only did so in the middle of the night."

Rural customers have often expressed concerns about the reliability of the internet services available in their communities, including whether advertised speeds are in fact being delivered by ISPs (Competition Bureau Canada, 2019). For example, testing of upload and download speeds in over 20 First Nations communities revealed that the availability of networks fluctuated substantially during the day (Cybera, 2020). ISPs were technically meeting the CRTC's upload/download standards (50/10) in these communities, but only did so in the middle of the night.

Consistently unreliable internet can have prolonged negative impacts. Following a power outage on February 24, 2021, Ulukhaktok, Northwest Territories faced eight days of sporadic connectivity across the community (Scott, 2021a, 2021b). This meant that stores could often only accept cash, at the same time as residents were unable to use ATMs to withdraw money. A CBC article quoted the mayor of the community, Joshua Oliktoak: "We need help. We need somebody to come here and fix this situation because people are struggling to get groceries, [...] heating fuel, [and] gas for their snowmobiles" (Scott, 2021a). Oliktoak also "urged residents who are in dire situations to reach out to him personally since he 'has some food at home and some cash' to help them in the meantime" (Scott, 2021a). After eight days, and right before a major blizzard hit the town, internet connectivity was restored. A Northwestel spokesperson stated that, during the outage, "data was still flowing in and out of the community and we did not fully realize the impact it was having on customers," although residents reported they tried to inform the company of the issue (Scott, 2021b).

2.1.3 Symmetric or Near-Symmetric

Traditionally, residential internet connections are asymmetrical, with download speeds substantially faster than upload speeds (OECD, 2014). This limits the potential utility of the internet for users, slowing their ability to upload content relative to the speed of downloading content. The importance of fast upload speeds is growing, however; increasingly, all users benefit from having the potential to be active uploaders and online participants, as opposed to simply passive consumers of downloaded content.

The most immediate use for symmetrical upload speeds is videoconferencing, which can be a conduit to services such as healthcare, education, and counselling (Banbury *et al.*, 2016; Anders, 2021). The COVID-19 pandemic highlighted the importance of stable, interactive, high-resolution videoconferencing, which, during a lockdown, is essential for accessing many healthcare or educational services, and for working from home (ISED, 2019c; Brownell, 2021). There are many other applications, however, where large amounts of data need to be uploaded. Individuals and businesses frequently use offsite cloud storage to back up data. Faster upload speeds and unlimited data mean that securing data can happen more frequently, making backups more reliable (Carbonite, 2015; Lahn, 2020). Businesses and individuals are relying on cloud computing more to perform tasks that require high levels of computational power (Andrew, 2019; Vennam, 2020) and users need fast upload speeds to benefit from these advancements (Andrew, 2019; Vennam, 2020). Further, shared connections used by families, people at public access points, or groups of employees — which are linked to several connected devices — will similarly overwhelm restrictive upload speeds (Lahn, 2020; Morrison, 2021). The Panel notes that the NRC's HTSN program is focused on developing networks that are symmetric in terms of upload and download speeds (1 Gbps or faster) (NRC, 2020).

As with download speed, access to faster upload speeds may be limited by cost. Some providers do offer symmetrical options, but these are generally more expensive than asymmetrical plans (Middleton, 2013). This means that customers unable to afford more expensive plans are limited in their ability to use certain digital applications. An individual's engagement in the information society can, in part, be assessed by determining the frequency of use and superficiality of participation (Middleton, 2013).

2.2 Current State of Government Initiatives to Support Rural and Remote Connectivity

The importance of providing comparable broadband access to everyone in Canada, including those living in rural and remote communities, has long been recognized. In 2005, the Government of Canada appointed the Telecommunications Policy Review Panel (TPRP). The TPRP was tasked with recommending how to modernize the country's telecommunications policy framework in a way that would ensure Canada had a strong, internationally competitive telecommunications industry that delivers world-class services for all residents. As one of its recommendations, the TPRP suggested that a new initiative "immediately commence" to ensure that affordable and reliable broadband services "are ubiquitously available in all regions of Canada, including urban, rural, and remote areas, by 2010 at the latest" (TPRP, 2006). Ten years after this recommended deployment deadline for ubiquitous connectivity, the Broadcasting and Telecommunications Legislative Review (BTLR) emphasized the same unmet needs in rural and remote communities. The BTLR echoed earlier expert panel recommendations, calling for more funding to support universal service in order to bridge the pronounced digital divide in Canada (TPRP, 2006); that review included specific recommendations (some of which are discussed in Chapter 6).

Federal policy response has emphasized the use of market mechanisms to deliver connectivity

In response to the TPRP's recommendation to exercise previously unused authority under Section 8 of the *Telecommunications Act* (TPRP, 2006), the federal government issued a *Policy Direction* to the CRTC that instructed the commission to rely on markets as much as possible to achieve telecommunications policy objectives (GC, 2006). These regulatory measures were supposed to preserve technological neutrality but not deter efficient competitive entry or promote economically inefficient entry in markets (GC, 2006; Rajabiun & Middleton, 2013b; GC, 2019). In the years following this *Policy Direction*, the CRTC deregulated many segments of the market it deemed to be sufficiently competitive, and broadly streamlined its regulatory measures (Intven, 2014).

In 2019, the federal government issued a second *Policy Direction* to the CRTC, asking it to consider how it might promote competition, affordability, consumer interests, and innovation (GC, 2019). One of the principles noted that the CRTC should consider the extent to which its decisions ensure that "affordable access to high-quality telecommunications services is available in all regions of Canada, including rural areas" (GC, 2019).

One of the BTLR's key findings was that exclusive reliance on market-based mechanisms will not necessarily result in internet users having access to more affordable internet service choices (BTLR, 2020). For instance, high-speed internet deployment projects led by incumbent telecommunications companies have largely been unable to address the digital divide if the projects do not generate adequate returns on investments (Philpot *et al.*, 2014). Historically, the provision of essential services to rural and remote communities in Canada has relied on non-market mechanisms of government subsidies to achieve equitable access (Chapter 6).

In 2019, the federal government launched the *High-Speed Access for All: Canada's Connectivity Strategy*, which committed to bring 50/10 internet speeds to at least 90% of consumers in 2021, 95% by 2026, and 100% by 2030 (CRTC, 2018a; ISED, 2019c). While the strategy includes goals and promises, including several adopted from the CRTC Universal Service Objective (CRTC, 2016), it does not set out an action plan or roadmap on how to actually achieve universal connectivity, particularly in rural and remote communities. Improving rural and remote connectivity continues to be an issue of focus for the federal government and was included in the 2020 Speech from the Throne with a commitment to accelerate the current connectivity timelines and ambitions of the Universal Broadband Fund (GC, 2020a).

Many programs now exist to provide funding for rural and remote broadband networks

Several government programs have the goal of improving connectivity in rural and remote regions in Canada (see selected federal examples in Table 2.1). Some of these programs stem from Canada's connectivity strategy, while others predate it. These programs have overlapping goals, but they are operated by a range of government departments or entities, and have different requirements, application processes, and means of evaluation.

Beyond federal programs, there are also multiple provincial/territorial and regional programs focused on improving internet access in rural and remote regions; many were created (or enhanced) during the COVID-19 pandemic. Summarizing all of the available funding programs across Canada is outside the scope of the Panel. The sheer number and overlapping mandates of these programs illustrate the complexity of the funding environment, and the challenges for a given community trying to navigate the system. The effectiveness of these programs is impacted by this complexity, as well as the intricacies and overlap between federal and provincial/territorial mandates. These challenges will be addressed in Chapter 6.

Table 2.1 Selected Federal Programs and Initiatives Aimed at Improving Connectivity in Rural and Remote Regions

Program or Initiative	Description
Canada Infrastructure Bank	Provides "low-cost, flexible financing" for broadband projects that are not considered commercially viable. The Canada Infrastructure Bank began investing in broadband projects in 2021.
Connecting Canadians	Contributed towards the total cost of projects bringing high-speed broadband to underserviced communities by providing up to 75% of eligible project costs for Indigenous communities, and up to 50% for the rural component. It was replaced by the Connect to Innovate program.
Connect to Innovate	Primarily supports new backbone infrastructure, but also some upgrade projects. A portion of the fund also goes to support last-mile connectivity. Any entity (not individuals) outside of federal entities could apply. The application process (through ISED) is now closed.
CRTC Broadband Fund	Supports projects bringing broadband and mobile wireless connectivity to underserved areas. Through industry contributions rather than direct government funding, it provides CRTC funding for three types of projects (new or upgraded): • transport (internet transport network capacity to one or more interconnection points) • access (fixed broadband internet access network infrastructure to connect communities to an interconnection point on the transport network) • mobile wireless
Universal Broadband Fund	Support for broadband projects across Canada. This ISED program was "designed to meet the unique needs of rural and remote communities." The application period closed in March 2021.

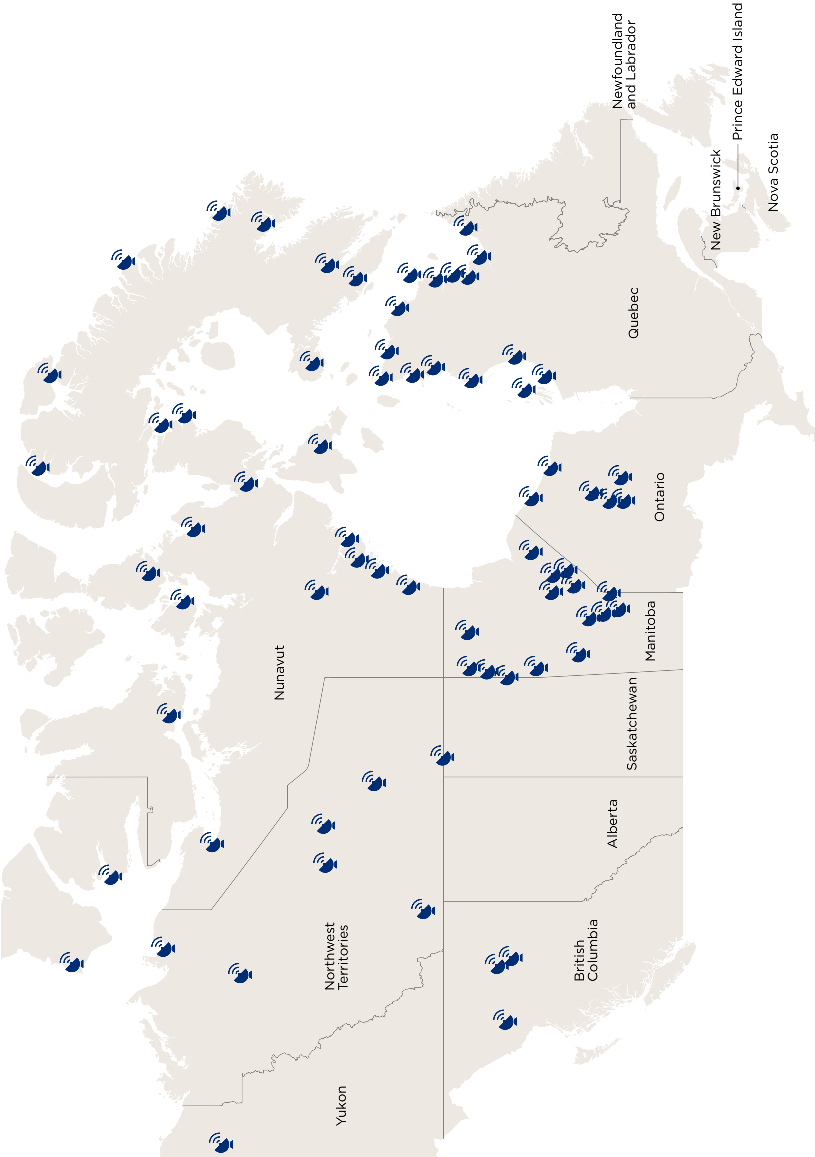
Adapted from ISED (2020b)

2.3 Current State of Connectivity in Rural and Remote Canada

Compared to urban centres, broadband connectivity in rural and remote regions has generally been characterized by slower transmission speeds, less availability, and higher costs. As of 2019, 54% of rural households in Canada did not have access to broadband services meeting the Government of Canada target of 50/10 with unlimited monthly data transfer (50/10 unlimited) (CRTC, 2020e). In comparison, only 1.4% of households in urban areas did not have access to that level of service. Underservice is not restricted to one region of the country, and there are communities in all provinces and territories that do not have access to wired or fixed wireless broadband at 50/10 (CRTC, 2020e).

"As of 2019, 54% of rural households in Canada did not have access to broadband services meeting the Government of Canada target of 50/10 with unlimited monthly data transfer (50/10 unlimited) (CRTC, 2020e). In comparison, only 1.4% of households in urban areas did not have access to that level of service."

In 2019, Prince Edward Island, Saskatchewan, and Manitoba had the lowest levels of access to high-speed internet among provinces, with 39%, 29%, and 27% of households respectively lacking access to 50/10 unlimited (CRTC, 2020e). Access is worse in the territories, however, and there were no households in the Northwest Territories or Nunavut with access to 50/10 as of 2019 (CRTC, 2020e). Beyond the territories, access can be limited in the northern regions of many provinces, including Manitoba, Quebec, and Newfoundland and Labrador, where broadband access is often only possible through satellite connectivity (Figure 2.2). Northwestel received approval in 2020 to fund broadband access of 50/10 with unlimited data to several Yukon communities; however, the cost for consumers there will continue to be higher than in the rest of Canada, nor is this level of connectivity universally available in the territory at the moment (CRTC, 2020d; Northwestel, 2020). In rural Manitoba and rural Saskatchewan, 86% and 76% of households respectively do not have access to 50/10 speeds (CRTC, 2020e). Of all provinces and territories, Nunavut has the most limited access to high-speed internet. No households in the territory have access to broadband speeds of 25 Mbps or faster (CRTC, 2020e). As suggested above, underservice does not only relate to the transmission speed of a broadband network, but also the presence of data transfer limits, or caps, that make it challenging for users to fully take advantage of broadband networks.



Data Source: ISED (2021b)

Figure 2.2 Satellite-Dependent Communities in Canada

Communities that depend exclusively on satellite connectivity in Canada are illustrated with a satellite dish.

A connectivity gap persists and has the potential to grow

Over the past decade, the federal government has announced several programs with respect to improving internet access in Canada's rural and remote regions. However, these efforts have not eliminated the problem of underservice. Overall, the divide between urban and rural communities remained virtually unchanged between 2014 and 2018 for 50/10 speeds, and the divide between urban and remote communities grew over the same period of time (BTLR, 2020). More recently, 50/10 unlimited was found to be available to almost all of households in urban centres, while only 46% of those in rural areas have access to the same service speeds (CRTC, 2020e). Although the connectivity gap is generally described as urban regions having better internet connectivity than rural and remote regions, a substantial internet connectivity gap also exists between Indigenous communities (located in urban, rural, and remote areas) and non-Indigenous communities (CRTC, 2019a; BTLR, 2020) (Chapter 3).

The longer the connectivity gap persists, the further behind rural and remote communities lag in terms of having access to comparable infrastructure, technology, and services. This continued limited access to services prompted the BTLR to state that the digital divide in Canada is a question of nation-building (BTLR, 2020). While the urban and rural divide is common in many of Canada's peer countries, Canadian broadband speeds lag substantially behind countries that have invested more in digital infrastructure, including France, Sweden, and the United States (SWIFT, 2017; Auditor General of Canada, 2018a; Speedtest Global Index, 2021).

The Panel notes that the connectivity gap is not simply an issue of access. The digital divide can also be narrowed through digital inclusion actions such as interventions to increase access and adoption (Public Policy Forum, 2018). Addressing digital inclusion across remote and rural areas may involve complementing community advocacy with stronger intergovernmental programs and increasing access through subsidies, the donation of devices, and public–private partnerships (Public Policy Forum, 2018). The importance of adoption is discussed in Chapter 4, and the importance of holistic funding is discussed in Chapter 6.

In Canada, broadband internet provision is dominated by five ISPs

Internet service providers (ISPs) play an essential role in the deployment, maintenance, and provision of broadband networks. ISPs are categorized in three main groups in Canada: (i) incumbent Telecommunications Service Providers (TSPs), which traditionally also provide home phone services (e.g., Bell, TELUS), including Small Incumbent Local Exchange Carriers (SILECs); (ii) cable-based carriers (e.g., Rogers, Shaw, Vidéotron); and (iii) other service providers, including wholesale-based providers (e.g., Distributel, TekSavvy) and satellite-based providers (e.g., Telesat) (CRTC, 2018a, 2020e). The vertical integration of Canadian media companies has increased over the past decade, with Bell, Rogers, Shaw, and Québecor accounting for 56% of revenue across the network media economy in 2019 (Winseck, 2020). In 2015, the CRTC noted that there is minimal competition among the incumbent carriers to limit market power; current competition is largely due to regulatory intervention (CRTC, 2015a).

There are different TSPs and cable-based carriers across Canada, but only one of each for any given region. For example, the TSP in British Columbia is TELUS and the cable-based carrier is Shaw, while in Ontario the TSP is Bell and the cable-based carrier is Rogers or Cogeco (both operate in the province, but not in the same locations) (CRTC, 2019a). Overall, Canada's internet market is dominated by five ISPs (namely, Bell, Québecor (Vidéotron), Rogers, Shaw, and TELUS), which collectively account for 72% of total broadband revenues, and which own and operate most of the broadband infrastructure utilized by other providers (CRTC, 2019a).[5]

While incumbent TSPs and cable-based carriers are the dominant providers, there are other models of ownership and investment in rural Canada. For example, Brooke Telecom is a co-operative telecommunications service provider that has been in service in southwestern Ontario since 1911 (Brooke Telecom, 2021). Brooke Telecom offers rural customers various telecommunications services, including broadband, television, phone, and mobile service (Brooke Telecom, 2021). Recent infrastructure investment by Brooke Telecom and Southwestern Integrated Fibre Technology (SWIFT) will bring future-proof fibre to 530 underserved households and businesses by 2022 (SWIFT, 2020c). Additional ownership models are discussed in Chapter 5.

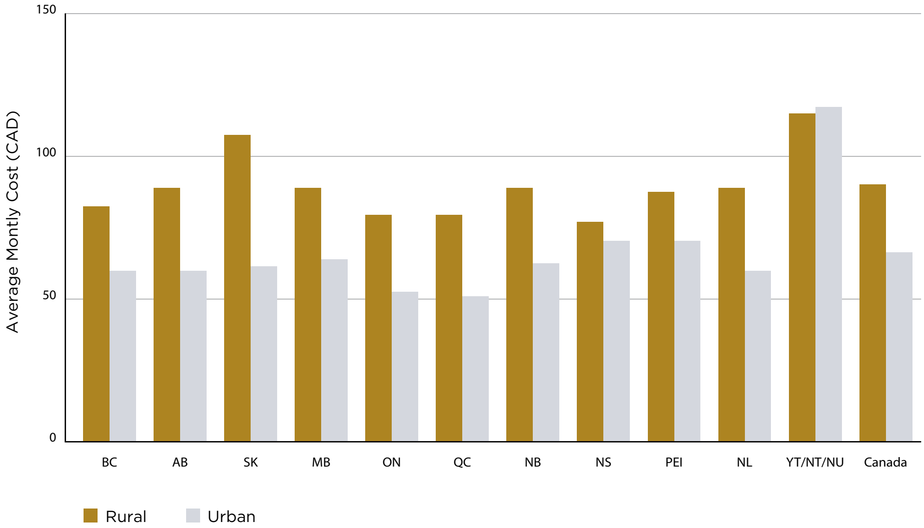
5 In March 2021, Rogers Communications announced it had reached an agreement to buy Shaw Communications (Lim, 2021). The acquisition is under review with the Competition Bureau, the CRTC, and ISED, each of which have authority to alter or prevent the merger from occurring. These reviews were not completed at the time of this report's publication.

Internet access costs vary substantially across the country

Rural communities have fewer ISP options than urban customers. On average, rural and remote communities have access to four ISPs, while urban communities have access to eight providers (CRTC, 2018a). Some regions have only a single service provider. With fewer internet service providers, rural and remote communities subsequently have fewer ISP options and higher prices than urban customers, resulting in a variation in cost across the country. However, it is challenging to compare costs across Canada due to the incompleteness of data on broadband costs for subscribers, as well as considerations beyond service price, including device and installation costs, which may vary substantially by location.

Recent price reporting from the territories shows that urban, rural, and remote communities that are offered a speed of 25/3 Mbps with a 100 GB/month data cap pay between $100 and $130 per household per month, where service is available (CRTC, 2018a, 2020b). The average prices for 25/3 Mbps internet are used to compare prices across the country, since 50/10 service is not currently available in Yukon, Northwest Territories, and Nunavut. The costs of 25/3 internet varies substantially between urban and rural or remote communities across Canada (Figure 2.3) and the national average in urban centres is $66 while in rural communities it is $90. Where available, 50/10 unlimited plans cost an average of $73 and $65 per month in rural regions and urban centres, respectively (CRTC, 2020e).

While many northern regions in the provinces experience similar connection costs as the territories, these data are not separated from provincial averages by the CRTC. Outside of the territories, 50/10 unlimited prices in recent years have generally been highest in Atlantic Canada (CRTC, 2018a), although average service prices were highest in Saskatchewan in 2019 (where rural 50/10 unlimited plans were made available in that year) and lowest in Quebec (CRTC, 2020e). The presence of data transfer limits can substantially increase the cost of broadband access if users exceed their monthly limit. For example, in Blueberry Creek, British Columbia, the top internet plan costs $103.97 per month for maximum download/upload speeds of 15/1 with usage capped at 300 GB. Any usage above this cap costs an additional $2.50 per GB (Northwestel, 2021).



Data Source: CRTC (2020b)

Figure 2.3 Monthly Cost of 25/3 Internet in Rural and Urban Communities, 2019

The average cost of 25/3 internet service varies between urban centres and rural communities, where the latter are defined as communities with fewer than 1,000 residents, or areas with fewer than 400 people per km^2. The national average in urban centres is $66.31 while in rural communities it is $90.18. Costs are highest in the territories in those locations where 25/3 is available.

New satellite services are expanding access, but at a cost

Advancements in satellite connectivity have the potential to significantly expand access to broadband for many customers in Canada, including those in rural and some remote communities where service is currently planned. These new services, provided by constellations of LEO satellites, allow for faster internet connections by operating at a distance of 1,000 km or less, as compared to traditional geostationary satellites, which orbit at 36,000 km (Jackson, 2019). Household access to satellite connectivity is, however, contingent on consumers being able to afford the initial cost of the satellite dish and ongoing service fees (Daigle, 2020). Socio-economic disparity within communities may lead to unequal access if satellite services are provided solely through profit-based service models.

Multiple companies currently use, or plan to use, LEO satellites to improve internet connectivity. Two major companies operating in Canada are Telesat and SpaceX. Telesat, a Canadian company, received $85 million from the federal government in

2019, with a total funding commitment of up to $600 million over 10 years if the satellites are brought into service (Telesat, 2020). The Government of Canada has provided Telesat with other financial support in the form of loans and the purchase of preferred shares (Telecompaper, 2021). Telesat plans to launch a total of 298 LEO satellites to improve connectivity and access in rural and remote regions across Canada (Jackson, 2019; ISED, 2020f). SpaceX, an American company, received CRTC approval in 2020 to provide internet to Canadian businesses and homes through small satellites orbiting at 550 km from Earth. According to a CBC news article, SpaceX has been launching approximately 60 satellites twice a month since May 2019 and had over 800 satellites in orbit as of October 2020 (Smith, 2020). Initial beta testing of households in Canada and United States have provided considerable improvements in internet speed for some rural and remote customers (Dunne, 2021). There are concerns, however, that the cost of satellite internet will put it out of reach of many people in rural and remote Canada, and that the speed of satellite connectivity will decrease as more users sign up (Dunne, 2021).

2.4 Diversity and Policy Considerations in Rural and Remote Communities

Rural and remote communities in Canada are diverse and heterogeneous, and not always well represented by strict definitions of *rural* and *remote*. These communities may be characterized by a combination of factors, including differing topographies, population densities, distance to urban centres, and local economies. Due to this varying combination of distinct features in rural and remote communities, place-based policy can help reduce the exclusion of communities from social services, programs, and initiatives (Morisson & Doussineau, 2019).

Varying definitions of rural, remote, and underserved impact funding eligibility for communities

What constitutes a rural or remote community by definition varies among programs and services across the country — that is, classification may be based on one or several features, such as population density, demographics, infrastructure, topography, or income. This can impact subsequent policy decisions. The definitions of *rural* most often used by the Government of Canada are based on density or population size alone. For example, Statistics Canada classifies a rural area as any territory outside a population centre of 1,000 residents or more (StatCan, 2017b), while non-census metropolitan areas (non-CMAs) or non-census agglomerations (CAs) are any regions with populations of less than 100,000 or 10,000, respectively. The metropolitan influence zones (MIZ) categorize the influence of metropolitan areas on non-CMAs and CAs by assessing the percentage of the workforce that commutes to urban centres from the surrounding rural area (StatCan, 2011). Similarly, the

CRTC defines a community as rural if the population is fewer than 1,000 individuals or if it has a density of 400 or fewer people per square kilometre (CRTC, 2019a).

There are many examples where definitions of *rural, remote*, or *underserved* have created challenges for service providers trying to access funding (McNally *et al.*, 2018). One program that relied on a variable definition of *rural* ended up including both the village of Caroline (population 512) and the City of Medicine Hat (population 63,000) in the same rubric — two Alberta communities with very different connectivity needs. Another example is the former Connecting Canadians program, which defined *underserved* as a population that did not have access to download speeds of 5 Mbps. This excluded many rural communities as satellite technology can, in theory, deliver those speeds (McNally *et al.*, 2018).

Rurality and remoteness may be better conceived based on factors relevant for a community's connectivity needs (Du Plessis *et al.*, 2001). *Rurality* is a spatial concept that refers to the location of individuals and is defined by the density of a population and its distance — either physically or by travel-time expenditure — to a location of higher density (Bollman & Reimer, 2018). The *remoteness* of communities in Canada, by contrast, can be determined by population density and distance to higher population centres in combination with the measurement of the accessibility of services, which is used to estimate service availability (Alasia *et al.*, 2017). Accessibility to a service could be calculated through a combination of factors such as commuting times of less than 150 minutes and connection to main road networks. Communities without a service available in their own census subdivision (CSD) and not connected to a road network are considered to have no access to the specified service (Alasia *et al.*, 2017). The classification of remoteness or rurality can also include factors such as distance from infrastructure, topography, and means of transportation (Alasia *et al.*, 2017). These factors also greatly impact the cost and feasibility of deploying different types of broadband infrastructure.

Income disparity among and within rural and remote regions influences customer ability to pay for connectivity

An important non-geographic factor that influences a community's connectivity needs and capacity is income and cost of living. There is substantial heterogeneity between and within the rural and urban regions in Canada when it comes to these factors. Cost of living is of particular importance for Canada's remote communities. Often, remoteness is used as a potential determinant of socio-economic outcomes, primarily due to distance and isolation, which result in high transaction costs with major market centres, including the availability of goods (Wu & Gopinath, 2008; Alasia *et al.*, 2017).

In 2016, the CRTC ruled that broadband internet is an essential telecommunications service in Canada. Previously, local landline telephone was the only telecommunications service deemed essential and therefore the expansion of local landline telephone access was historically subsidized (CBC, 2016). The costs of essential services, including telecommunications, have a proportionally larger impact on households that spend a greater than average proportion of income on essential needs. The COVID-19 pandemic has reinforced that internet is an essential component of cost of living.

The threshold below which a family is likely to spend a larger share of its income on necessities (e.g., food, housing, clothing, utilities) than the national average is called the low-income cut-off (LICO) (StatCan, 2010). Statistics Canada defines this line "as the income below which a family is likely to spend 20 percentage points more of its income on food, shelter and clothing than the average family" (StatCan, 2015). It is not, however, intended to measure poverty or identify those who are poor (Singh, 2002). The LICO varies based on the urbanization or rurality of regions, since rural residents tend to have lower costs (especially housing costs) than urban residents (Singh, 2002). Despite substantial income heterogeneity within rural regions, average rural incomes within provinces continue to be lower than those in urban centres (Singh, 2002; Ahmed, 2019). While the LICO does not include internet access, it has shown that the overall trend in living standards has improved in Canada and, as of 2015, only 9.2% of households were below the cut-off (Jackson, 2018). As a household level of analysis, the LICO has limited application for determining the affordability of broadband for an individual.

The nature and quality of parallel infrastructure influence connectivity contexts and needs

Communities depend on several infrastructure systems, of which broadband is only one. Other essential infrastructures include transportation (e.g., roads, rail), water, electricity, and education. These infrastructure networks do not exist in isolation, and the quality of one can create challenges or supports for the development and maintenance of the others. While it is technically possible for an individual to become self-sufficient with respect to most community infrastructure (e.g., generating their own power through solar panels or wind energy, or providing education), broadband access always requires connection to some external infrastructure systems owned and controlled by separate entities. Place-based policy considers the overall community access to essential infrastructure in order to provide appropriate levels of funding and service.

Transportation, education, and electricity are key parallel infrastructures that can either support, or create challenges for, the deployment and maintenance of broadband in rural and remote communities. For instance, the absence of transportation infrastructure increases the costs of deploying and maintaining broadband networks substantially because it is more challenging to source materials. Similarly, high-quality broadband internet deployment requires affordable and dependable electricity infrastructure, which creates challenges for the many communities in Canada that are not connected to the North American electrical grid and natural gas distribution pipeline (CFN, 2014; CER, 2021) (Section 5.3).

The presence of broadband networks supports local education infrastructure; and likewise, strong local education infrastructure supports the deployment and maintenance of networks by providing skilled workers (Chapter 5). For many rural and remote communities, improving the access to, and quality of, education is a particularly relevant connectivity need (Chapter 4). Canada's rural communities often (but not always) have a higher proportion of adults without a high school diploma as compared to urban centres (StatCan, 2017a). The gap is even greater between remote and urban communities. This trend is true for the overall adult population, as well as for young adults (20 to 34) (StatCan, 2017a).

Place-based approaches consider the local contexts of communities in decision-making

Place-based decisions move away from broadly applied government policy towards a focus on understanding local community values and goals (Reimer & Markey, 2008). Different social policies — including education, healthcare, and employment — have traditionally been developed independently from one another. This approach does not always enable a full consideration of the physical location where these policies intersect. Public policy decisions have often been tailored to local conditions, but place-based policy goes beyond this practice by making location the central focus for the development of the policy (Kraybill & Kilkenny, 2003).

Rural and remote community characteristics — including a strong sense of cultural identity and community dependence on services with multiple functions — impact the effectiveness of public policy (Reimer & Markey, 2008). Local capacity for rural and remote development will continue to require partnership with federal and provincial/territorial governments due to jurisdictional responsibility (Reimer & Markey, 2008). Connectivity decisions in rural and remote communities are more likely to be effective if they consider the unique local conditions. The Canadian Rural Revitalization Foundation notes that the socio-economic benefits of internet connectivity may be realized when rural and remote residents, governments, and businesses are able to successfully accomplish community goals (Canadian Rural Revitalization Foundation, 2017). Relatedly, McNally *et al.* (2016) explain that community action plans for the implementation of broadband connectivity need to consider potential local challenges, such as costs, a lack of community engagement, and challenges with private sector partnerships. The diverse needs of rural and remote communities based on specific community composition can be met effectively through the collaborative development of place-based policy.

2.5 Summary

The quality of broadband connectivity can be improved across the country using current technology. Despite this, many rural and remote communities have poor access. The reliance on market-based mechanisms to fund broadband connectivity programs in rural and remote communities has consistently failed to deliver levels of service comparable to those available in urban Canada. Rural and remote communities in Canada face diverse challenges due to geography, socio-economic factors, and access to infrastructure. Subsequently, the provision of equitable and sufficient broadband connectivity in rural and remote communities must be place-based, while also considering available technology, parallel essential infrastructure, and funding.

3

Broadband Connectivity in Indigenous Communities

3.1 Connectivity and Self-Determination

3.2 Inequitable Connectivity in Indigenous Communities

3.3 Delivery of Broadband Connectivity to Indigenous Communities

3.4 Path Forward for Broadband Delivery to Indigenous Communities

3.5 Summary

Chapter Findings

- Connectivity is an important tool in achieving Indigenous self-determination through participation in governance, economic development, and the delivery of healthcare and education services, infrastructure design and ownership, and the application of Indigenous worldviews, values, and objectives to emerging technologies.
- There is a substantial internet connectivity gap between Indigenous communities and rural communities in Canada.
- Access to high-quality broadband connectivity is a fundamental component of the Government of Canada's role in reconciliation. The failure to deliver high-quality broadband services to Indigenous communities has exacerbated inequities between Indigenous people and non-Indigenous people in Canada.
- Broadband networks, like all essential services, are best developed with meaningful, respectful and ongoing engagement with Indigenous communities. Indigenous partnerships and entrepreneurships enable substantive solutions.

Within Canada, the term *Indigenous communities* refers broadly to First Nations, Inuit, and Métis communities (CIRNAC, 2017). Many of these communities are small, remote, and rural, although Indigenous people live in major urban centres as well (CIRNAC, 2021). Indigenous communities face challenges as a result of the intersection of geographic, socio-economic, and political factors. These factors vary substantially among communities and are often distinct from factors affecting non-Indigenous rural and remote communities in Canada (Section 2.4) due to the legacy of colonialism and the Government of Canada's paternalistic treatment of Indigenous people. This unique context impacts the provision of reliable broadband connectivity to Indigenous communities, which is not comparable to the connectivity enjoyed in non-Indigenous communities. The development, delivery, and adoption of broadband connectivity in Indigenous communities should be led by, and developed in partnership with, Indigenous people.

3.1 Connectivity and Self-Determination

Connectivity can support Indigenous self-determination in Canada

Reliable and accessible connectivity in Indigenous communities is required to deliver a variety of essential services (e.g., healthcare, education), while enabling community members to actively participate in the knowledge economy, governance, and economic development (Chapter 4). Beyond the provision of services and economic opportunities, including economic reconciliation, the flow of information in and among Indigenous communities supports self-determination, cultural sovereignty, and pathways to decolonization, as identified by Indigenous leaders (Duarte, 2017). Broadband delivery is not just the installation of physical devices and network infrastructure; it also depends on the policies and people involved in connectivity. The process of delivering broadband includes key opportunities for legal, policy, and government intervention, including the allocation of spectrum, public and private investments, and regulatory decisions to improve access.

Some federal legislation in Canada, including the *Indian Act* first codified in 1876, continues to marginalize and regulate Indigenous communities, inhibiting the rights of Indigenous people to achieve self-determination, self-governance, and self-sufficiency (GC, 2020c). The First Nations Technology Council (FNTC, 2020b) and others (McMahon, 2014a) argue that connectivity constitutes an important tool in achieving Indigenous self-determination for multiple reasons. Firstly, increased connectivity facilitates Indigenous participation in governance, economic development, and the delivery of healthcare and education services (McMahon, 2014a). Secondly, self-determination involves ownership and control over key infrastructure, including broadband networks. The Canadian Broadcasting and Telecommunications Legislative Review (BTLR) reported Indigenous people's concerns about who owns infrastructure; Indigenous people sought greater control of telecommunications services within their communities, citing that doing so will contribute to self-determination and economic development (BTLR, 2020). Economic reconciliation — through mechanisms such as dedicated Indigenous funding — strengthens the ability of communities to build a culturally appropriate economic framework, reflect community values, and advance self-determination. Thirdly, self-determination is also achieved by ensuring Indigenous data sovereignty (Section 4.4.2), and by securing spectrum rights (Internet Society, 2020a). Spectrum sovereignty involves Indigenous Nations having first access to spectrum over their lands (Internet Society, 2020a), and is discussed further in Section 6.3.

Finally, self-determination entails applying Indigenous laws, practices, institutions, worldviews, principles, values, and objectives to protect Indigenous cultures, ideas, and expressions (Burrows, 2005). This approach can be applied to the development, operation, and ownership of emerging technologies, including broadband (McMahon, 2014a). Indigenous people in Canada and elsewhere are already engaged in this process. For example, mapping spatial information as a land-use planning tool to represent Indigenous knowledge and assert Indigenous rights through Geographic Information Systems (GIS) has begun in Canada (Olson *et al.*, 2016). Securing access to and control over mapping and data resources serves to advance self-determination efforts (McMahon *et al.*, 2017). Winter and Boudreau (2018) offer additional examples of how Indigenous people create spaces in digital environments in line with their worldviews and ways of knowing (e.g., digital storytelling, video games, apps, virtual reality).

Access to high-quality internet connectivity is needed to fully implement the United Nations Declaration on the Rights of Indigenous Peoples

The United Nations (UN) has played an important role in advocating for the recognition of Indigenous Peoples' rights worldwide and has highlighted the importance of internet connectivity. For example, a UN Human Rights Council Special Rapporteur report noted that the internet is a key enabler of human rights by generating new opportunities to create and share information and perspectives (UN Human Rights Council, 2011). In so doing, the internet provides Indigenous people with a voice and a platform that they may not otherwise have.

In 2007, the UN adopted one of the most consequential resolutions for Indigenous Peoples globally. The United Nations Declaration on the Rights of Indigenous Peoples (UNDRIP) enshrines the rights that "constitute the minimum standards for the survival, dignity and well-being of the Indigenous peoples of the world" (UN, 2007). UNDRIP codified the right of Indigenous communities to self-determination, and with that right they "freely determine their political status and freely pursue their economic, social and cultural development" (UN, 2007).

British Columbia was the first province in Canada to formally pass legislation to implement UNDRIP in 2019 (Gov. of BC, 2021b). The Government of British Columbia released a draft action plan to meet these objectives in June 2021. The draft plan was created following "a year of discussions with First Nations and Indigenous partners." Following a period of engagement with Indigenous partners and the opportunity for online feedback, the action plan will be finalized and is expected to be released in the fall of 2021 (Gov. of BC, 2021a). Canada's federal government also introduced legislation to implement UNDRIP in December 2020 and Bill C-15 received Royal Assent on June 21, 2021 (GC, 2020d). While internet connectivity is not explicitly mentioned in UNDRIP, it has been argued that many of the basic human rights under UNDRIP are difficult to implement without adequate and equitable access to the internet (Borrero, 2016; FNTC, 2020a). In the view of the Panel, a legislated, action-driven UNDRIP, embedded in a robust connectivity framework, can contribute to a more inclusive nation-building effort in Canada with Indigenous people at its core.

High-quality broadband connectivity is needed to meet several of the Truth and Reconciliation Commission's Calls to Action

Ensuring there is equitable access to comparable broadband connectivity for Indigenous people is necessary to address the Government of Canada's fiduciary duty, obligation, and responsibility to advance reconciliation. High-quality connectivity is required to deliver on many of the Calls to Action put forth by the Truth and Reconciliation Commission (TRC). These include access to well-funded, culturally appropriate education (Call 10) and healthcare (Call 18), as well as access to "jobs, training, and education opportunities in the corporate sector" so that "communities gain long-term sustainable benefits from economic development projects" (Call 92) (TRC, 2015a).

Furthermore, connectivity can support self-determination, which is crucial in reconciliation (TRC, 2015b; FNTC, 2020a). Each of these sectors (education, health, and economic development) now depend on access to broadband networks, particularly in rural and remote regions (Chapter 4).

Connectivity is integral to safety and well-being

Providing people with the connectivity to communicate is necessary for offering a degree of safety (Moffitt *et al.*, 2020). For example, access to 911 emergency services, including search and rescue, requires reliable connectivity alongside critical infrastructure, with sufficient redundancy to meet the data needs of first responders (PSBN Innovation Alliance, 2021). Upwards of 40 women, mostly Indigenous, are missing or have been murdered along Highway 16 ("Highway of Tears") from Prince Rupert to Prince George in British Columbia (Hall, 2020). The British Columbia and federal governments have committed to funding reliable phone and internet service along this stretch of highway to help protect women travelling this corridor, as recommended by the *Highway of Tears Symposium Recommendations Report* and the National Inquiry into Missing and Murdered Indigenous Women and Girls (Gov. of BC, 2021). Barb Ward-Burkitt, Executive Director of the Prince George Native Friendship Centre, said this connectivity project "serves as an important step of reconciliation and honouring for murdered and missing sisters, daughters, mothers, aunties and their families" (Gov. of BC, 2021).

Broadband is becoming an increasingly integral aspect of effective emergency response. Technological failures, including telecommunications limitations, hamper rescue operations and endanger lives (Redfern, 2014). The need for emergency response such as search and rescue is of particular importance to rural and remote communities, especially along the coast and in northern regions. The Government of Canada has allotted spectrum for public safety broadband operations to improve emergency response (Public Safety Canada, 2019). The Government of Canada considers interoperability of broadband radio technologies "an essential feature for public safety" (GC, 2015) to promote coordination in a modern safety radiocommunications infrastructure (GC, 2015; TNCO, 2020). Among these technologies, broadband is increasingly important for emergency management, and search and rescue, because it provides the speeds necessary for advanced smart technologies such as unmanned aerial systems (e.g., drones) and real-time monitoring, as well as the efficient transfer of large datafiles (Eshed, 2015; Gov. of BC, 2019; Gov. of YT, 2020; Güldenring *et al.*, 2020). Though many technologies use commercial wireless systems (e.g., 4G), these networks become congested and unreliable during emergencies (Eshed, 2015; Gov. of YT, 2020; Güldenring *et al.*, 2020).

3.2 Inequitable Connectivity in Indigenous Communities

Indigenous people in Canada do not have the same level of access to reliable, affordable high-speed broadband connectivity as non-Indigenous people in rural Canada

As noted in Section 3.1, connectivity allows Indigenous communities and governments to set their own cultural, economic, and governance priorities and effectively advocate for services, including essential services such as healthcare and education (Sellars, 2020). A lack of connectivity limits the ability of Indigenous governments to provide these necessary local services to the community and restricts Indigenous business opportunities. Willie Sellars, Chief of the Williams Lake First Nation, noted the essential need for connectivity during the COVID-19 pandemic: "[O]ur newfound connectivity has allowed our government to remain open and communicate effectively with our membership to ensure they have the information they need to stay safe" (Sellars, 2020). Connectivity enables communities to complete business promptly and allows them to focus on more substantive community priorities (Sellars, 2020).

Despite the critical importance of high-quality broadband connectivity for Indigenous communities, access continues to lag substantially behind that provided to non-Indigenous people in Canada. Although the connectivity gap is often ascribed to urban regions having better internet connectivity than rural and remote regions, this gap also exists between Indigenous and non-Indigenous communities (CRTC, 2019a; BTLR, 2020). Notably, as of 2017, 76% of households in all Indigenous communities did not have access to 50/10 connectivity (ISED, 2019c). While more recent data related to connectivity in Indigenous communities is lacking, as of 2019 65% of households on First Nations reserves did not have access to 50/10 unlimited (CRTC, 2020e). The Panel could not identify any data related to connectivity in Inuit and Métis households. Having said this, as of 2019, no households in Nunavut had access to download speeds of 25 Mbps or greater (half of the Government of Canada's download target of 50 Mbps) (CRTC, 2020e). The COVID-19 pandemic has amplified the negative impacts of the lack of internet access on Indigenous communities with respect to education, work, and economic development (Buell, 2021) (Chapter 4).

The inequitable level of connectivity available to Indigenous people in Canada is not a new phenomenon and has been identified as unacceptable by Indigenous leaders and others for decades (Duarte, 2017; BTLR, 2020). The failure to deliver sufficient broadband connectivity and to meaningfully consult with Indigenous communities on issues related to connectivity (Section 3.4), reflect an extension of Canada's history of colonialism that has driven racist practices, behaviours, and policies (including the *Indian Act*). These policies have led to prolonged and systematic inequality in all areas including, but not limited to, connectivity, economic development, and education and health outcomes. The continued reliance on the same types of government policies for expanding broadband service has reinforced this disparity, resulting in racist outcomes.

3.3 Delivery of Broadband Connectivity to Indigenous Communities

Access to high-quality internet is an essential service

Essential services for Indigenous communities include utilities, education, policing, emergency services, and healthcare (Metallic, 2016). High-quality broadband connectivity is both an essential service in and of itself, but also a necessary component for delivering other essential services. In Canada, delivering essential services to Indigenous peoples is different than for non-Indigenous people in Canada. A report by INAC and AFN (2017) notes, for example, that "First Nations have established governance structures and their governments must fully participate in the design and delivery of essential programs and services to First Nations citizens including supporting fiscal arrangements" (INAC & AFN, 2017). While the Government of Canada has acknowledged its fiduciary obligation to Indigenous people (GC, 1982; INAC, 1995), policy development and the allocation of resources have disenfranchised Indigenous communities. For example, the ongoing reliability of funding and the provision of essential services on reserves must be negotiated between the federal government and the provinces (Metallic, 2016). In 2011, the Auditor General noted that this structural complexity severely limits "the delivery of public services to First Nations communities and hinder[s] improvements in living conditions on reserves" (Auditor General of Canada, 2011). Furthermore, critics have argued that the current system for essential service provision is not culturally appropriate, as it applies provincial/territorial rules despite Indigenous people having needs, rights, and legal traditions that differ from non-Indigenous people (Burrows, 2010). Metallic (2016) argues that the system allows the chronic underfunding of services to Indigenous communities to go unchallenged for long periods (Metallic, 2016).

Essential service provision through contracts, as opposed to legislation, makes it difficult to challenge under the Canadian Charter of Rights and Freedoms, or human rights or administrative law. Furthermore, it makes provisions for resolving disputes in funding agreements ineffective (Promislow & Metallic, 2018). Metallic (2016) notes that agreements for ownership of essential service delivery in First Nations communities are negotiated on a "take it or leave it" basis, in which the federal and provincial/territorial governments hold greater bargaining power than Indigenous governments (Institute on Governance, 2008). The Canadian Human Rights Tribunal ruled that the well-known and well-documented inequalities in access to basic services for children and families in First Nations communities are a form of racial discrimination (Amnesty International Canada *et al.*, 2017).

In 2016, the Assembly of First Nations signed a memorandum of understanding with the Government of Canada that mandated that the design and delivery of essential services for First Nations must include the full participation of First Nations governments (INAC & AFN, 2017). The Joint Advisory Committee on Fiscal Relations (2019) noted that the widening socio-economic gaps experienced by First Nations can be relieved through Indigenous self-determination, including fiscal autonomy.

Indigenous people experience health and social challenges related to inadequate service delivery, resulting in the deprioritization of broadband connectivity

There are several well-documented socio-economic gaps between Indigenous and non-Indigenous communities in Canada. Socio-economic inequities include those related to threats to physical and mental health, limitations on the availability and quality of education and employment opportunities, inadequate access to housing, and food and water insecurity (McCaslin & Boyer, 2009). Many of these inequities are exacerbated by an absence of adequate broadband connectivity

(Chapter 4). In 2015, the Government of Canada committed to developing strategies to eliminate education and employment gaps as well as measure and close the gaps in health outcomes between Indigenous and non-Indigenous communities (Auditor General of Canada, 2018b).

In recent decades, community well-being (CWB) index scores have consistently been between 10 and 20 points lower in First Nations and Inuit communities compared with non-Indigenous communities (OECD, 2020). The Auditor General's 2018 report noted that the index was not created with meaningful engagement with Indigenous people; while Indigenous Services Canada (ISC) recognized that the CWB index was incomplete, the measure has not been made more comprehensive (Auditor General of Canada, 2018b; INAC, 2019). The index scores are calculated using the four socio-economic indicators of income, education, housing, and participation in the labour force (INAC, 2019) — but omits data on health, environment, language, and culture, which are important aspects of well-being for Indigenous people (Auditor General of Canada, 2018b). Burrows (2016) notes that "Indigenous peoples' relationship to the land, its resources, and other peoples could be considered one of the organizing features of Canada's unwritten constitution.[6] Despite the limitations of the CWB index, it remains one of the major sources of data used for comparing socio-economic inequity between Indigenous and non-Indigenous communities in Canada. It also provides an example of a tool used to support policy-making that does not accurately reflect the needs or contexts of Indigenous people.

The range of social and economic challenges facing Indigenous communities mean that broadband connectivity is often not seen as a priority. It is, however, a necessary service for improving the socio-economic realities of Indigenous communities. In the view of the Panel, Indigenous Services Canada (ISC) lacks the capacity to improve broadband access given other competing priorities facing the department. This is reflected by the fact that, despite its impact on a range of sectors and outcomes (Chapter 4), broadband connectivity is not mentioned in the ISC's 2021–2022 departmental service plan (ISC, 2021). While broadband connectivity is included in previous departmental service plans, omitting it from the most recent plan suggests it is not a major priority for ISC, despite the increased demand for internet services during the COVID-19 pandemic in 2020.

6 "The Supreme Court has recognized that unwritten principles of the Constitution can in some cases be the source of substantive constitutional protections. 'These principles may, in certain circumstances, give rise to substantive legal obligations, which constitute substantive limitations upon government action. These principles may give rise to very abstract and general obligations, or they may be more specific and precise in nature'" (DOJ, 2020).

3.4 Path Forward for Broadband Delivery to Indigenous Communities

Indigenous people are drivers of change and leaders in the digital economy

Various authors have argued that, at least in part, the design of broadband delivery programs in Canada has been based on a narrative of dependence — whereby Indigenous people are perceived as "helpless and dependent upon government and telecommunications industry intervention" (Philpot *et al.*, 2014). Winter and Boudreau (2018) question the current digital divide discourse in Canada that portrays Indigenous people primarily as consumers, beneficiaries, and passive recipients of digital technologies. By offering multiple examples of how Indigenous people create space in digital environments in line with their worldviews and ways of knowing, the authors call for a re-orientation of the digital divide discourse. That is, one in which Indigenous people are viewed as innovators and creators, and not just consumers (Winter & Boudreau, 2018).

The diversity of Indigenous communities is an important consideration in provisioning broadband networks and their infrastructure. Challenges vary substantially among communities, each of which needs to be considered at the local level. For example, both the climate and the small population in eastern Arctic communities limit infrastructure (including road access), while the sub-arctic (milder) climate in the western Arctic allows for industrial activities and a larger population (O'Donnell *et al.*, 2016; AEC, 2021). These variations make digital infrastructure solutions different in each region and community.

Meaningful and ongoing Indigenous engagement is needed to design effective broadband policies

Governments in Canada often design internet delivery programs with substantial industry input yet limited contributions from local communities (Internet Society, 2020a; McMahon *et al.*, 2020). As a result, some government-led funding programs have received limited support from communities on the ground, particularly Indigenous communities, as they tend to view these initiatives as top-down impositions, inhibiting the potential impact of high-speed internet provision programs (McMahon *et al.*, 2020). McMahon (2020) has also argued that most programs designed to encourage the adoption of internet services in Canada's rural and remote regions do not properly address community needs, as they have followed a "corporate-driven, one-size-fits-all" approach while de-emphasizing community-based initiatives. Community-led initiatives are often crucial to successful connectivity by allowing communities to implement solutions that work for them (Buell, 2021). In the view of the Panel, Indigenous engagement is needed at the first stages of program design and throughout the entire development and implementation of broadband policies, in order to ensure the initiatives are appropriate and meet community needs.

Indigenous leadership and entrepreneurship are key components in shaping digital society; these can be facilitated by partnerships with governments and industry stakeholders. Funding opportunities could prioritize community choice, including community-run networks (Internet Society, 2020a). Indigenous people have also called for non-Indigenous networks operating on Indigenous land to build capacity within the community through training on maintenance and operation of the network (Internet Society, 2020a). Properly resourced partnerships between Indigenous and non-Indigenous entities, as well as among Indigenous communities, can deliver more successful outcomes at the community level (O'Donnell *et al.*, 2016).

The BTLR highlighted the importance of the federal government having meaningful, respectful, and ongoing engagement with Indigenous people on how broadband projects will be implemented in their traditional (and in some cases unceded) territories (BTLR, 2020). The importance of consulting on the supports needed to facilitate Indigenous ownership of telecommunications networks has also been highlighted (BTLR, 2020). The Internet Society notes that "Indigenous governments and/or representative organizations must be engaged during the early planning stages of any project or policy that may affect their communities or land" (Internet Society, 2020a). Spectrum access, like water, is a critical natural resource for Indigenous communities and, therefore, Indigenous governments and communities should be meaningfully engaged throughout the spectrum management process (Internet Society, 2020a). The opportunities related to Indigenous ownership of spectrum are discussed in Section 6.3.

Meaningful consultation and benefit to the community are needed for infrastructure development in Indigenous communities

Major infrastructure development projects across the country are obligated, under Section 35 of the *Constitution Act*, 1982, to meaningfully consult and accommodate Indigenous communities "whose potential or established Aboriginal or Treaty rights may be adversely impacted by the project" (Box 3.1). The TRC questioned the effectiveness of Section 35 in achieving meaningful reconciliation, because Canadian legislation affecting Indigenous people is still rooted in colonial practices such as the doctrine of discovery and *terra nullius*, which maintains that nobody owned the land now known as Canada prior to European assertion of sovereignty (TRC, 2015b). Many Indigenous communities have emphasized the need to go beyond the duty to consult towards co-development and participation in infrastructure projects as a business partnership (SCNR, 2019).

Reconciliation in the telecommunications industry includes the requirement for meaningful consultation for all projects involving Indigenous people and their land and resources (TRC, 2015a). The Auditor General of Ontario noted in 2020 that the Minister of Indigenous Affairs is not always aware of consultations performed by other ministries and does not collect sufficient data to ensure the legal obligation to consult is being met (Auditor General of Ontario, 2020).

In addition to investing in infrastructure, building capacity within Indigenous communities, including education, is necessary for reconciliation. The Panel agrees with the view of Gray (2016) that it is imperative for the government to move beyond viewing consultation as an obligation, and using it as a valuable opportunity to advance reconciliation and reach shared objectives with Indigenous communities.

Box 3.1 The Duty to Consult

Relationships with the land are critical to Indigenous identity. Anthropogenic environmental impacts such as resource exploitation and climate change have profoundly affected the health of Indigenous people and Indigenous identity (Richmond & Ross, 2009; Willox *et al.*, 2013). The Supreme Court of Canada has affirmed the obligation of the Government of Canada to engage in meaningful consultation with Indigenous people through a number of case judgments primarily related to resource and land development on Indigenous land (Gray, 2016). Extractive natural resource sectors, including mining and oil and gas, for example, are required to conduct environmental impact assessments and consult with Indigenous communities. However, these processes have been criticized for failing to acknowledge First Nations and Métis concerns, and are bureaucratically labour-intensive (Baker & Westman, 2018). Industry consultation processes have benefited from specialized land-based knowledge from First Nations communities while failing to meet the required levels of respect and reciprocity (Baker & Westman, 2018).

(Continues)

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Meaningful consultation entails substantively addressing the concerns of Indigenous people. It focuses on building relationships, involves early and ongoing engagement in good faith, and secures free, prior, and informed consent (SCNR, 2019). Guidelines published by the Government of Canada in 2011 regarding the duty to consult note the importance of beginning consultation early in the planning process (GC, 2011). Critics argue these guidelines minimize government responsibility, fail to incorporate Indigenous perspectives on how to operationalize consultations, and result in implementation failures outside major projects (Gray, 2016). Critics have also noted that the duty to consult should be viewed by government and industry as an opportunity to build better relationships and advance shared objectives with Indigenous communities instead of a cost or legal obligation to manage. Government officials have indicated that areas of improvement could include enhanced guidance, training for federal employees, and intergovernmental coordination (Gray, 2016).

Ownership, Control, Access, and Possession (OCAP) principles provide guidance for ensuring Indigenous data and information sovereignty

The digitization of Indigenous knowledge, data, and art means that cultural heritage can be subject to appropriation and commodification (Brown & Nicholas, 2012). The protection of Indigenous cultural and intellectual property in digital spaces is limited in Canada (Brown & Nicholas, 2012). Thus, it is pivotal for internet connectivity strategies to incorporate an Indigenous data sovereignty component (Internet Society, 2020a).[7] The OCAP principles (Box 3.2) originate from a First Nations research space and perspective, but they offer one potential approach to achieving data and information sovereignty that may also be applicable for Inuit and Métis communities (FNIGC, 2016).

7 Open data has a practical impact on the ability of Indigenous communities to have sufficient information to participate in the digital economy and increased connectivity will accelerate the issue of Indigenous data sovereignty.

Box 3.2 OCAP Principles

Historically, Indigenous communities in Canada have been negatively impacted by non-Indigenous researchers from academia, government, and other outside institutions. In response to these concerns, the OCAP principles were established in 1998. OCAP stands for *ownership, control, access*, and *possession*. These principles assert that Indigenous communities in Canada: (i) collectively own the cultural knowledge, data, and information they produce; (ii) control how information about them is collected, used, and disclosed; (iii) have access to information and data about themselves and can decide who can access such information, and (iv) possess information within the communities' jurisdictions and control. Overall, OCAP is intended to guide decisions about why, how, and by whom information is collected from Indigenous communities, and asserts Indigenous people's jurisdiction over information about them. OCAP also exemplifies how Indigenous sovereignty can be realized in relation to data, information, and knowledge as part of a broader self-determination goal.

(FNIGC, 2016)

3.5 Summary

The development and availability of essential services in Indigenous communities, including adequate connectivity, continue to fail to meet the needs of communities. Resolving inequitable broadband access is an essential part of how non-Indigenous people, and especially the Government of Canada, can meet their obligation to address reconciliation. Beyond government funding for infrastructure, ensuring that all Indigenous communities in Canada have high-quality, reliable broadband access means building the required capacity in communities, including operating networks, education, and partnerships among government, industry, and Indigenous-led initiatives. Effective broadband strategies require partnership with Indigenous communities at all stages, beyond the legal obligation of consultation.

4

Impacts of Connectivity and Digital Technologies

4.1 Economic Impacts of Connectivity

4.2 Connectivity and Education

4.3 Connectivity and Healthcare

4.4 Connectivity's Cultural and Governance Impacts on Indigenous People

4.5 Adoption Challenges

4.6 Summary

Chapter Findings

- High-quality connectivity provides more economic, education, and healthcare choices and opportunities in rural and remote communities.
- Connectivity facilitates the formation of new companies in rural regions, motivates skilled workers and youth to stay in or return to their communities, and enables innovations such as e-commerce, automation, and digital tools for agriculture.
- Connectivity empowers Indigenous people to more easily access services, preserve their cultures, and stay in touch with their communities. Indigenous people can also participate, lead, and innovate in the digital economy.
- Positive impacts of connectivity are not shared equitably and can only be fully realized if internet is available, adopted, and used. Limited digital literacy and high costs are salient adoption barriers, especially for older adults. The most significant adoption obstacle is the inability of internet connectivity to meet users' needs.
- Proper supports and adequate planning can help mitigate any unintended economic impacts on rural and remote communities as they become more connected, such as increased competition for local businesses and labour market disruptions.

A lack of high-quality broadband limits the choices and opportunities of people living in rural and remote communities. This chapter identifies some of the key economic, cultural, educational, and health-related benefits of adopting or expanding high-speed broadband in rural and remote regions, and the barriers that prevent these benefits from being realized. In considering these categories, the Panel does not suggest a hierarchy of needs. Recognizing the heterogeneity of rural and remote communities, it is up to every community to determine the areas of utmost importance to their members. The chapter places a particular emphasis on communities and individuals most likely to experience broadband underservice (i.e., remote communities and Indigenous communities). In addition to benefits, this chapter examines some possible unintended economic and cultural impacts of connectivity. The Panel includes these in response to the charge and to demonstrate the importance of proper mitigation, planning, and support for communities that may experience disruptions as internet connectivity is established or expanded.

4.1 Economic Impacts of Connectivity

Underservice hinders the economic development of rural and remote communities

Broadband connectivity has an overall net positive impact on the economy (BCDD, 2011). While connectivity alone does not automatically translate into economic growth (Salemink *et al.*, 2017), it is generally positively correlated with labour productivity, trade, employment growth and employee retention, foreign investment, GDP, and competitiveness (BCDD, 2011; Kolko, 2012). The deployment of broadband in Canada has historically promoted growth in employment and wages in rural areas, especially in service industries (Ivus & Boland, 2015). E-commerce has the potential to help rural retailers in Canada be more competitive (e.g., by accessing a wider range of markets), and allows entrepreneurs to establish themselves without the need to re-locate to urban areas (SCIT, 2018). The COVID-19 pandemic has accelerated e-commerce growth, with retail e-commerce sales increasing by almost 70% in December 2020 over December 2019 (StatCan, 2021c).

Residents in rural and remote areas of Canada have identified limited access to high-speed, reliable internet as their main challenge in achieving economic growth (Infrastructure Canada, 2019). Lack of connectivity hinders their ability to retain youth, attract new talent, expand their businesses, train workers, and adopt new technologies (Infrastructure Canada, 2019). The business community has echoed this challenge. Many Canadian businesses (large and small) do not have the internal capacity to implement digital technologies into their operations (e.g., increase automation, online sales), even if they wish to do so (ISED, 2019b). This is compounded by the fact that some businesses do not know where to access the expertise and resources needed to adopt digital technologies (ISED, 2019b), and by a shortage of skilled workers in rural and remote regions (Infrastructure Canada, 2019). Many skilled workers are forced to move to metropolitan areas in search of employment opportunities, and those who can stay are often hired by large companies, leaving smaller companies at a disadvantage (ISED, 2019b).

Connectivity in rural and remote regions attracts new companies and retains skilled workers

A systematic review found that internet connectivity has a positive effect on migration (and return migration) to rural and remote regions, which may serve as an economic driver in some communities (Salemink *et al.*, 2017). For example, studies have found that broadband availability has a positive effect on location decisions for newly formed rural companies (Kim & Orazem, 2016; Duvivier, 2019). This effect is more pronounced in heavily populated rural areas as well as rural regions near metropolitan centres (Kim & Orazem, 2016; Duvivier, 2019). Further, while some studies from the United States show that internet availability has no impact on jobs or income, wider internet *adoption* (Section 4.5) is correlated with higher incomes, and an increased number of firms and employees in rural counties (Whitacre *et al.*, 2014a, 2014b). Internet connectivity can also benefit the rural economy by facilitating telecommuting. A study in rural southwestern Ontario found that the annual economic benefits of telecommuting in the region (including costs saved and opportunity costs) range between $8,820 and $23,964 per telecommuter (Hambly & Lee, 2019).

Internet alone, however, does not result in the creation of new companies; skilled labour, talent retention, and skills development are also vital (Infrastructure Canada, 2019). High-speed internet and investments in training and leadership allow for people living in rural and remote regions to be included (and innovate) in the digital economy (ISED, 2019b; FNTC, 2020a) and contribute to Indigenous economic reconciliation efforts (Duarte, 2017; NIEDB, 2019). The First Nations Technology Council (FNTC), for example, offers a Foundations and Futures in Innovation and Technology program on digital skills development training for Indigenous people exploring in-demand fields within the technology sector (FNTC, 2021a, 2021b).

Opportunities in the digital economy can motivate youth to stay in, or return to, rural and remote communities

Young people in Canada's rural and remote regions are more likely to use the internet and social media than older adults (Schimmele *et al.*, 2021; StatCan, 2021a), and are often early adopters and promoters of internet applications once available in their communities (Lemoine & Ramsey, 2011). The lack of broadband connectivity has hindered the ability of rural and remote communities to attract and retain youth (Infrastructure Canada, 2019). Many young people, for example, move to urban centres for educational or work-related opportunities (Infrastructure Canada, 2019). Better-connected rural communities have the potential to mitigate this problem. For example, the internet enables rural and remote inhabitants to work and develop skills in the wider digital economy

(Bakardjieva & Williams, 2010). With better connectivity, there can be multiple opportunities for youth in rural and remote regions who seek training in technology-related fields; having that connectivity would allow them to stay in (or come back to) and serve their communities (Bakardjieva & Williams, 2010).

Based on qualitative evidence from town hall meetings in rural Alberta, one study has documented that improved connectivity contributed to reverse-migration among skilled urban workers returning to their rural communities where they can work in sectors they were not able to before (e.g., digital economy, website development) (Bakardjieva & Williams, 2010). There are no larger Canadian studies on the potential for return migration among youth associated with better internet connectivity. Some international evidence does point to internet connectivity (and social media) as factors encouraging youth to leave their communities. For example, one study of young adults in Sweden (including those living in rural areas) found that the internet influenced and facilitated their decision to move within the country, as well as their destination choice (Vilhelmson & Thulin, 2013). This finding, however, is not universal. Research from South Korea did not find a significant correlation between internet use and rural residents' intentions to migrate to urban areas (Moon *et al.*, 2010).

Canada's agricultural and natural resource industries benefit from broadband connectivity

Access to high-speed internet enables the use of technological innovation in the agriculture and natural resource sectors, which are important industries in Canada's rural and remote regions. The Canadian Federation of Agriculture has identified rural broadband access as "essential for keeping up with the latest innovations and technologies" (CFA, 2020). This includes applications of precision agriculture (Box 4.1), such as online tools that help determine optimal fertilizer rates or pesticide application timing (OFA, 2020). Yet, the internet available in most of rural Canada does not meet farmers' needs (APAS, 2021; OFA, 2021). Most internet options available in rural Ontario do not offer a stable enough connection to use digital technologies in farm equipment (OFA, 2021). A survey by the Ontario Federation of Agriculture also found that 62% of respondents report disruption in their business activities caused by internet outages, directly impacting their profitability (OFA, 2021).

Box 4.1 Precision Agriculture in Canadian Farming

Precision agriculture is broadly defined as "a management strategy that gathers, processes and analyzes temporal, spatial and individual data, and combines it with other information to support management decisions" (ISPA, 2021). Precision agriculture allows for comprehensive, data-driven decisions producing either higher yields or increased returns through more efficient input management (Mitchell *et al.*, 2017; Tran *et al.*, 2019). A study of southern Ontario farms found that ~78% of farmers had adopted at least one form of precision agriculture (Hambly & Chowdury, 2018). However, 92% transferred data via physical media (e.g., external drive), and 10% used WiFi. Real-time cloud-based strategies were out of reach for 97% of farmers who did not have broadband access capable of large data transfers (Hambly & Chowdury, 2018).

The lack of rural broadband is an important barrier to the full application of technological innovations (Advisory Council on Economic Growth, 2017; Hambly & Chowdury, 2018). A survey of farmers in western Canada found that the main barriers to precision agriculture adoption were price, internet speeds and/or cellular coverage, lack of expertise, continuously evolving technology, and outdated farm equipment (Steele, 2017). The cost of adopting precision agriculture can also exacerbate inequality. Barrett and Rose (2020) note that technological advancements may favour larger farm businesses over smaller ones, which often have limited capacity and resources to invest in new technologies. Additional government supports (including capital) (Barrett & Rose, 2020) and regulatory oversight (Bronson, 2019) can help with this challenge. Cost-benefit analyses of rural broadband expansion in Alberta, including farm income, indicate an approximately $4 return for each $1 spent, which matches analyses done in Indiana (Grant *et al.*, 2019; Tran *et al.*, 2019).

High-quality broadband enables active safety monitoring, autonomous exploration, and real-time supply chain management, which have already started to transform natural resource sectors (e.g., forestry). In so doing, it has boosted worker efficiency and facilitated sustainable practices (Newman *et al.*, 2017; Roy, 2019). Broadband access can also facilitate logistics, training, and expansion into new markets (Hudson, 2013). For example, Ontario's Ministry of Energy, Northern Development and Mines plans to support the development of smart-mining technology to improve worker safety, enhance efficiency, increase employment through supporting regional entrepreneurship, and promote investment in rural areas (OMENDM, 2020). As smart-mining requires high-speed connectivity

(CENGN, 2020a) and mining projects often require investments in infrastructure, including telecommunications (Conference Board of Canada, 2013; MAC, 2020), the Panel believes smart-mining projects have the potential to bring high-speed connectivity to some remote communities. For such projects to be successful, however, proper community consultations and benefit sharing is required (Chapter 3).

4.1.1 Mitigating Unintended Economic Impacts

While improved broadband connectivity has a net economic benefit for rural and remote communities, potential unintended negative impacts need to be considered, planned for, and mitigated. The Panel notes that these unintended impacts do *not* justify broadband connectivity underservice; rather, they illustrate the need for proper supports, a holistic planning approach, and ongoing engagement with communities themselves.

Proper supports for rural businesses make them more competitive in the digital economy

One Canadian study found that the introduction of high-speed internet decreased entrepreneurship in Alberta's rural and remote regions, at least in the short term (Cumming & Johan, 2010). The authors argue that this was due to the limited ability of small local businesses to compete with online businesses offering similar goods and services remotely (Cumming & Johan, 2010). Further, there is evidence of the proliferation of e-commerce negatively impacting some storefront retail services (CRRF, 2015). Nevertheless, there is no consensus in the literature on the effects of internet on entrepreneurship (Salemink *et al.*, 2017). Another study found that, in three highly rural American states, the number of ISPs per capita is positively correlated with the number of entrepreneurs from traditional businesses and industries (Gallardo & Scammahorn, 2011). In the Panel's view, the potential unintended impacts on local business need to be considered when designing and implementing broadband programs. Likewise, appropriate mechanisms to empower local businesses to take advantage of all the opportunities broadband connectivity offers are critical.

Internet connectivity is linked to automation and may result in labour market disruptions if proper supports are not in place

Changes brought about by increased automation[8] are important considerations, particularly for rural and remote regions that depend on industries at highest risk of job loss. Broadband connectivity is one of the components needed to increase

8 Automation refers to machines, robots, and algorithms performing some or most job duties previously done by people (Frenette & Frank, 2020).

automation (ISED, 2019b), which can result in labour losses in some types of employment, or labour displacement and redistribution (C.D. Howe Institute, 2017). The most important industries in Canada's rural and remote regions (i.e., wholesale and retail, manufacturing, natural resource extraction) (CRRF, 2015) are among the most susceptible to automation (BIIE, 2017); these regions also have a limited capacity to re-distribute displaced labour (BIIE, 2017). In Canada, jobs held by Indigenous people are often more concentrated in industries with a higher risk of job loss due to automation (Canadian Council for Aboriginal Business, 2020).

Labour market disruptions brought on by increased automation can be partly alleviated through appropriate planning and supports. It is important to consider potential employment impacts of connectivity when rolling out high-speed networks, which may require training (or re-training) for those affected (C.D. Howe Institute, 2017), as well as ensuring people have the resources and skills needed to use the internet to its fullest potential (CIRA, 2018). Additionally, while Indigenous communities are at higher risk of job loss due to automation, there are also opportunities to create new, well-paying jobs through connectivity programs. For example, local ISPs can employ local people as part of connectivity programs, which re-invest in communities (O'Donnell *et al.*, 2016).

4.2 Connectivity and Education

Connectivity provides more learning choices to rural and remote communities

The multiple benefits of having internet connectivity in schools are documented in Canada's most remote regions; these benefits include easier access to learning platforms, research tools and information for students, and collaborative organizational tools (e.g., Google Drive) for teachers (Laronde *et al.*, 2017). In addition to formal educational opportunities, people in rural and remote regions use internet applications for informal learning. For example, a survey of community members in five remote First Nations in northern Ontario found that 84% of respondents use the internet on a daily or weekly basis to learn something new (Beaton & Carpenter, 2014). Similarly, 45% of respondents reported watching videos online regularly to learn how to complete a particular task or make something they had not made before (Beaton & Carpenter, 2014); these usage rates have likely increased since then.

In the Panel's view, a lack of access to education (including online education) can lead to a loss of Canada's talent base. Youth tend to move away from Canada's rural and remote regions to pursue educational opportunities (Infrastructure Canada, 2019). It is also challenging to recruit and retain educators in these communities (Looker & Bollman, 2020). Post-secondary distance education gives people in rural and remote regions the option to stay in their communities

(O'Donnell *et al.*, 2016) and to maintain and enhance their skills via online learning, contributing to the economic development in these communities (Infrastructure Canada, 2019).

The COVID-19 pandemic severely limited access to education in underserviced regions

During the COVID-19 pandemic, inadequate broadband access meant that students in many rural and remote regions were unable to engage in online learning when schools closed. While few peer-reviewed studies on the effects of the pandemic are available, multiple Canadian news reports have documented how students in these regions were unable to attend remote lessons because their speed did not allow for video calls (Stewart, 2020). For instance, 32 out of 49 communities in the Nishnawbe Aski Nation in northern Ontario did not have access to sufficient internet speeds to engage in remote learning, and many households could not afford electronic devices (Flanagan, 2020). Other rural communities in southern Ontario relying primarily on satellite internet pointed to service interruptions when trying to attend online classes, especially on cloudy days (Butler, 2021). As a result, many community members had to drive to locations where WiFi was available to upload students' homework (Butler, 2021). As multiple devices had to be used to work and study from home, some families reported that their current plans were limiting because of data caps (Johnson & Uda, 2020).

4.2.1 Overcoming Barriers to Remote Education

While connectivity offers many benefits and provides more choices to students and educators, internet access alone is insufficient. A study with post-secondary distance education students from the Elsipogtog First Nation in rural New Brunswick showed that some had difficulties navigating online educational platforms, especially if they had limited computer skills (Simon *et al.*, 2014). Similarly, students expressed dissatisfaction with video-conferenced classes if the lack of technical support led to delays (Simon *et al.*, 2014). These challenges are not unique to Indigenous communities. In rural Alberta, for example, a lack of comfort with online learning technologies among students was also documented (Gereluk *et al.*, 2020).

Internet access at schools alone is not sufficient. A survey of households with school-aged children in the Kitigan Zibi Anishinabeg First Nation in Quebec showed that, while the majority of children had access to internet connectivity at school, more than a quarter did not have internet at home because of the high cost of devices and internet plans, or because their homes were outside service areas (Lockhart *et al.*, 2014). This affected students' ability to access assignments and limited the ability of families to provide a holistic educational support system for their children (Lockhart *et al.*, 2014). Another study in northern Ontario found that educators possess different degrees of skill and expertise for adopting online teaching applications, highlighting the need for professional development programs specific to remote learning and its tools (Laronde *et al.*, 2017). Similar trends are documented in rural Ontario schools more broadly, where infrastructure and capacity challenges are especially acute in a small number of remote communities (Chen, 2015).

A sense of ownership over educational processes can help communities adopt distance learning

Research shows that First Nations students do not feel they or their communities have any meaningful input into the delivery of distance courses, or control over the methods used (Simon *et al.*, 2014). Interviews with students suggest that taking more ownership of the educational process, and having a better understanding of their own needs and preferences, may motivate more community members to take advantage of distance education (Simon *et al.*, 2014).

4.3 Connectivity and Healthcare

Telehealth applications can improve the quality and availability of healthcare in rural and remote communities

Healthcare in Canada depends on digital technologies to deliver services to rural and remote communities. Multiple benefits of telehealth applications are documented. It can expand the delivery of and access to health services in remote regions (O'Donnell *et al.*, 2010; COACH, 2015), and reduce waiting times (CMA, 2019; Jong *et al.*, 2019; Seto *et al.*, 2019). Telehealth can also increase patient comfort by reducing travel time and allowing patients to stay in their communities while receiving care (O'Donnell *et al.*, 2010; COACH, 2015). Similar advantages are documented in the context of telemental health services. Greater comfort may facilitate disclosure and increase access significantly (Gibson *et al.*, 2011). The human resource dimension of healthcare can also improve, especially in remote regions, where healthcare providers are scarcer. For example, greater connectivity enables professional development opportunities, improves healthcare administration, and decreases feelings of isolation among staff (O'Donnell *et al.*, 2010; Kakekaspan *et al.*, 2014). Telehealth also increases patient engagement with their wellbeing and improves access to health-related information in Canada (COACH, 2015). All of these benefits can result in considerable cost savings for patients living in Canada's rural and remote regions, and for the healthcare system more broadly (O'Donnell *et al.*, 2010; COACH, 2015; Jong *et al.*, 2019; Seto *et al.*, 2019). For example, a feasibility study of a remote-presence robot to provide real-time physician expertise remotely in an Inuit community reduced medical air transportation of patients by 60% among cases that would have otherwise required transportation, making it cost-effective (Mendez *et al.*, 2013). Patients, caregivers, nurses, and doctors were satisfied with this technology, and deemed it beneficial for improved care, workload, and job satisfaction (Mendez *et al.*, 2013).

Connectivity enables multiple health-related applications in rural and remote regions besides direct telehealth services (Steele & Lo, 2013). For example, social media can be used to design preventative, peer-support programs and disseminate public health information (Steele & Lo, 2013). Further, it can serve as a platform to facilitate healing, especially among young people. A Canadian study found that Indigenous youth use digital storytelling as a tool to communicate their feelings and heal from the impacts of colonialism and cultural erasure (Adelson & Olding, 2013). Indigenous youth also use digital storytelling to foster culturally appropriate conversations about sexual and mental health with fellow community members and beyond (Adelson & Olding, 2013).

The COVID-19 pandemic made it more difficult for underserviced communities to access remote healthcare

Connectivity underservice during the COVID-19 pandemic prevented many people in rural and remote regions from accessing healthcare services when in-person options were unavailable or unsafe. For example, the community doctor for the Chawathil First Nation in British Columbia was unable to see patients online. Band Councillor and child-and-family advocate Deanna John notes "I would like [the internet] to be up and available [so] that we're actually connecting our people to the mental health specialists out there" (Stewart, 2020). Other residents of rural and remote regions were unable to access healthcare remotely, which forced them to travel long distances for medical appointments (White, 2020).

4.3.1 Overcoming Barriers to Adopting Telehealth

The provision of telehealth services in rural and remote regions is not possible without high-quality internet connectivity (O'Donnell *et al.*, 2010). While telehealth services have increased in Canada, they are under-utilized (COACH, 2015; Seto *et al.*, 2019), and Canada lags behind other OECD countries in this area (CMA, 2019). In many remote communities, connectivity infrastructure is outdated (Kakekaspan *et al.*, 2014; Seto *et al.*, 2019). Studies point to negative clinician experiences with outdated technology as a barrier to participation in telehealth (Seto *et al.*, 2019). A systematic review found that the most common barrier for organizations to adopt telehealth globally (with a focus on OECD countries) is the unavailability of proper technology and limited technical competence (Scott Kruse *et al.*, 2018). People who are less comfortable with technological applications also express lower levels of satisfaction with telehealth services in Canada (Walmark *et al.*, 2012).

In-depth interviews with members of two remote communities within the Nishnawbe Aski Nation in northwestern Ontario reveal a range of perceptions about telehealth services for mental health. For example, 47% of participants reported a positive view of telemental health services, while 32% reported a negative view (Gibson *et al.*, 2011). Some interviewees noted that in-person mental health services may be more culturally appropriate for Indigenous people (Gibson *et al.*, 2011). Privacy and confidentiality concerns were also noted. Community members who were unable to access telehealth services from their homes found it difficult to achieve privacy in the office spaces where videoconferencing took place (Gibson *et al.*, 2011). A key challenge to providing meaningful telehealth services in Canada is understanding the needs, capacity, and concerns of local communities within this context (O'Donnell *et al.*, 2010). In response to these concerns, some Indigenous communities have formed their own telehealth network (Box 4.2).

Box 4.2 Keewaytinook Okimakanak e-Health Telemedicine (KOTM)

KOTM is the only telehealth network in Canada that is managed and operated by Indigenous people. Its service model is community-led, rooted in Indigenous needs and priorities, and culturally competent by focusing on Indigenous values and views on health and wellness (KOTM, 2014). The network began providing services in 2002, and now serves 26 First Nations in northern Ontario, especially remote communities (KOTM, 2014). Between 2008 and 2012, KOTM facilitated over 26,000 events, including remote clinical consultations and health education events, and more than 400 health professionals have participated (KO e-Health, n.d.).

(Continues)

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A survey conducted in First Nations communities served by KOTM found that more than 65% of participants consider telehealth a suitable alternative to visiting a healthcare professional in person (Walmark *et al.*, 2012). Close to 80% of the participants rated KOTM services as excellent, good, or fair, while 18% said they were not aware of these services. The more familiar users were with technology, the higher their satisfaction ratings. Almost half of the respondents were concerned about privacy in a telehealth context (Walmark *et al.*, 2012).

4.4 Connectivity's Cultural and Governance Impacts on Indigenous People

Internet connectivity can have positive cultural benefits for Indigenous people

In addition to the health benefits outlined above, internet connectivity and online applications (including social media) are associated with cultural benefits for Indigenous people. Studies in Canada have found that connectivity enhances social capital (Mignone & Henley, 2009), and contributes to building community resilience (Molyneaux *et al.*, 2014). Evidence from multiple First Nations in northern Ontario suggests that the internet serves as a tool for cultural preservation in that community, as members are able to share their stories and land-based knowledge, access Indigenous music and art, read works by Indigenous authors, and promote cultural events (Carpenter *et al.*, 2014). Broadband connectivity also allows rural and remote communities to stay in touch with Indigenous people elsewhere in Canada (Carpenter *et al.*, 2014).

Social media can help inspire and empower Indigenous youth

Social media has become a part of daily life, particularly for young people. Castleton (2018) finds that Inuit youth use social media to access content associated with their cultural identity, discuss socio-cultural topics, and remember traditions. Similarly, Wachowich and Scobie (2010) conclude that digital technologies inspire and empower Inuit youth to tell their stories publicly; in doing so, they mobilize themselves, assert their presence in the world, and increase their social networks. Similar trends have been observed in rural American youth, where the quality of internet connection affects the degree to which young people get involved in their communities (Ei Chew *et al.*, 2011). Social media has also been an effective tool to engage Indigenous and non-Indigenous youth in activism and facilitate more knowledge and awareness-building around issues affecting Indigenous peoples in Canada (Tupper, 2014).

Digital technologies can be used to preserve and reinvigorate Indigenous languages

There are concerns that the internet may fuel the disappearance of Indigenous languages in Canada, given that the overwhelming amount of online content is in English (O'Donnell *et al.*, 2016). However, research points to connectivity having an overall positive impact on Indigenous languages (BCDD, 2011). A survey across 13 countries (including Canada) found that digital technologies play an important role in revitalizing, promoting, and teaching Indigenous languages (Galla, 2016). Canadian studies found that Inuit communities in Nunavut use digital technologies to preserve their language (Alexander, 2011). Community-based network initiatives also contribute to the preservation of Indigenous languages. For example, the Ktunaxa Nation Broadband Network in British Columbia was created specifically with the purpose of disseminating the Ktunaxa language, which is critically endangered (Mignone & Henley, 2009). Additional online tools have been created since then to revitalize the language, including an online community portal and a language app (Ktunaxa Nation, 2020).

Online voting can serve as a tool for Indigenous self-determination

As noted in Chapter 3, broadband connectivity can support Indigenous self-determination through enhanced civic participation in governance processes (McMahon, 2014a). For example, online voting can be a key tool to make voting more accessible in remote Indigenous communities (Gabel *et al.*, 2016; Budd *et al.*, 2019). Based on a study with the Wasauksing First Nation in Ontario, Budd *et al.* (2019) found that online voting was a low-cost means of keeping community members informed and engaged with discussions on local policies, especially those living off-reserve. Another study with the Whitefish River First Nation found that online voting made political participation more accessible and engaging to youth and Elders, and facilitated accommodation of community members' needs (Gabel *et al.*, 2016). More accessible voting is important because federal legislation requires First Nations communities to meet voting participation thresholds in order to pass community laws (e.g., referendums) that can help First Nations regain greater autonomy (Budd *et al.*, 2019). While not all Indigenous communities can or wish to pursue online voting, it can be part of a path towards greater Indigenous self-determination (Budd *et al.*, 2019).

4.4.1 Mitigating Unintended Cultural Impacts

Unprotected online content can jeopardize Indigenous cultural and intellectual property

As noted in Section 3.4, connectivity can help preserve Indigenous cultures through digitization, but also opens them up to appropriation and commodification (Brown & Nicholas, 2012). Because the protection of Indigenous cultural and intellectual property in digital spaces is limited in Canada (Brown & Nicholas, 2012), it is vital that connectivity strategies have an Indigenous data sovereignty component (Internet Society, 2020a) based on the OCAP principles outlined in Box 3.2.

Social media can make Indigenous people more vulnerable to online racism and hate

While not a challenge unique to Indigenous people, research from Canada and Australia shows that, with increased social media use, Indigenous youth and women become more susceptible to bullying, racism, and hate online (Bailey & Shayan, 2016; Rice *et al.*, 2016). In the Panel's view, these concerns are especially relevant if connectivity and social media are suddenly available to communities that do not yet have the tools to be online safely. As part of self-determination and reconciliation efforts (Chapter 3), culturally sensitive and community-led supports (e.g., education, outreach), sometimes facilitated by the internet itself, can empower people to address these impacts (Bailey & Shayan, 2016; Rice *et al.*, 2016).

4.5 Adoption Challenges

There is an internet deployment–adoption gap in Canada

The presence of a broadband network alone does not yield benefits for a community. In order for connectivity to have positive and lasting impacts, it needs to be high-quality, and community members and businesses need to be able to adopt and use it. Further, internet adoption does not automatically result in the utilization of a particular technology or service, nor does it inevitably provide potential users with the skills, capabilities, and tools to use what they adopt (Middleton, 2013). Adoption is "the ability of an individual to subscribe to internet services in their home" (Whitacre & Rhinesmith, 2016). This definition has evolved to recognize the perceptions and behaviours of individuals that influence their internet subscription choices (Gant *et al.*, 2010), and whether the internet meets users' needs (Middleton, 2013). Therefore, the term adoption in this report refers to a person being able to subscribe to internet services that meets their needs and choosing to do so.

The number of people who subscribe to (i.e., adopt) internet services is lower than the number of people who have access to these services (SCIST, 2018; CRTC, 2020e). In other words, some people in Canada are not connected to the internet even if the service exists in their area (no matter the quality). This trend is accentuated in rural and remote regions, where the gap between potential and actual internet adopters is larger than in urban regions (CRTC, 2018a).

This deployment–adoption gap reflects, at least partially, the high cost of the available networks, and/or the inability of existing networks to meet users' needs. Evidence on internet adoption in rural and remote regions points to a series of socio-demographic considerations (e.g., age, income, education) that impact the needs of users, including challenges related to affordability and digital literacy. The Panel notes that investments in high-speed internet should not be limited because of adoption challenges. When user needs are met and barriers removed, high adoption rates are possible (O'Donnell *et al.*, 2016).

4.5.1 Socio-Demographic Considerations

Older adults and people with disabilities are less likely to adopt the internet

Broadband connectivity is important for older adults. Studies show that most older adults use the internet to maintain social connections, as well as to access health-related information (Vroman *et al.*, 2015). However, older adults are substantially less likely than younger people to use the internet. In Canada, approximately 38% of older adults (i.e., older adults aged 75 years and up) did not use the internet on a regular basis in 2019, compared to less than 10% of people aged 64 and younger (StatCan, 2021b). Notably, however, internet use doubled among older adults in Canada between 2007 and 2016, and the internet use gap between older and younger adults is declining (Davidson & Schimmele, 2019). Older adults with higher education and those living with a spouse/partner are more likely to use the internet (Vroman *et al.*, 2015). Lower adoption among older adults is due to a variety of reasons that include affordability and digital literacy (Sections 4.5.3 and 4.5.4). Data from Canada show that 23% of older adults do not own a device capable of connecting them to the internet (compared with 2% of younger adults) (Davidson & Schimmele, 2019).

Connectivity is also important for people with disabilities. Research from Australia suggests that social media use leads to increased social participation among rural youth with communication disabilities (Raghavendra *et al.*, 2015). In the context of the COVID-19 pandemic, internet access was vital for people with disabilities to access up-to-date public health information and services (StatCan, 2020). Yet, approximately 16% of people with disabilities in Canada do not use the internet compared to 7% of people who do not have disabilities (StatCan, 2021b). Studies from Europe and the United States also show that people with disabilities living in rural regions are far less likely to report internet use than those who do not have disabilities (Vicente & López, 2010; Wang *et al.*, 2011). Reasons for this gap include affordability, difficulties accessing technical support, and low levels of digital literacy (Vicente & López, 2010). For example, youth with physical disabilities often require intensive, personalized, and long-term support from within and beyond their families to access the internet and its applications (Newman *et al.*, 2017).

Education, income, and language are associated with internet adoption

Education and income are well-documented socio-demographic factors associated with internet usage (Whitacre & Rhinesmith, 2016; Salemink *et al.*, 2017). In Canada, lower income and level of education in rural and remote regions are correlated with lower internet adoption (McConnaughey *et al.*, 2013). Similar socio-demographic trends can be found consistently in other high-income countries, including the United States (NTIA, 2010) and Australia (Hill *et al.*, 2011). These trends may not be universal in all cases, however. A study conducted with remote First Nations in northwestern Ontario found no significant correlation between levels of education and adoption of digital technologies; people of all education levels adopted internet in that community at similar rates (Walmark *et al.*, 2012). Language may also impact internet adoption in some remote communities in Canada, especially in Inuit Nunangat. In Nunavut, for example, Inuktitut is the most commonly spoken language at home for 71% of the population (StatCan, 2017c). Some community members may be more comfortable with Indigenous languages as opposed to English, which dominates the internet (O'Donnell *et al.*, 2016).

Unmet connectivity needs can result in lower internet adoption

Another cited reason for not using internet in Canada's rural and remote regions, even if internet services are available, is having no time, need for, or interest in using it (McConnaughey *et al.*, 2013). This is reflective of broadband connectivity programs not meeting the needs of potential users (Middleton, 2013; USGAO, 2021). Indeed, not all internet networks are the same (Chapter 2), and thus, the various benefits brought by connectivity discussed in this chapter are not equally applicable to every user (Middleton, 2013). For example, evidence from Australia suggests that, if internet services are not able to provide tangible benefits (such as access to online education or tele-commuting), rural households are less likely to adopt it (Hill *et al.*, 2011). Households in rural Australia are also less likely to subscribe to internet services if local options are slow, have limited data, and are not readily available (Hill *et al.*, 2011); this suggests that unreliable, low-speed internet may be an adoption deterrent where it is the only option.

4.5.2 Unaffordability

The high cost of internet services in some remote communities is a salient adoption barrier

People may not be able to afford high-speed internet, or the necessary devices to access it, even where broadband connectivity exists. As discussed in Chapter 2, in most of Canada's rural and remote regions, high-speed internet is more expensive than in urban areas, there are fewer ISPs to choose from, and households spend a higher proportion of their income on telecommunications services (including internet) (Ekos Research Associates, 2016; CRTC, 2018a).

Survey data from Canada and the United States show that the cost of internet and the lack of an appropriate device to access it are the most common reasons for not subscribing to internet services (McConnaughey *et al.*, 2013). Over 50% of households in multiple remote First Nations in northwestern Ontario, for example, have expressed the need for a computer or a better computer in order to access the internet (Walmark *et al.*, 2012). This is consistent with the observed correlation between lower income and lower internet adoption rates in Canada (McConnaughey *et al.*, 2013). Research from rural Australia shows that even small upfront costs of internet connectivity can pose significant barriers for people (Hill *et al.*, 2011). Similarly, evidence from the United States shows that households that previously had internet access cite cost as the main reason for no longer having internet connectivity in their home (Whitacre & Rhinesmith, 2016). Overall, the combination of high poverty levels in some rural and remote regions, and the elevated cost of high-speed internet in those communities makes connectivity unaffordable for many, even if they wish to adopt it (O'Donnell *et al.*, 2016).

Affordability is a significant challenge in communities that do not have unlimited upload and download speeds. Satellite-based connectivity in places such as Nunavut comes with data transfer limits. As a result, excess usage charges (often hundreds of dollars per month) are cost-prohibitive (CIRA, 2018; Borealis Telecommunications, 2020). The higher cost of internet also forces rural households to make trade-offs between paying for internet and other expenses, including savings and vacation time (Ekos Research Associates, 2016). Similar patterns have been documented in First Nations in northwestern Ontario (Walmark *et al.*, 2012).

Finally, unaffordability may force some people in rural and remote regions to have intermittent access to internet connectivity. In other words, they can afford internet from their mobile phones some months, but not others (O'Donnell *et al.*, 2016). This intermittent access limits the ways in which people would like (or need) to use the internet without concerns about overage charges they cannot afford (O'Donnell *et al.*, 2016).

4.5.3 Digital Literacy

Lower levels of digital literacy limit internet adoption

Digital literacy is defined as the ability to safely use the internet to meet one's needs, as well as being able to recognize credible online sources (CIRA, 2018). The CRTC identified digital literacy as a key factor influencing internet use, with 24% of survey respondents citing lack of skills as a reason for limiting internet use (Ekos Research Associates, 2016). Compared to urban regions, there are lower levels of digital literacy in rural and remote regions in Canada, especially among older adults and Indigenous people (CIRA, 2018). For those who do adopt high-speed internet, a lack of digital literacy is associated with a number of cybersecurity concerns such as increased vulnerability to malware, online scams, and phishing (CIRA, 2018). Digital literacy is also cited as an important technology-based need by community members (Walmark *et al.*, 2012). Lower levels of digital literacy can make people more likely to be excluded from digital developments, which may exacerbate their marginalization (Salemink *et al.*, 2017).

Despite this recognized gap, digital literacy is often not part of internet connectivity programs in Canada (Chapter 6), and CIRA (2018) argues it continues to be underfunded. This trend is especially evident in remote communities in Canada's northern regions (O'Donnell *et al.*, 2016). Research in rural Alaska demonstrates that locally employed community members with IT skills can successfully help increase the digital literacy of their communities (Hudson, 2013). This is, in part, because these employees are often more familiar with the local context and needs (Hudson, 2013). Similar initiatives to train and employ local people continue to be limited in Canada's rural and remote regions (O'Donnell *et al.*, 2016).

Digital literacy is a key need for older adults

There is a strong correlation between digital literacy levels and some of the socio-demographic considerations discussed in Section 4.5.2. Older adults, especially those with low incomes, have the lowest levels of digital literacy in Canada and the United States (CIRA, 2018; Hargittai *et al.*, 2019). This issue is particularly relevant for rural and remote communities in Canada since, on average, their populations are older than those in urban centres (StatCan, 2018). It is most relevant for those communities where a large percentage of the population consists of older adults living on limited incomes.

If older adults have lower digital literacy levels, they may be unable to participate in various activities that are increasingly done online (e.g., banking, shopping), which is compounded by limited physical mobility and shrinking social networks (Hill *et al.*, 2015). Hill *et al.* (2015) characterize digital connectivity as a tool that can simultaneously empower and disempower older adults, depending on the support they receive.

Additional challenges related to digital literacy include age-related stereotypes. These influence internet use because they affect how older adults perceive themselves and their capabilities (Lagacé *et al.*, 2015). For example, age-related stereotypes about older adults' competence and learning abilities can make them more hesitant or anxious to adopt new technologies (Lagacé *et al.*, 2015).

4.6 Summary

Poor internet connectivity results in fewer choices and opportunities for rural and remote communities and hinders their economic development as well as access to education and healthcare. Connectivity facilitates the formation of new companies, motivates skilled workers and youth to stay in (or return to) their communities, enables more people to participate in the digital economy, and accelerates innovation. However, potential benefits are not shared equitably. Proper supports and adequate planning can mitigate potential unintended economic impacts that affect newly connected rural and remote economies, such as increased competition for local businesses or labour market disruptions. Internet connectivity is also vital for Indigenous people, who can more easily access services, share/preserve their cultures, stay in touch with their communities, and innovate in the digital economy, while supporting self-determination efforts. These positive connectivity impacts can only be fully realized if internet is available and adopted. Older age, lower incomes, and lower educational levels are some socio-demographic factors correlated with lower internet adoption. Limited digital literacy and the high cost of internet services are also salient barriers. The most consequential adoption obstacle is the inability of internet connectivity to meet users' needs.

5

Deployment and Maintenance of Networks

5.1 Deployment Cost

5.2 Land and Access

5.3 Maintenance and Upgrades

5.4 LEO Satellite Infrastructure

5.5 Summary

Chapter Findings

- The value proposition for investing in broadband networks is different for large and small ISPs, but even more so for municipalities and not-for-profits that have broader metrics for success and more options for recouping investment costs.
- Infrastructure cost — deployment and maintenance — is a surmountable but significant obstacle for stakeholders, whether they are large ISPs, small ISPs, municipalities, or not-for-profit organizations.
- Location-specific solutions meet regional needs through various strategies, funding sources, technological choices, training programs, and partnerships.
- User, community, and municipal organizations can provide broadband infrastructure and service through placed-based strategies, independent of large ISPs, when they determine such solutions to be of significant community value.

The availability, speed, reliability, and cost of broadband networks are customers' primary concerns, rather than the type of connection or the particulars of service delivery. However, the challenges associated with deployment, maintenance, backhaul, and last-mile infrastructure have considerable impact on access, speed, and reliability in the short and long term; moreover, infrastructure decisions made now may create challenges in the future. This chapter examines some of the issues related to deployment costs, land and access requirements, and maintenance and upgrades, while also offering case studies of communities that have successfully navigated the challenges.

5.1 Deployment Cost

The choice of broadband network technology alters the cost of deployment and maintenance

Wired networks are generally more expensive to deploy than wireless; therefore, in the short run, wireless options may be more appealing. According to ISED's 2016 estimate, the cost of connecting everyone in Canada to a wired fibre optic network (which allows for virtually unlimited upload and download speeds — the only future-proof technology) is between $40 billion and $50 billion (Auditor General of Canada, 2018a). With respect to wireless backhaul options, ISED estimates that its target speeds of 50/10 could be provided across Canada at the cost of about $6.5 billion, with the exact cost depending on future improvements to the technology (Auditor General of Canada, 2018a; CRTC, 2018a). The reduced costs are due to the substantially smaller amount of infrastructure that needs to be installed, at least in the short term. In the long term, the upgrade costs of different infrastructures come into play (Section 5.3).

A community's population density and residential patterns (e.g., freestanding homes versus apartment buildings, the distance between homes) impact the cost of installing last-mile connections (OECD, 2014). More dispersed populations require additional fibre and incur higher installation costs, such as digging and labour, to complete connections. Further increases to these costs are incurred when encountering inhospitable climate conditions or difficult terrain, including dense forests, mountains, and water bodies (CUI, 2015; OECD, 2018). Transporting material and personnel to rural and remote regions often costs more, particularly when there is limited or no road access. Transportation in northern regions is more expensive than in other parts of Canada (O'Donnell *et al.*, 2016), further increasing the cost of investment.

One decision affecting short- and long-term expenditures is the choice of network architecture. Having only a fibre backhaul and using a less expensive technology to deliver internet to homes can reduce cost by 25% to 50% compared to fibre to the home (FTTH) (OECD, 2014). This creates a cost incentive for a fibre backhaul and a wireless last-mile (OECD, 2018). However, these savings may only be a cost deferral of future upgrade investments (Section 5.3). Dawn-Euphemia Township in Ontario opted for a mix of last-mile and backhaul technology — fixed wireless and fibre — to provide different constituencies with internet. This approach balanced reliability, speed, and cost to determine which technologies would best serve each group (Box 5.1).

Box 5.1 Dawn-Euphemia Township: An Example of a Hybrid Solution (Fixed Wireless + Fibre)

The costs for ISPs and consumers impede infrastructure deployment as well as adoption. Canada's Centre of Excellence in Next Generation Networks (CENGN) frequently funds projects that employ a hybrid of wireless and fibre to minimize infrastructure cost, increase redundancy, and future-proof rural networks (CENGN, 2020b). In Dawn-Euphemia Township, Ontario, CENGN and MPVWifi (a local ISP) connected the dual fibre backhaul to a new wireless backhaul tower as part of a mesh network of access and relay towers. This network was then connected to an FTTH network covering the final 4 km to reach the Village of Florence. The fibre network provides future-proof wired internet to Florence, Ontario, while the expanded network of towers provides wireless internet coverage to the surrounding regions in two forms: 5 GHz high-capacity internet at 5 to 7 km from towers, and 3.65 GHz low-capacity high-penetration as far as 15 km. The project included redundant backhaul technologies, increased redundancy in wireless access through mesh networking, offered multiple spectrum options, in addition to the fibre network in Florence, all to improve reliability. This expansion saved $600,000 on middle km infrastructure costs (and 80% of total build costs) by making it wireless and by using existing grain elevators as towers (CENGN, 2020b). CENGN expects that ISPs will achieve return on investment in two to four years with 50% government funding. The project brought fibre connectivity to 250 residents, wireless with fibre speeds to 40 residents, and high-speed wireless to 700 residents (Kirby Koster, presentation to the Panel).

Two pre-existing facets of this project facilitated implementation: the first was geography — the relatively flat farmland and the low density of trees — and the second was the fact that some backhaul infrastructure was already available for the middle and last km expansion (Kirby Koster, presentation to the Panel).

Some programs, such as the Eastern Ontario Regional Network (EORN), use multiple technologies to ensure access to the internet for rural individuals, including fixed wired and wireless, satellite, and fibre — choosing the most appropriate technology for each area (EORN, 2020a, 2020b). The next stage of EORN is the Gig Project (EORN, 2020c). It is estimated to cost $500 to $700 million to get 95% of homes and businesses in the region on 50/10 Mbps service, and

$1.2 to $1.6 billion to upgrade the same population to 1 Gbps internet. EORN has endorsed moving forward with the 1 Gbps network development, which it believes will improve long-term global competitiveness and significantly benefit the local economy (EORN, 2020c; Phillips, 2020). The Government of Canada and Ontario denied funding to the ERON program announcing their own $1.2 billion joint venture, but the technical details, regions and choice of technology have not yet been announced (Andrews, 2021).

Southwestern Integrated Fibre Technology (SWIFT), which provides funding for broadband programs across southwestern Ontario, is working with local telecommunications providers in Lambton County to build future-proof FTTH networks (SWIFT, 2021). SWIFT is a non-profit, municipally led project that helps fund rural broadband expansion through the New Building Canada Fund – Small Communities Fund (NBCF-SCF), and through municipal and private investments (SWIFT, 2021). Five projects are planned to connect thousands of homes and businesses in 16 communities within the county (SWIFT, 2020a). The Kettle and Stony Point First Nation fibre network will bring high-speed internet to 900 homes and businesses within the First Nation, and to 130 nearby homes and businesses (SWIFT, 2020b). Chippewas of Kettle and Stony Point Chief Jason Henry notes that "[t]his investment is a game-changer for our community that will open the door to economic and educational opportunities widely available elsewhere and improve quality of life for residents" (Graf, 2020).

Lower revenues limit ISP investment in rural and remote regions

Because a network's fibre line will pass every home in a region, whether or not it provides service to that residence, the costs of building broadband infrastructure are relatively fixed (OECD, 2014). The number of subscribers only adds a relatively small infrastructure cost, but directly drives revenues (OECD, 2014, 2018). In rural and remote communities, low population density means fewer customers accessing (and paying for) connectivity that requires high infrastructure costs to reach them. The low revenues associated with internet delivery in rural and remote regions can pose a risk for small ISPs that exclusively provide services to those areas; these small ISPs are at greater risk of failure compared to larger providers (Columbia Telecommunications Corporation, 2010; EC, 2020). In communities with only one small ISP, low revenues therefore create the risk that the ISP will fail, and the community will completely lose connectivity (EC, 2020). One approach to address infrastructure cost is for governments to deploy infrastructure to facilitate competition among small ISPs, as was done in Suupohja, Finland (Box 5.2).

Box 5.2 Open Access Network: Suupohja, Finland

In 2004, half of the 55 villages in the Suupohja sub-region of Finland had no broadband access (EC, 2020). At that time, Suupohja's eight municipalities were renting copper connections at a high rate, but copper cables were being removed by the national operators. Suupohja's population density is less than nine people per km^2, which is equivalent to or denser than rural regions in Canada (StatCan, 2016; EC, 2020). Seven of its municipalities formed the non-profit company Suupohjan Seutuverkko Oy (SSV), which has the following goals: to allow people and businesses to remain in rural areas; to offer universal access; to decrease costs; and to allow for future connected services and broadband speeds (ENGAGE, 2014). SSV built out its fibre network through municipally guaranteed bank loans and national funding, with the E.U.-funded last-mile covering 45% of the cost between 2005 and 2007 (ENGAGE, 2014). Initially, municipal centres were connected via an intermediate trunk line. From there, cables were extended into denser areas, ultimately connecting each house to the network. The ENGAGE rural broadband report notes that this area has geographical features favourable to underground cable installation (EC, 2020).

SSV operates, expands, and maintains the network, allowing ISPs to use it for free (open access), a first in Europe (EC, 2020). This model gives users the choice of multiple ISP and Internet Protocol Television (IPTV) providers. The FTTH end-users pay a fixed network fee to SSV for maintenance. Many customers opt for the 150 Mbps symmetrical connection, a system capable of ≥1 Gbps with a 10 Gbps backhaul (EC, 2020). These improvements provide new opportunities in the health, education, and business sectors. The project is expected to achieve a positive return on investment in 8 to 10 years (EC, 2020).

The expansion of broadband networks is not free from risks; careful planning and long-term outlooks are called for. The Government of the Northwest Territories and the Northern Lights General Partnership built the Mackenzie Valley Fibre Link (MVFL) to replace existing microwave infrastructure and provide a future-proof backhaul network (Hathout, 2021). The MVFL is a 1,200 km fibre line designed to connect six communities in the Northwest Territories. It is an $84 million backhaul project, but it has, as of yet, failed to attract enough last-mile ISPs to recover the cost of operations, leading to a $9.2 million annual operational deficit (Hathout, 2021). This project is, however, in the early stages; despite being designed around a 23-year development and financing period, it is already producing increased reliability and speed to individuals and the public sector (Hathout, 2021). A spokesperson for the project says they expect increased growth and eventual profitability. Members of the NWT Legislative Assembly are encouraging municipalities to secure funding from the Government of Canada's Universal Broadband Fund to support connectivity in their regions (Hathout, 2021).

Projects like these must either be designed around economic sustainability and technical feasibility or, in instances where sufficient demand is lacking, sustained by capital funding. In the latter situation (such as the MVFL example), funding for installation is insufficient to maintain broadband operations, particularly in remote regions such as the Arctic; funding for ongoing operational expenses is necessary (AEC, 2021).

The benefits that rural and remote communities gain from broadband investment are holistic and not limited to profits

While there may not be a business case for providing connectivity to rural and remote communities from the large ISP perspective, other approaches can be successful. For example, communities can recuperate the invested costs of network infrastructure from service fees and taxes; save money through organizational efficiencies; benefit from improved personal and business development; and reduce prices by running at-cost (McNally *et al.*, 2016).

Estimates from rural communities in Alberta and Indiana indicate the potential of a full return on investment in five years (Grant *et al.*, 2019; Tran *et al.*, 2019). However, even without profit, rural and remote communities benefit directly from business development, as well as healthcare and education improvements provided by broadband (McNally *et al.*, 2016). This is the view of i-Valley, a not-for-profit responsible for the Pictou County, Nova Scotia rural broadband project; i-Valley designs its programs around the community's needs and the benefits broadband provides (i-Valley, 2020). It focuses on a community value model: "if rural regions are considered in terms of community value, then broadband service becomes not only possible but compelling" (i-Valley, 2021).

In 2005, the Government of Alberta connected 420 communities via the SuperNet program (Gignac, 2010). SuperNet was a middle-mile project bringing internet to communities with a school, hospital, library, or government office, with ISPs expected to provide last-mile service, although financial incentives to do so were reportedly scarce (Gignac, 2010). Many communities determined their own last-mile and ISP solutions (McNally *et al.*, 2016). The town of Olds, Alberta leveraged SuperNet to provide ultra-fast broadband internet to its residents using a community-owned entity (Box 5.3). Other communities relied on partnerships with private companies (private network operations and/or private ISPs) to gain access to the network.

Box 5.3 Olds, Alberta's Municipal Ownership: A Place-Based Model for Internet Provision

In 2013, the Town of Olds, Alberta created O-NET, Canada's first community-owned, not-for-profit open fibre network (SCIST, 2018). The town engaged community members from diverse backgrounds in a series of facilitated discussions to generate an action plan for its broadband development (McNally *et al.*, 2016). Four years after deployment, O-NET, provided service to 40% of the Olds market with speeds ranging from 140 to 2,400 Mbps (at the top end, more than twice the minimum definition of ultra-fast speeds) (SCIST, 2018). The SuperNet network provided the backhaul infrastructure that supported Olds' venture (Gignac, 2010; Warwick, 2017).

The Town of Olds has cited numerous benefits to high bandwidth internet: access to internet-based services; free community WiFi; retention of employers; personal and business savings; and attracting new firms (McNally *et al.*, 2016). When Waterton Lakes was looking to improve its local internet offerings, it launched its community network through an agreement with the Olds Institute to allow O-NET to act as the ISP (McNally *et al.*, 2016).

Olds cited several issues with creating and deploying ISPs, such as lack of local expertise, limited funding, and insufficient federal guidance (SCIST, 2018). To address these, the town recommended that the government organize collaborations, especially public-private partnerships, and provide funds to ensure that other municipalities undertake these ventures in the future (SCIST, 2018).

There have been long-term challenges related to funding and oversight in Olds. The municipal government cut annual funding to the Olds Institute in half, the Olds Institute has been ordered to begin paying back its loan for infrastructure installation, and the town has created a committee to oversee "matters related to the Town of Olds broadband investment" (Collie, 2020, 2021; Town of Olds, 2020).

Different national and regional strategies, in Canada and abroad, have been used to bring connectivity to rural and remote regions

In Canada and around the world, orders of government and private companies employ different ownership and operation models to provide broadband access to rural and remote communities (Figure 5.1). The international examples included by the Panel demonstrate that remoteness, difficult climate conditions, and geographical features are not insurmountable obstacles but can be overcome with various place-based solutions. The regional examples illustrate how different local funding strategies can expand access in distinct place-based ways. Suupohja, Finland (Box 5.2) operates a public open-access network that allows ISPs to provide services, while Olds, Alberta (Box 5.3) owns and operates a local network and ISP connected to a public-private backhaul network (SuperNet). Taber, another Alberta town, opted for a fully private, facilities-based provider.

Funding and operations strategies for providing access to rural and remote communities are diverse and are often built upon existing infrastructure, funding systems, and organizational structures; thus there is no universal solution, but existing programs may provide direction on promising practices. For example, New Zealand's Rural Broadband Initiative (RBI) — a government initiative — has committed to bringing internet access to all people in rural areas (CPI, 2016). Both RBI and ISPs provide funding for infrastructure expansion and upgrades; the government sets goals, collects data provided by ISPs, and measures progress, while the major ISPs use their existing capabilities to build and manage the networks (CPI, 2016). Government-owned TELE Greenland is Greenland's largest ISP; as such, it operates under universal service obligations and monopoly concessions (Tele Greenland, 2020a, 2020b). TELE Greenland owns and operates fibre networks, satellite ground stations, and fixed wired and wireless networks (Tele Greenland, 2020a).

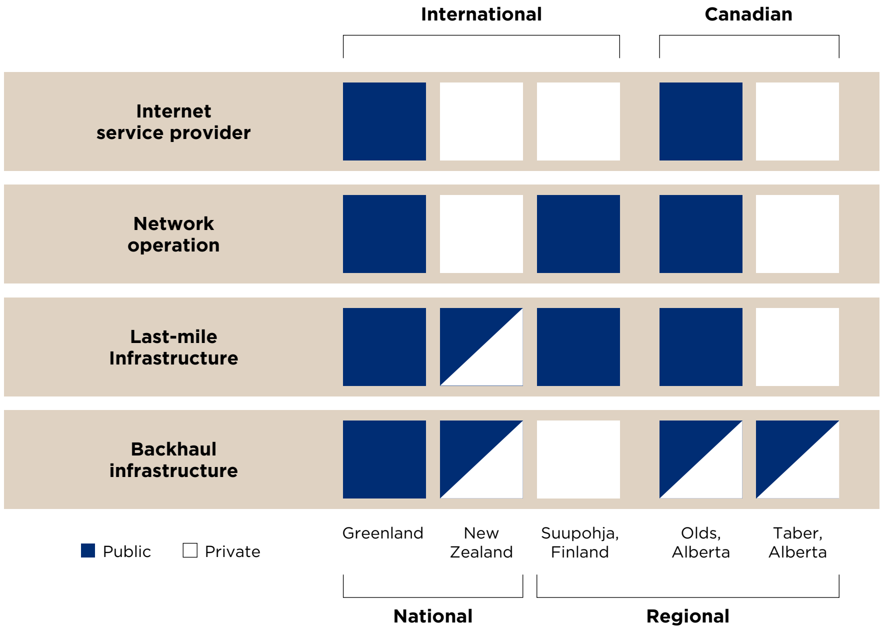

Figure 5.1 Funding Structures for National and Regional Rural or Remote Internet Strategies

This schema represents some public (blue) and private (white) funding practices for the construction, operation, and ISP responsibilities of broadband networks from Canada and internationally. Some programs are national, others regional and connected to a shared backhaul network. Shared efforts between government and private actors involve both funding agreements and government regulation and guidance. Private facilities-based providers operate under governmental regulatory regimes. The funding schemes illustrated may not be the only option for connectivity in a given region.

The CRTC's wholesale rates affect connectivity access in rural and remote regions

CRTC policy requires facilities-based providers (those that own infrastructure) to allow non-facilities-based competitors (those that don't own infrastructure) wholesale access to their networks. This allows the non-facilities-providers to offer internet services and compete with facilities-based providers (CRTC, 2008, 2010a, 2019b). This minimizes duplicate network infrastructure, which is cost-prohibitive in rural and remote regions (Rajabiun & Middleton, 2013a). While wholesale regulations have fostered competition in some rural areas (McNally *et al.*, 2018), most of rural and remote Canada is not served by wholesale-based competitors (Environics Research Group, 2019).

In 2019, the CRTC mandated lowering high-speed wholesale access rates (CRTC, 2019b, 2020c), making it less expensive for non-facilities-based providers to access networks. The incumbent telecommunications companies argued that lower wholesale access rates deter infrastructure investment in rural communities by reducing the expected returns (Karadeglija, 2021). Analysis by the Competition Bureau concluded that this disincentive to invest is expected to affect Canada's rural and remote regions the most (Competition Bureau Canada, 2019). For example, Bell announced that it would scale back a program to expand internet connectivity to 200,000 rural households in response to the 2019 CRTC decision (Bickis, 2019).

In May 2021, the CRTC decided to permanently reverse its decision to implement lower rates, citing "substantial doubt as to the correctness" of the rates set in the 2019 decision, despite the lengthy evidence-based process used to set these rates (CRTC, 2021b). In practice, this means that higher rates would be reinstated, with some minor adjustments (CRTC, 2020c, 2021b). The decision reflects the CRTC's desire to promote "facilities-based competition, in which competitors primarily use their own telecommunications facilities and networks to compete instead of leasing them from other carriers" (CRTC, 2021b).

While the big telecommunications providers are expected to benefit from this decision (Karadeglija, 2021; Paddon, 2021), smaller providers are anticipating negative impacts. For example, the CEO of Distributel (a smaller ISP), said he expected the decision would result in fewer smaller competitors in the market and predicted a rise in internet prices (Paddon, 2021). The non-profit group Open Media agrees with these predictions and notes that they feel that the CRTC decision does not benefit consumers (Open Media, 2021). TekSavvy, a non-facilities-based provider that, in addition to serving urban areas, provides services to rural communities in southern Ontario, is appealing the decision (TekSavvy 2021a, 2021b). They have scaled back investment plans, cancelled plans to offer mobile service, and withdrew from the 3,500 MHz band spectrum auction (Box 6.2) (ISED, 2021g; TekSavvy, 2021c). Canada's federal Standing Committee on Industry, Science and Technology said it was "deeply frustrated with the CRTC's decision to cancel the new wholesale rates," noting how this does not meet the public's expectations of broadband affordability (SCIST, 2021).

5.2 Land and Access

Different backhaul and last-mile infrastructure have unique access requirements

Beyond cost, a key challenge for network deployment is the physical access needed (OECD, 2014). Fibre requires excavation of streets and trenches outside homes, access to telephone poles or conduit space, and securing physical access to the house, building, or node site. Granting this access is inconvenient for residents; this may, in some cases, make municipalities reluctant to approve the work, particularly if there is existing infrastructure in place. If fibre is being run through existing utility conduits underground, access to those facilities is required. These conduits are often owned by municipalities or utilities, which may charge high rates for access. Navigating the complexities of deployment across different channels can make it particularly challenging for smaller companies or groups with fewer resources to deploy fibre networks (OECD, 2014).

Wireless options with no physical last-mile connection do not require digging near homes, yet they still rely on fixed infrastructure on the ground, such as backhaul capacity and elevated facilities (e.g., towers, masts) (OECD, 2018). These towers must be sufficiently high to avoid line-of-sight obstacles (CENGN, 2020b). Uninterrupted signals are harder to achieve in regions with dense forests, rolling hills, or mountains. Because 5G often uses higher frequencies, the signal cannot travel as far and is more affected by obstacles, necessitating the installation of more towers to cover the same area (Lawson, 2016; OECD, 2018). Generally, due to bandwidth, higher frequencies enable faster transmission, and lower frequencies provide coverage at greater distances, albeit with more limited bandwidth and slower speeds (OECD, 2018; Triggs, 2021). These properties mean that 4G networks are mostly fibre networks, with only a small proportion of their last-mile composed of wireless technology; they are thus subject to many of the same impediments as wired networks (OECD, 2014).

There is a debate over which 4/5G technology companies (e.g. Ericsson, Huawei, Nokia) provide the best equipment, with the least expensive options considered a security risk by many countries (Kane, 2019). The major Canadian telecommunications companies have cited security risks as a determining factor when deciding which manufacturer they source from (Duckett, 2020; Ljunggren, 2020). Despite this, small rural and remote ISPs have begun installing less expensive 4G technologies, as ISPs often have constrained budgets due to low profit margins (Kane, 2019; Longo, 2019; The Guardian, 2019; Ljunggren, 2020).

Pairing broadband installation with large-scale infrastructure programs, such as the building of roads or pipelines, can mitigate some costs. Rural Ontario Municipal Association (ROMA) (2020) has identified "dig once" policies as a method of reducing the cost of broadband deployments for municipal governments. These policies combine infrastructure projects to minimize repeat expenditures. It is estimated that 90% of fibre deployment cost is digging (Patterson, 2020). Employing the "dig once" policy could decrease ISED's universal fibre-to-the-premises estimate from $50 to $5 billion. This policy could be valuable in Canada's northern regions, where digging is particularly challenging because of permafrost and inclement weather (CUI, 2015).

Another way to combine infrastructure projects is using broadband infrastructure as the primary project, then adding additional value by combining it with the deployment of a secondary project. For example, adding sensors to underwater fibre optic cables could dramatically improve environmental and seismic monitoring and the reliability of the cables (Duraibabu *et al.*, 2017; Sladen *et al.*, 2019; Williams *et al.*, 2019). For combined infrastructure projects to work, both the broadband infrastructure and the parallel project must be of comparable quality and longevity. For example, there would be little value adding fibre lines to old hydro poles slated for removal.

5.3 Maintenance and Upgrades

Infrastructure that is not scalable or sustainable risks rural and remote communities' long-term connectivity

The deployment of broadband infrastructure is only the first step in providing high-quality broadband. Small ISPs may face particular challenges in maintaining networks. As with deployment, the presence of challenging geographic features makes maintaining networks more expensive (McMahon *et al.*, 2020), which is compounded by the lower profits of ISPs operating in these regions due to the small subscriber base and low population density (Chapter 2). Evidence suggests that, without ongoing investment in building, upgrading, and maintaining infrastructure, the provision of high-speed internet in rural and remote regions is unlikely to be sustainable (O'Donnell *et al.*, 2016).

In the long term, factors related to ownership and operation can create uncertainty for customers. For instance, a lack of transparency around SuperNet regarding price, performance, ownership, and governance could create challenges for the deployment of broadband projects in some Alberta communities (alannahpage1, 2018; McNally *et al.*, 2018).

The cost of accessing existing support structures necessary for backhaul or fixed networks also creates challenges. The Independent Telecommunications Providers

Association (ITPA) notes that, in the case of hydro poles, "vastly divergent rates [are] being charged for identical services only because hydro's support-structure rates are set by provincial regulators" (ITPA, 2018). In Ontario, rural internet providers cited the cost of access to hydro poles as a problem for maintaining and expanding network coverage when pole attachment costs increased in 2018 (OEB, 2018). The Government of Ontario is trying to address this problem with the *Supporting Broadband and Infrastructure Expansion Act*, which will allow the province to regulate utility pole rental charges, enforce timelines for broadband installation, and require joint installation planning by utility companies (Gov. of ON, 2021). The Government of Quebec created a coordination table among ISPs, Hydro-Québec, and Ministère de l'Économie et de l'Innovation to accelerate access to telecommunications support infrastructures owned by third parties, and expedite deployment (Quebec Minister of the Economy and Innovation, 2020).

In communities where there are existing networks, whatever the quality, there may be apprehension about installing new infrastructure because of concerns related to sunk costs (OECD, 2014). These prior investments may encourage operators to continue supporting first-generation broadband networks — which cannot deliver ultra-fast speeds — instead of investing in newer, future-proof networks (Howell, 2010). If inadequate speed targets are set or if broadband development is not designed around meeting people's future needs, the newly installed technology will ultimately act as a barrier to the next round of investment and upgrades. To build networks as inexpensively as possible (particularly if the project depends on grants that have requirements favouring low costs), communities may opt for cheaper, non-scalable infrastructure options. Without long-term considerations of future broadband uses, communities may be locked into technologies that will not meet their ongoing needs. Lack of planning for future technologies and applications will have a more significant effect on rural and remote communities than on urban centres because of the smaller customer base from which to generate revenue (Section 5.1) (Howell, 2010).

As noted, fibre optic cable is considered the only future-proof option for connectivity, since its carrying capacity using laser pulses is essentially unlimited (OECD, 2014; Middleton, 2016). Similarly, FTTH last-mile has important advantages in terms of long-term stability for a community. Effective FTTH, which provides consistent and reliable high-speed access, must be connected to a middle-mile and backhaul network capable of processing gigabytes of data per second from all of the network's users (Berendt, 2010; Ahamed & Faruque, 2018). Current backhaul technologies required to connect devices to the broader internet can become a bottleneck for data transferred through high-speed networks such as 5G or fibre (Berendt, 2010; Ahamed & Faruque, 2018). This inability to process local aggregate data will result in poorer-than-expected capacity, availability, and latency (Berendt, 2010). Fibre networks with the correct middle-mile and backhaul technology have the potential for essentially limitless, synchronous capacity with relatively inexpensive upgrades (OECD, 2014). Fibre-to-the-node (FTTN) networks that use another last-mile technology to the home may be more challenging to upgrade, requiring the removal of the old technology and installation of fibre to meet future needs (OECD, 2014, 2018). Building a complete network involves the consideration and coordination of different technologies and operators. Choice of technology, backhaul leasing, and even sharing backhaul capacity can all substantially increase the complexity of deployment (Jafari *et al.*, 2015; Gordon, 2020; Sharma, 2020).

In the case of mobile connectivity, ISPs that have fixed infrastructure in place may choose to provide fixed 5G service with existing backhaul and cellular towers (Engebretson, 2017). This change may impact network performance because, as noted in Section 5.2, 5G functions over shorter distances than earlier generations of wireless technology. When interviewed by Engebretson (2017), rural mobile wireless providers in the United States noted that, compared to 5G, LTE (4G) would provide better coverage in rural areas because it requires fewer towers and small antennas, or repeaters. Approximately 75% of the cost of 4G LTE networks is fibre backhaul. The backhaul of these networks represents a significant investment in infrastructure, and a hybrid 4G/5G model (as described in Box 5.1) may be able to leverage this investment to expand access (Forzati & Mattson, 2013).

Reliable broadband requires a reliable power supply

Successful and reliable broadband deployment requires an affordable and dependable power supply (CFN, 2014). This creates challenges for the approximately 300 communities in Canada that are not connected to the North American electrical grid and natural gas distribution pipeline (CER, 2021). The majority of these are Indigenous communities (Heerema & Lovekin, 2019), with the most extreme discrepancy in access occurring in Nunavut, where all Indigenous communities use diesel for power generation (CFN, 2014). The resulting energy costs for these communities are double the national average (CER, 2017). Aging infrastructure and lack of year-round access to liquid fuel threaten these power systems' reliability and can lead to frequent outages (Heerema & Lovekin, 2019; CER, 2021). An unreliable power supply will disrupt broadband usage, potentially limiting uptake and preventing the use of applications that require a consistent connection. Facing similar challenges, TELE Greenland has sought to combat the unreliability, greenhouse gas emission, and fuel costs of powering remote areas by installing solar panels and wind turbines at their telecommunication stations, and using diesel as a contingency power supply (Branlard, 2010; Telektronikk, 2012).

Public, private, and not-for-profit actors have had some success building local capacity

Small ISPs, municipalities, and not-for-profit groups have developed strategies to ensure that the requisite skilled workers are available to support local networks. For example, the not-for-profit First Nations Technical Services Advisory Group (TSAG), in partnership with Health Canada, connected First Nations health centres to Alberta's SuperNet (Warwick, 2017). Once the project was complete, each First Nation became the owner and operator of its network. TSAG provides technical support and training to the peoples of Treaty 6, 7, and 8 territories (Warwick, 2017).

As with other types of broadband infrastructure, smaller providers can use (or have been using) satellite technology to provide broadband in rural and remote communities through medium Earth orbit (MEO) and geosynchronous (GEO) technologies. Even in the deployment and maintenance of satellite infrastructure, it is possible to engage in private, public, and not-for-profit collaboration while building local capacity by training local technicians and local community service providers, as was done by the satellite connectivity company Qiniq (Box 5.4).

Box 5.4 Community Consultation and Public Investment in Remote Broadband Access

Using MEO and GEO satellites, Qiniq provides broadband connectivity to 25 communities in Nunavut at LTE (4G) speeds (SES Networks, 2021). Qiniq was conceived and deployed by SSi Micro Limited and the Nunavut Broadband Development Corporation (NBDC), a not-for-profit that identifies broadband needs in the territory. In 2002, NBDC was funded by Industry Canada's Broadband for Rural and Northern Development (BRAND) program (Qiniq, 2020). SSi Micro Limited, the company that built and launched Qiniq, has suggested that public investment in backhaul infrastructure can encourage private innovation in last-mile connectivity (SSI Canada, 2017).

Qiniq has engaged the community by offering a community service provider program that trains local residents on the installation of modems and basic troubleshooting to ensure success (Hudson, 2013). The local support of community service providers addresses some of the challenges caused by geographic isolation in Nunavut, and supports increased technological connectivity in communities (Qiniq, 2020).

5.4 LEO Satellite Infrastructure

LEO satellites offer better speeds than other satellites but create new challenges

Satellite connectivity allows many distant communities to be connected on the same infrastructure more easily than fixed wired systems. Historically, satellite communication has involved GEO systems, which have become increasingly capable since communications satellites were initially launched in the 1960s (Daehnick *et al.*, 2020b).

The uncertain economic viability and connectivity of LEO satellites leave the future of rural and remote connectivity unclear. Currently, however, non-geostationary satellite systems (NGSO) communications constellations, including LEO and MEO satellites, are being ambitiously designed, funded, and deployed (Daehnick *et al.*, 2020b). If current satellite internet communications proposals are realized, 100,000 active satellites could potentially be orbiting Earth within 10 years (America Astronomical Society, 2020), up from 2,500 (Daehnick *et al.*, 2020b). These new technologies may create direct competition for fixed broadband projects, the effects of which remain unclear (Desmarais, 2020). Challenges will arise in several vital areas due to the unprecedented scale and rate of satellite manufacturing and deployment.

Current satellite deployment plans are estimated to be as or more expensive than their predecessors in the 1990s. In that decade, four companies tried to provide global satellite connectivity. Ultimately, all but one (Iridium) scaled back or cancelled their intended constellations because of high costs and low demand (Daehnick *et al.*, 2020b). This history leaves some investors and industry analysts skeptical about large LEO constellations' viability (Daehnick *et al.*, 2020b). Since then, some remote communities have been successful in acquiring, integrating, and operating their own satellite internet infrastructure.

There are drawbacks to satellite dependence: weather affects signal quality, satellites lack redundancy, and even the newest technology provides slower service than fibre (Liu & Michelson, 2009; Pelton, 2017; Gomez, 2019; Segan, 2021). Past satellite disruptions have grounded flights, interrupted communications (including those related to emergency response services), and hampered search and rescue efforts (CBC News, 2011; CAMSAR, 2014; Scott, 2015; Segan, 2021). Addressing these shortcomings would provide a more dependable internet that better serves communities. Using a community-centric first-mile approach allowed the Northern Indigenous Community Satellite Network to focus on Indigenous needs while connecting Indigenous people in Manitoba, Ontario, and Quebec (Box 5.5).

Box 5.5 First-Mile Approach Used in Satellite Network Deployment

Titus Moetsabi coined the term *first-mile* to reframe last-mile connectivity as a way of creating a more equitable view of rural and remote access (Paisley & Richardson, 1998). McMahon (2014b) explores Canadian and international first-mile approaches. These focus on a local approach to infrastructure, capacity, and sustainability, by not treating rural and remote communities as exclusively peripheral to urban centres (McMahon, 2014b). These principles were used during the development of the Northern Indigenous Community Satellite Network (NICSN) to support autonomy through consultation with Indigenous people. The first-mile approach helped participants address the importance of community ownership of networks, the desire for broadband to be a public service, and the need to support economic development (Jansen & Bentley, 2004). NICSN was formed from multiple Indigenous ISPs and community groups across northern Canada. Between 2004 and 2008, the project grew from 4 connected remote Indigenous communities to 43 (McMahon, 2014b). Though not without significant challenges, NICSN represents a case study of how Indigenous communities, governments, the private sector, and user groups create infrastructure that supports self-determined community and economic development (McMahon, 2014b).

The cost of LEO satellite deployment generates uncertainty about sustainability

A typical communications satellite costs approximately US$50,000 to $60,000 per kilogram to manufacture (Daehnick *et al.*, 2020a). LEO satellites are smaller and less expensive than their GEO counterparts, with correspondingly lower launch costs (OECD, 2017). Having said this, a larger number of satellites are needed to make up a LEO constellation in order to provide a commercial internet service with high speeds (OECD, 2017). This is because the satellites are moving much faster, so more are needed for consistent signal. LEO satellites are closer to the Earth, so each satellite provides signal to a smaller area (EC, 2017). Because of this, there are relatively high upfront costs of constructing and deploying a global LEO constellation.

Without improvements in manufacturing and deployment costs, large LEO constellations will be unaffordable to maintain, and profitability will be difficult to achieve without government intervention (Daehnick *et al.*, 2020b). Improvements include leveraging economies of scale and automation, improving the affordability of launching services by cutting material and manufacturing costs, and increasing reusability. Estimates for deploying an operational satellite system range from US$5 to $10 billion, although costs are changing and many uncertainties remain (Daehnick *et al.*, 2020b).

Ground equipment is the second-largest source of infrastructure cost for satellite internet providers. In an Australian satellite project, ground equipment cost approximately AU$280 million of the $2 billion total costs (Molnar, 2014). Larger infrastructure projects, such as SpaceX's Starlink, will require an estimated 123 ground stations and 3,500 antennas (Daehnick *et al.*, 2020b). Innovation in active antennas is necessary for LEO satellite internet use, and artificial intelligence (AI) allows for more cost-efficient ground equipment (Daehnick *et al.*, 2020a). The current cost estimate of user equipment — the electronically scanned apertures (ESAs) required for broadband access — is US$300 to $500, which is prohibitively expensive for some users, creating a barrier to adoption (Daehnick *et al.*, 2020b). High entry costs may increase disparities between economically advantaged and disadvantaged groups (Chapter 4). Furthermore, in the Panel's view, *exclusive* dependence on satellite connectivity leaves a community at considerable risk of connectivity loss.

LEO satellites have a shorter lifespan than GEO satellites and other broadband network infrastructure

The higher speeds provided by LEO satellites compared to GEO satellites are the result of their orbiting much closer to the Earth's surface (OECD, 2017). These lower orbits come at a cost to lifespan. The expected lifespan for a LEO satellite is approximately 5 years, compared to 8.9 years for those satellites currently in use (i.e., GEO satellites) (NSR, 2018; Malik, 2019). For comparison purposes, fibre connections are built to operate for at least 25 years (Cyphers, 2019). The shorter lifespans of LEO satellites necessitate continuous planning and result in uncertainty for communities dependent on the clusters being replaced (OECD, 2017). The annual operating costs are also considerable. The annual cost of replacing satellites will total US$1 to $2 billion for a large constellation, assuming a five-year product lifespan (Daehnick *et al.*, 2020b).

5.5 Summary

Before broadband technology can be adopted and provide community benefits, the infrastructure must be designed and deployed to serve a given region. The model that provides broadband service to most of Canada — large ISPs building networks in regions expected to generate profit — has failed to promote investment in rural and remote connectivity. The costs of deployment and maintenance discourage large ISPs and are significant hurdles for other actors (e.g., small ISPs, not-for-profits, municipalities) trying to serve their communities. This chapter highlighted many strategies that have overcome these and other barriers to providing internet to underserved communities. Consistently, as with all expensive infrastructure projects, securing funding has been a problem. Government funding has been necessary for many of these programs to provide the initial investment or incentivize other financing. Notably, groups across the country have proven that diverse funding models and different technologies can effectively deliver broadband to their communities. A service region such as the communities covered by the NICSN has unique technical and cultural needs, and deployment challenges, compared to rural Ontario, for example. These differences require a local understanding of people, usage, and the land to find solutions that provide reliable, sustainable, and high-quality service. Satellite technology, specifically LEO, has the capacity to deliver higher speeds than previous constellations while maintaining the coverage advantage of satellite technology, but the cost to launch the LEO satellites and their short lifespan leave the value of these networks unclear.

6

Policy Challenges and Opportunities

6.1 Funding Access

6.2 Coordination and Consultation

6.3 Spectrum Allocation

6.4 Monitoring and Accountability

6.5 Policies Supporting Adoption

6.6 Satellite Connectivity

6.7 Summary

Chapter Findings

- Canada's current broadband funding and consultation schemes are often complex, onerous, and involve many actors, making them difficult for small, capacity-limited organizations to navigate.
- Limited funding for capacity building, organizational infrastructure, community leadership, and adoption initiatives — coupled with short-term funding cycles — prevents a holistic and inclusive approach to broadband connectivity.
- Canada's spectrum allocation approach creates entry barriers for smaller providers in rural and remote communities. Unlike other countries, Canada does not set aside a portion of spectrum for Indigenous Nations.
- While some information on connectivity exists, it focuses on availability (as opposed to adoption or economic benefits), and is not collected systematically or in a coordinated fashion. Current data therefore offer an incomplete picture of Canada's connectivity landscape.

The Government of Canada's efforts to deliver high-speed broadband to rural and remote communities have depended primarily on a market-based, private-sector-led approach, with the additional assistance of government programs, subsidies, and regulations that incentivize investments, competition, and service delivery. As part of this system, multiple orders of government have taken a programmatic approach to funding broadband infrastructure. Funding is often made available through federal, provincial/territorial, and regional government programs (Chapter 2), and is typically accessed through a competitive, zero-sum proposal process — one in which all of the available funds are awarded to a few projects, leaving the remaining projects unfunded. This approach has been insufficient to bring high-quality and affordable internet to all of Canada, with many people living in rural and remote communities continuing to be underserved, and unable to take full advantage of the benefits of broadband (Chapter 4). A competition-based approach to funding, if unchanged, will likely fail to bring universal internet access to Canada in the years to come.

This chapter identifies select policy challenges facing broadband access in rural and remote communities. Specifically, it focuses on challenges associated with funding and competition policies, spectrum allocation, the inter-jurisdictional nature of internet connectivity, and the need for more comprehensive consultation schemes and partnerships. While the implications are relevant to connectivity programs based on any technology, the anticipated challenges stemming from the emerging use of LEO satellites are also examined. Promising practices or alternative approaches for addressing these challenges are noted throughout this chapter, accompanied by specific examples in Canada and other countries.

6.1 Funding Access

The complexity of available programs acts as a barrier to accessing funding

While funding to support broadband access is available, the current landscape in Canada makes it difficult for small organizations and local communities to access funds. The sheer number, variety, and complexity of funding programs (e.g., different funders, uncoordinated system, limited support) constitute a barrier for communities to access the supports they need. The CRTC has increasingly allowed a greater diversity of ISPs to be eligible for their broadband fund (CRTC, 2020f). Some argue that future broadband projects would benefit from an expanded range of applicants, including individuals, not-for-profit institutions, and private sector organizations (BTLR, 2020). A more diverse funding system would allow for a more holistic and robust internet connectivity model that would benefit rural and remote regions (CIRA, 2020). Important considerations include support for more than technology deployment, and funding by different investors (e.g., governments, private foundations) available to different types of organizations (CIRA, 2020).

Onerous funding application processes limit the ability of small ISPs to apply

Historically, governments in Canada have invested in, and provided subsidies for, ISPs in rural and remote regions to help address the connectivity gap (CRTC, 2016, 2018b; ISED, 2020b). However, many of these programs are often readily available to large, incumbent telecommunications companies, whereas small, community-based ISPs have limited means of accessing them (Philpot *et al.*, 2014; Blake *et al.*, 2016). Some small ISPs, especially in rural and remote regions, may be unaware that there are funding opportunities available to them (CIRA, 2018). For example, the Auditor General of Canada (2018a) found that ISED did not provide sufficient information to potential applicants about the criteria for selecting funding proposals. Even if ISPs know funding opportunities exist, onerous application processes and unclear guidelines constitute significant barriers, leading to project delays (McNally *et al.*, 2018; ISED, 2020c). Funding application processes are often complex (APAS, 2021), requiring specialized skills and, in some cases, qualified consultants (CIRA, 2020).

As a result of these complexities, ISPs have to assess whether it is worth investing a considerable amount of time and resources in funding applications; in some cases, this acts as a deterrent to apply (McNally *et al.*, 2018; ISED, 2020e). In addition, when funding applications are rejected, there is often no explanation provided as to why, which is a missed learning opportunity for small organizations (CIRA, 2020). This funding model means that organizations and communities with better resources and capacity have an advantage, even if they are not the ones who are connecting the most underserviced communities (CIRA, 2020).

Similarly, while funding may be available, it is often not guaranteed. As a result, small communities and local organizations often find themselves competing with each other for scarce funding opportunities (CIRA, 2020). This frustration was captured by Oana Spinu, former Executive Director of the Nunavut Broadband Development Corporation, who remarked that "what we have in Nunavut is market failure. Private sector providers are competing for subsidies and not for customers" (Mathisen, 2016).

Some proposed actions identified by a self-evaluation of ISED broadband funding programs include enhancing application flexibility for rural and remote communities. This could be accomplished by, for example, removing the requirement for anchor institutions[9] to provide financial contributions, as they may not exist in some communities; publishing application guidelines further in advance; allowing for a variety of project types to be funded (e.g., last-mile, backup infrastructure for redundancy); and investing in capacity-building (ISED, 2020c).

9 Anchor institutions are "facilities that serve a public function (e.g. school, medical facility, library, First Nations band office, or other anchors around which a community is formed), in addition to providing capacity for other uses, including residential, business, and/or mobile services" (ISED, 2018b).

Short-term, project-specific funding models for broadband connectivity do not provide the needed long-term stability

The funding available to applicants is often short-term and for specific projects (CIRA, 2020). Core, ongoing funding for the establishment and maintenance of local organizations with long-term visions and goals — particularly around systemic changes — is extremely limited (CIRA, 2020). Evidence suggests that, without ongoing investment in building, upgrading, and maintaining infrastructure, the provision of high-speed internet in rural and remote regions is unlikely to be sustainable (O'Donnell *et al.*, 2016). Some funding programs in the past have ended or changed suddenly as a result of government turnover or modified funding priorities (McMahon *et al.*, 2020; APAS, 2021). Indigenous people have also explicitly called for consistent, stable, and accessible funding (BTLR, 2020).

Few programs fund local capacity-building, including organizational infrastructure and community leadership

Some communities in rural and remote regions continue to be limited in terms of local expertise to build, operate, and maintain broadband infrastructure (O'Donnell *et al.*, 2016; McNally, 2019). Evidence suggests that community-based skills development and training within these regions are key for addressing several of the challenges hindering the adoption of high-speed internet technology (Clement *et al.*, 2012).

A recent survey of non-profit organizations concluded that funding for internet-related projects beyond basic infrastructure continues to be limited or inaccessible, especially for non-profits and charities (CIRA, 2020). More concretely, funding sources for the following areas were identified as being particularly needed, but remain limited or non-existent:

- **Organizational infrastructure** — This entails physical infrastructure (e.g., connecting communities to fibre), but also infrastructure that is created/designed within community-led and Indigenous-led connectivity frameworks, and sustainable infrastructure business models (CIRA, 2020).
- **Community leadership** — Funding for community leadership can stimulate policy advocacy and development at the local level (including research and evidence to support it), and is key to making changes in other areas, such as infrastructure and digital literacy projects (CIRA, 2020).
- **Training** — There is a lack of investment in skills to empower individuals, communities, and businesses as they enter or embrace the digital world (e.g., training for new jobs, training and support for businesses to embrace the digital economy) (C.D. Howe Institute, 2017; ISED, 2019b).

In the experience of the Panel, capacity constraints within governments, including in departments developing and operating funding programs, also pose challenges for rural and remote communities. There have been concerns raised about the limitations of current community consultation requirements within funding programs, including little information provided about proposed broadband projects for affected communities, lack of examples of evidence of consultations, and no explicit mention of consent (First Mile Project, 2020). Further, governments often do not collect the necessary information to ensure legally mandated consultations with Indigenous communities are taking place (Auditor General of Ontario, 2020). This reflects, in part, a lack of internal knowledge, capacity, or institutional memory (Blake *et al.*, 2016), and/or administrative turnover within provincial, territorial, and federal governments (McMahon *et al.*, 2020).

6.2 Coordination and Consultation

The variety of government actors that play a role in broadband connectivity adds complexity to funding programs and consultations

There are multiple federal actors working on expanding broadband connectivity in rural and remote communities in Canada, including the CRTC, ISED, Infrastructure Canada, Indigenous Services Canada, and the NRC (ISED, 2020c; NRC, 2020). In addition to federal actors, provincial, territorial, regional, municipal, and Indigenous governments play important roles (ISED, 2020c; AFN, 2021). ISED sets policy and manages spectrum, which is separate from the broader, quasi-judicial telecommunications jurisdiction of the CRTC (CRTC, 2010b; Intven, 2014; ISED, 2020c). Many of these actors have overlapping responsibilities, however. For example, most of the above-mentioned bodies provide broadband infrastructure investment (CRTC, 2018b; ISED, 2020c; AFN, 2021). A lack of continuous, coordinated, and lasting partnerships among governments (including Indigenous governments) and ISPs in Canada has been documented (O'Donnell *et al.*, 2016).

This funding overlap, if uncoordinated, can cause delays in the initiation of broadband projects (ISED, 2020c). It also has the potential to duplicate efforts, as well as increase costs and time spent (BTLR, 2020; ISED, 2020c). Several municipalities in rural and remote regions have expressed a desire to better collaborate with provincial/territorial and federal governments, but have faced challenges doing so, including limited financial resources and on-site expertise needed to implement large-scale internet deployment projects (Cybera, 2017; OICRD, 2017). Empowering regions and municipalities through stronger partnerships, cost sharing, and capacity boosting can allow them to provide internet access to their communities (SCIST, 2018; APAS, 2021).

A self-evaluation undertaken by ISED confirmed the need to "clarify and communicate to stakeholders the federal roles and responsibilities related to broadband programming" (ISED, 2020c). Examining the feasibility of an enhanced coordination role on the part of ISED, such as establishing "a 'single window' for stakeholder inquiries and interactions regarding projects and funding," was also proposed (ISED, 2020c). The same self-evaluation demonstrated that ISPs see the federal government as having an important coordination and collaboration role to support an efficient national broadband strategy (ISED, 2020c).

Small ISPs and non-industry actors are often unable to participate fully in broadband policy consultations

The CRTC and ISED consider input from consultations when making decisions about broadband-related policies that serve the public interest (CRTC, 2015b; ISED, 017). However, studies have shown that, compared to smaller ISPs, large, incumbent ISPs tend to dominate broadband policy consultations (Shepherd *et al*., 2014; Rajabiun & Middleton, 2015). Participating in broadband-related consultations and hearings necessitates time, resources, and capacity (e.g., lawyers), which could limit the involvement of smaller organizations (Shepherd *et al*., 2014; CIRA, 2020). While some ISPs have formed associations and take part in consultations in a coordinated fashion, they have underscored in interviews that they often lack the capacity and resources required to participate fully in CRTC or ISED consultations (McNally *et al*., 2018). There is also limited support available for small ISPs to understand the full implications of new broadband policies (McNally *et al*., 2018). To address this challenge, ISPs have suggested that policy-makers would benefit from reaching out to small ISPs directly during consultations as an alternative to waiting for submissions (McNally *et al*., 2018). Investing in capacity-building can also help address this challenge (CIRA, 2020).

Limited participation and transparency have been noted in ISED consultations (Shepherd *et al*., 2014). In contrast, the format of CRTC consultations seems to generate more engagement and makes them easier to navigate (Shepherd *et al*., 2014; McNally *et al.*, 2018). In part, this is because there are provisions for not-for-profits and public interest groups to recover the costs of participating in CRTC consultations (BTLR, 2020). The BTLR noted the need for institutional mechanisms that formalize opportunities for Indigenous people (Chapter 3), the general public, consumers, small businesses, and academics to provide feedback on decision-making processes that are often inaccessible to them (Shepherd *et al.*, 2014; BTLR, 2020).

A dedicated office with specialized expertise facilitates broadband consultations with Indigenous people

The United States federal government has built institutional capacity to work with Indigenous people on broadband-related issues. The Office of Native Affairs and Policy (ONAP), within the U.S. Federal Communications Commission (FCC), was established in 2010 (FCC, 2021d). This office has dedicated staff members that conduct ongoing government-to-government consultations with Native American, Native Alaskan, and Native Hawaiian organizations, with the goal of increasing their participation in telecommunications policies and decisions, including broadband (FCC, 2021d). The ONAP also oversees a specialized Native Nations Communications Task Force, which provides "guidance, expertise, and recommendations to specific requests" made by the FCC (FCC, 2021b), such as how to improve engagement among Tribal governments and ISPs (NNCTF, 2020). These approaches may provide guidance to Canada on methods to improve internal capacity related to the broadband needs of Indigenous communities.

Beyond the support for institutional capacity, notable financial investments have also been made. For example, the U.S. Department of Commerce invested US$1 billion to expand broadband access and adoption on Tribal lands in 2021 (NTIA, 2021). Grants will be made available for "deployment as well as for digital inclusion, workforce development, telehealth and distance learning" (NTIA, 2021).

One-size-fits-all funding policies do not meet the needs of rural and remote communities

It has been argued that the Government of Canada's approach often comprises undifferentiated "one-size-fits-all" broadband policies and funding programs for rural and remote regions (Ashton & Girard, 2013; Taylor, 2018). In the Panel's view, an undifferentiated approach is unlikely to succeed given the heterogeneity of rural and remote regions (Chapter 2). A differentiated, needs-based approach to connectivity could better connect communities (Box 6.1).

Box 6.1 A Needs-Based Approach to Connectivity

The importance and benefits of a differentiated, fit-for-purpose approach to connecting rural and remote regions are well documented (Philip & Williams, 2019; McMahon *et al.*, 2020). Based on the results of a working group in rural Manitoba consisting of provincial government and local ISP representatives, Ashton and Girard (2013) developed a proposed framework to reduce the digital divide. The authors highlight the importance of coordinated partnerships across all orders of government, ISPs, and local businesses, and call for more engagement of citizens and youth. Their framework underscores the need for a differentiated policy response, which means delivering the most appropriate technology that fits the needs of a particular rural or remote community (Ashton & Girard, 2013). For example, some communities may need a one-time capital investment whereas others may need ongoing financial support (Blake *et al.*, 2016; SCIST, 2018).

Ashton and Girard (2013) highlight the importance of addressing short- and long-term societal dimensions (and impacts) associated with the introduction of high-speed internet. Addressing such dimensions necessitates longer timelines than the current broadband programs often plan for (Ashton & Girard, 2013; McNally *et al.*, 2017). Further, Ashton and Girard (2013) stress the importance of specific skills training for residents and business owners that match local needs, as these are usually absent from federal programs, or follow a general, one-size-fits-all training approach. Finally, the importance of having local technicians, "anchor tenants," and influencers in the implementation phase for successful adoption is noted (Ashton & Girard, 2013).

6.3 Spectrum Allocation

Limited spectrum access is a barrier for rural and remote broadband connectivity

ISED's approach to managing spectrum recognizes the need to ensure it is available for rural and remote regions (ISED, 2018c). Yet, difficulties in accessing spectrum have long been cited as a key challenge for rural and remote communities seeking to secure broadband connectivity (ISED, 2018c; McNally *et al.*, 2018). For example, ISED often auctions spectrum licences for geographic areas too large for small service providers to submit bids for, making it difficult for them to acquire spectrum in rural and remote areas (Auditor General of Canada, 2018a; SCIST, 2018). In an analysis of spectrum licences in different bands, Joseph (2018) notes that, "in contrast to claims about shortages, usage of spectrum licenses is low outside of urban areas."

The process for securing access to spectrum creates entry barriers for small service providers

ISED's auction approach to allocating spectrum in Canada has made it difficult for small local providers to obtain spectrum access, with large incumbents holding the majority of Canada's most valuable spectrum licences (Industry Canada, 2011; ISED, 2017; McNally *et al.*, 2018). Spectrum licence holders do have the option to make their unused spectrum available to third parties (including to regional service providers) through a subordinate licence (Industry Canada, 2007). However, as of 2018, Canada's three largest telecommunications providers held 1,351 spectrum licences that could be subordinated; yet, they had issued only 108 subordinate licences to regional and small providers (Auditor General of Canada, 2018a). The Auditor General of Canada (2018a) noted that there is limited business incentive to make unused spectrum available in a secondary market for subordinate licensing, and information on unused spectrum is typically not available to potential buyers.

Several smaller ISPs and consumer advocates who participated in ISED's Spectrum Outlook consultation highlighted challenges and recommended reforms needed to enable connectivity for households and businesses in rural and remote communities. Some participants recommended having smaller licence areas or using a different licensing approach for urban and rural areas, including separating auctions in urban areas from non-exclusive, shared "light licensing" in rural regions (ISED, 2018c). Other participants called for faster and expanded network deployment, noting that ISED's population-based spectrum licences incentivize ISPs to prioritize network deployment to urban centres (ISED, 2018c). Adopting a "use it or lose it" approach to spectrum licensing — requiring licensees to subordinate their spectrum to others if it has not been deployed — has also been proposed (ISED, 2018c; APAS, 2021). Others suggested ISED should develop policies that facilitate spectrum reassignment or an arbitration mechanism for subordinate licensing negotiations (ISED, 2018c; McNally *et al.*, 2018). For the June 2021 3,500 MHz band auction, ISED implemented several pro-competitive measures, including spectrum set-asides (Box 6.2).

Spectrum auction processes and length of licence terms are entry barriers for small ISPs

Recognizing the complexities with the spectrum allocation process in Canada, ISED attempted to provide more flexibility in its 600 MHz band spectrum auction in 2019 (Box 6.2). As part of the consultation process, associations representing small ISPs in rural and remote communities expressed several concerns. For example, some noted that the auction process is burdensome for small ISPs, and that 20-year licences (as opposed to 5-year licences) serve as a disincentive to participate (BCBA, 2017; Taylor, 2018). In response to these concerns, ISED provided bidder training, and justified 20-year licences by stating that "licence terms in excess of 10 years create greater incentive for financial institutions to invest in the telecommunications industry, and for the industry itself to further invest in the development of network infrastructure, technologies and innovation" (ISED, 2018a). An additional barrier for small ISPs is the cost of acquiring spectrum licences themselves, which can be addressed by providing partial reimbursements (SCIST, 2021).

Box 6.2 600 MHz and 3,500 MHz Spectrum Auctions

The spectrum auction in the 600 MHz band took place in 2019 (ISED, 2019d). This band was "designated for flexible use for commercial mobile, fixed, and broadcasting services" (ISED, 2018a). The low-frequency band carries signal over long distances and can travel through buildings more effectively than higher-frequency spectrum bands. It is therefore well suited for wireless service in both rural and urban communities. ISED sought to "promote more competition" by allocating 43% of the spectrum on auction for regional ISPs (ISED, 2019d). A total of 12 companies participated in the auction, with 9 winning licences. The auction included 54 rounds of bidding and raised a total of $3.47 billion (ISED, 2019d).

In 2019, ISED also initiated a 3,500 MHz band plan for flexible-use licensing, allowing licensees to choose the type of service they deploy (e.g., mobile 5G, fixed wireless services) (ISED, 2020a). The spectrum available is for a 20-year licence term (ISED, 2020d). For this auction, ISED implemented a set-aside in markets where enough spectrum is available, enabling smaller and regional ISPs to acquire the spectrum they need to compete in the market. The 3,500 MHz band plan requires flexible-use licences in all markets, mandating covering a certain percentage of the population in a given service area within 10 years of the licence issuance (ISED, 2020d). For rural service area tiers with a large population centre (typically, a population above 100,000), coverage to 95% of the population is required within the 10-year timeframe (ISED, 2020d). A total of 20 companies received licenses out of the 23 companies that participated in the 3,500 MHz auction; Bell, Rogers and TELUS received 49% of the awarded licences (ISED, 2021d, 2021e). In 2021, the Government of Canada announced that the auction for the 3,800 MHz spectrum band will take place in 2023 — with flexible-use licences to be issued — in order to support wireless internet services in urban and rural communities as well as 5G (ISED, 2021a, 2021c).

Ownership of spectrum by Indigenous Nations contributes to self-determination

The Government of Canada's policy objectives specify that making spectrum available at lower costs encourages wireless coverage in rural and remote regions (ISED, 2018c). ISED is set to continue to facilitate access to spectrum for "all entities, including small providers, non-profit providers, and new providers that may be interested in a low-cost spectrum option for broadband deployment in rural and remote areas" (ISED, 2018c). Additionally, the Government of Canada's Standing Committee on Industry, Science and Technology has recommended a re-examination of spectrum allocation, with a focus on licensing and pricing, to ensure that small, non-profit, and non-incumbent ISPs have reasonable access to spectrum for broadband deployment in rural and remote regions (SCIST, 2018).

There is no mention of Indigenous Peoples, however, in the Government of Canada's latest *Spectrum Outlook (2018-2022)*. The Canadian chapter of the Internet Society has called for the reallocation and/or setting aside of spectrum for Indigenous communities in underserved regions — in addition to small ISPs, municipalities, and community networks (Internet Society, 2020b). This could be done on a licensed, unlicensed, or shared/secondary spectrum use basis, particularly in areas within licensed allotments that current spectrum operators are not utilizing (Internet Society, 2020b). Similar proposals are at advanced stages in New Zealand and the United States (Box 6.3), and at a small scale in Mexico (Baca-Feldman *et al.*, 2018). The New Zealand government recognizes that Māori have an interest in spectrum given the role telecommunications plays in economic development; it plans to allocate short-term 5G spectrum rights as a first step (NZMBIE, 2019). As part of this effort, funding is also provided for Māori-led programs to build commercial and technical capacity, and to have more equitable representation and participation of Māori in spectrum-related activities (NZMBIE, 2019).

Box 6.3 Spectrum Sovereignty in Native American Tribes

In the United States, the federal government sets aside a portion of spectrum for the use of Native American Tribes prior to spectrum licences going to auction (AIPI, 2019). Airwaves are viewed as another natural resource that was ceded by Native Americans to the U.S. government. Thus, some have argued that access rights to spectrum are embedded in Native American treaty rights (Szwarc, 2018). The first-ever spectrum allocation to Native American Tribes was established in a 2010 AM/FM radio proceeding, but actions to expand this policy to commercial wireless spectrum licences have only recently been taken (AIPI, 2019). The FCC has directly sought input from Native American Tribes on several spectrum-related decisions, including whether to give priority to rural Tribal Nations for spectrum applications (FCC, 2018). Since then, additional policy proposals include:

1) Secondary market negotiations — A formal negotiation process that would allow Tribes to access currently held spectrum and to re-license dormant spectrum over Tribal lands from current licensees (AIPI, 2019).

2) Build-or-divest — A process that would “allow Tribes to require spectrum licensees to build or divest a geographic area covering unserved or underserved Tribal lands within its license area” (AIPI, 2019).

The Government of Canada does not allocate spectrum to Indigenous Nations (Szwarc, 2018). In the Panel’s view, this is a missed opportunity. Access to spectrum licences has the potential to allow Indigenous governments to build their own wireless networks or leverage their spectrum licences to attract other service providers to bring broadband to their territories (AIPI, 2019). Further, securing Indigenous access to spectrum over Indigenous lands is a key component of asserting sovereignty and achieving Indigenous self-determination (Chapter 3) (Duarte, 2017; Internet Society, 2020a).

6.4 Monitoring and Accountability

The data needed to accurately and systematically monitor connectivity services are not being collected

Robust metrics and greater access to accurate information aid in the monitoring and assessment of internet connectivity strategies and programs in Canada. While ISED publishes maps of broadband coverage in Canada, these tools paint an incomplete picture as they are based on information that is not collected in a consistent or comprehensive manner (i.e., information might be primarily based on applications for public funds) (BTLR, 2020). A survey of ISPs carried out by ISED showed that the lack of up-to-date connectivity mapping data required to support funding applications caused approval delays (ISED, 2020c). ISED asserts that the reason for not sharing more precise data with funding applicants is due to confidentiality concerns. One proposed action in response to this concern is improving collaboration with communities, since they can offer a wealth of knowledge about their specific needs and circumstances (ISED, 2020c).

Similarly, the CRTC does not currently have a comprehensive registration scheme that allows for periodic monitoring and measurements of high-speed internet coverage across Canada (BTLR, 2020). However, it does possess the legal powers required to assume responsibility for collecting data and creating databases on network deployment and the location of services (GC, 1993; BTLR, 2020). This information could be used to better identify (and address) broadband gaps in rural and remote regions, as it enables a more holistic view of where networks have been deployed, and who is providing internet services (BTLR, 2020). This information would also facilitate the inter-operation and deployment of new facilities (BTLR, 2020). In the Panel's view, the timing of reporting is also important. For example, the CRTC's annual *Communications Monitoring Report* includes data from the previous year (CRTC, 2020e), often making it out of date by the time it is published.

The lack of socio-economic and adoption metrics results in an inaccurate picture of broadband program success

Federal programs over time have switched their focus from targeting broadband adoption as a metric of success, towards broadband availability (McNally *et al.*, 2017). Moreover, the effectiveness of broadband programs is currently not sufficiently scrutinized (McNally *et al.*, 2017). Government documents are inconsistent in their reporting of broadband availability and adoption data, making comparisons among programs challenging. While Statistics Canada collects data on internet use, the survey is run infrequently and the data are not linked to specific broadband programs (StatCan, 2019). Over time, the provision of such information — even after broadband programs are completed — has become increasingly limited (McNally *et al.*, 2017).

In addition to adoption, there is limited monitoring of economic indicators associated with broadband programs, despite the emphasis on economic development as a justification for launching them (McNally *et al.*, 2017; ISED, 2020c; APAS, 2021). ISED-funded ISPs, for example, are not responsible for collecting information beyond their specific projects, including any indirect impacts of broadband connectivity (ISED, 2020c). ISED asserts it is not possible to conduct surveys with beneficiaries of broadband programs for reasons of privacy and confidentiality (ISED, 2020c). Nevertheless, measuring internet adoption rates and socio-economic impacts of broadband would allow for a more accurate picture of connectivity, and can help to better identify gaps even when internet is, in theory, available (McNally *et al.*, 2017).

There is insufficient transparency and accountability about how public funds are used to support broadband connectivity

There is a well-known information asymmetry between internet providers and consumers (BTLR, 2020). A lack of transparency, especially when public funds are given to ISPs, and a need for better accountability for funded ISPs have been noted (BTLR, 2020). Funds from the *Investing in Canada Plan* — which include broadband projects (Infrastructure Canada, 2021) — illustrate these challenges. Reporting on the plan's progress was incomplete in part because data within federal departments were inconsistent (Auditor General of Canada, 2021). Funds from this plan were spent more slowly than expected, hindering the plan's goals, and delaying potential socio-economic benefits for rural and remote communities. A lack of information regarding these delays was noted. In particular, the Auditor General of Canada (2021) found that Infrastructure Canada did not comprehensively collect information on project approval and completion, payment dates, and delays. Reliable and timely data are important for determining whether public funds are achieving their intended goals, for communicating this information to the public, and for helping to inform future decisions (Auditor General of Canada, 2021).

In the Panel's view, public funds used to subsidize internet services could be more transparent to users. Other product-specific subsidy programs require providers to explicitly display the subsidy amount on customers' receipts or bills (OEB, 2015; GC, 2020b). For example, in the case of Nutrition North Canada, the subsidy value for each eligible food item is printed on the customer's receipt along with the cost charged to the consumer (GC, 2020b). This is not the case with ISPs, which often receive funding for infrastructure projects; ISP customers have little insight into how public funds are affecting their bill.

To address accountability concerns, and in recognition of the multiple actors responsible for broadband expansion (Section 6.2), the BTLR (2020) and the Agricultural Producers Association of Saskatchewan (APAS) (2021) have proposed increasing ISED's accountability for achieving universal broadband objectives. Further, annual reporting on broadband connectivity by ISED to Parliament, informed by robust and comprehensive data, would help with the coordination of program design and public spending on broadband expansion (BTLR, 2020).

6.5 Policies Supporting Adoption

Funding approaches may be used to target barriers to adoption

Supporting the adoption and usage of internet services is as important as building infrastructure. Key barriers that prevent users from adopting available internet include the high cost of services, limited digital literacy, and unmet needs (Chapter 4). Funding policies designed to address these barriers have had success. For example, investment in digital literacy enables skills development; empowers Indigenous communities, youth, older adults, and people with lower incomes; helps combat misinformation; and facilitates public education on privacy in digital spaces (CIRA, 2020).

Internet subsidies for individuals can be an empowering policy tool to make connectivity more affordable

The ability to afford high-speed internet, if available, is a salient adoption barrier in rural and remote communities. It is important for internet programs and policies to address accessibility and affordability at the same time (SCIST, 2021). Funding policies that support the provision of electronic devices (e.g., computers) and corresponding upgrades for people who may not be able to afford them can also help address these challenges and stimulate internet adoption (Lyons, 2018). Studies have called for government policies to provide direct monetary subsidies for people with low incomes (as opposed to companies), as part of a holistic funding model (Lyons, 2018; Sun, 2020). While these subsidies do not constitute a universal long-term solution to systemic issues, they could empower targeted consumers by enabling them to participate in the broadband market, and potentially expanding the consumer base in areas where it is currently limited (Lyons, 2018). Peer-reviewed evidence may be limited, but it does suggest that these types of programs could succeed at increasing adoption levels among people with low incomes (Rosston & Wallsten, 2020). A recent example of a large-scale government-led program of this sort took place in the United States in light of the COVID-19 pandemic (Box 6.4).

Box 6.4 The U.S. Emergency Broadband Benefit

In February 2021, the U.S. FCC approved the Emergency Broadband Benefit, a broadband internet subsidy for households with low incomes; this benefit seeks to increase people's access to broadband connectivity during the COVID-19 pandemic (Kang, 2021). Any ISP qualifies to provide this discount (FCC, 2021c). As part of the program, households can receive up to US$50 per month in discounts for internet services, while households on Native American land can receive up to US$75 per month. The program also provides one-time discounts of up to US$100 for electronic devices. Any household that has experienced a substantial loss of income since February 2020 (e.g., job loss) is eligible if its 2020 income was below US$99,000 for individuals, or US$198,000 for families (FCC, 2021c). Rural residents, Native Americans, and Black people are expected to benefit the most from this program (FCC, 2021a).

In Canada, ISED's Connecting Families program — available until March 2022 — provides funding to distribute up to 50,000 computers to eligible households (ISED, 2019a). As part of this program, ISED also connects eligible low-income households with participating ISPs, which voluntarily provide internet packages for $10 a month (ISED, 2019a). As of 2021, only households that receive the maximum Canada Child Benefit (i.e., families with children with annual incomes lower than $31,711) are eligible (CRA, 2020; ISED, 2021f). Only a select number of ISPs voluntarily offer this discount, with no government funding for direct subsidies (ISED, 2021f). Instead, ISED's role is to securely connect eligible families to participating ISPs through a portal, and to provide eligibility letters to qualifying families (ISED, 2021f). Notably, none of the current participating ISPs serve the territories (ISED, 2019g), where the cost of internet connectivity is the highest (Chapter 2). Similarly, the speeds available for this program are inadequate for families with multiple children; this may have contributed to a low participation rate among eligible families (SCIST, 2021).

The Panel notes that adoption support programs have also been put in place to benefit underserved communities within urban centres. For example, in light of the COVID-19 pandemic, the City of Toronto recognized that many people do not have internet at home, reducing their access to public health information, pandemic-related supports, and family and friends. In response, the city implemented a pilot project to provide free internet access for one year to 25 large residential apartment buildings in low-income neighbourhoods (City of Toronto, 2020).

Focusing solely on household internet subscriptions is not enough to increase adoption

Internet adoption can be encouraged by moving beyond a focus on household-level internet subscriptions alone. Integrating connectivity with a broader range of community institutions and players — a whole-community approach (Box 6.5) — is a promising means of connecting residents in rural and remote regions.

Box 6.5 A Whole-Community Approach to High-Speed Internet Adoption

O'Donnell and Beaton (2018) propose a "whole-community" approach to deploying and adopting connectivity in rural and remote Indigenous communities, especially in the northern Canada. This approach recognizes the inextricable link between internet access and the broader ecosystem of community services in rural and remote regions, contrasting with models that focus almost exclusively on internet adoption at individual or household levels. The authors identify four key factors in their approach: (i) community members and households, (ii) community businesses, services, organizations, and facilities (e.g., health centres, schools, libraries), which serve as 'anchor tenants'; (iii) Indigenous owned and operated digital transport infrastructure that can connect multiple communities within a region; and (iv) surrounding lands, waters, and space in order to recognize that the land-based activities and lifestyles of Indigenous people are key to design, building, and maintenance strategies (e.g., mobile wireless networks may be deemed essential) (O'Donnell & Beaton, 2018). In line with this approach, some incumbent telecommunications companies in Canada, such as Shaw, have stated that targeting investments to communities (as opposed to households) increases the potential for choice and sustained competition in the medium to long term (SCIST, 2018).

6.6 Satellite Connectivity

An overreliance on satellite connectivity may create vulnerabilities in northern Canada

Some shortcomings related to Canada's satellite funding structure have been identified. Firstly, in line with Section 6.1, Molnar (2014) found that incremental, short-term funding for satellite-enabled broadband makes it difficult for service providers to plan for the long term. Secondly, in the Panel's experience, an overreliance on satellite funding would create vulnerabilities in the North, where there is already a lack of redundancy. An Arctic Economic Council report argues that the future of internet connectivity in the Arctic needs to be technologically diverse (AEC, 2021). The report asserts that there is no one single technological solution to connecting northern Canada. Rather, "private and public sector participants must remain technologically agnostic, choosing the best available and most viable mode rather than a pre-determined one" (AEC, 2021). Yet, recent government funding has been disproportionately supportive of some solutions. For example, 35% of funds ($600 million) allocated to broadband initiatives in Budget 2019 were earmarked for Telesat to secure capacity for a constellation of LEO satellites (ISED, 2020e). A key rationale for this funding concentration was to provide internet connectivity to remote communities in the North that continue to be underserved (ISED, 2020e). This funding will be available to Telesat once its LEO constellation enters service (Telesat, 2020).

The market for satellite internet provision in Canada has been highly concentrated

A report by a CRTC-appointed Inquiry Officer on the marketplace for satellite services in Canada found that it was highly concentrated, and barriers for entry into the satellite market were high (Molnar, 2014). Many satellite operators were authorized to provide commercial (business-to-business) satellite internet in Canada, but only three did so in practice. Telesat was the predominant commercial GEO satellite services operator, particularly in the C-band[10] market. Telesat was also the only operator that had a national footprint, as other satellites serving Canada did not cover northern Canada. Considering the concentrated satellite market conditions, regional ISPs that rely on satellite internet believed additional regulations may be necessary in the Canadian satellite service market (Molnar, 2014).

10 The C-band is one of the three frequency bands commonly used to "provide transport service to deliver [...] high-speed internet access services through a community aggregator model" (as opposed to a direct internet service to users' homes) (Molnar, 2014).

New players have started to enter Canada's satellite internet market, but their coverage remains limited

Since 2014, the composition of Canada's market for satellite services has not changed considerably. Telesat continues to maintain a major presence in the commercial service segment. For example, ISED announced a memorandum of understanding with Telesat to secure broadband capacity across Canada using the company's planned LEO constellation (ISED, 2019e, 2019f). This agreement is expected to enable wireline broadband and mobile service providers to acquire LEO satellite capacity "at substantially reduced rates" to bring universal broadband connectivity to rural and remote Canada, at transmission speeds that meet the CRTC's target of 50/10 Mbps with unlimited data (Telesat, 2020). Telesat has stated that it plans to begin offering broadband coverage to northern Canada in 2022, and all of Canada in 2023 (ISED, 2019f). Similarly, a new owner acquired Xplornet, a Canadian ISP that plans to accelerate investment in its satellite broadband network (Xplornet, 2020).

As mentioned in Chapter 2, more satellite entrants, including some foreign-owned competitors, have the potential to increase broadband service competition in rural and remote communities. The American company, SpaceX, recently received a licence to operate its Starlink satellite service in Canada (CRTC, 2020a). As part of a pilot project, SpaceX's Starlink began providing residential internet services directly to select rural households in Canada, with the aim of expanding service globally in the future (Ho, 2020). While Starlink's approval received support from some businesses and individuals in rural Canada (Ho, 2020), concerns were also raised about the high cost of the internet service and the required hardware (Daigle, 2020; SCIST, 2021). Another foreign satellite service provider, U.K.-based OneWeb, has also announced plans to offer commercial LEO broadband services in Canada by the end of 2021, but will not provide direct service to consumers (Posadzki, 2021).

Large-scale investments in satellite connectivity projects, particularly LEO satellites, also come with some risk. Historically, global satellite operators were forced to cancel large-scale constellation projects due to high costs and limited demand (Daehnick *et al.*, 2020b). The lack of sustainable funding for satellite connectivity in particular (Molnar, 2014), coupled with the short lifespan of satellites (Chapter 5), exacerbates this problem (Freeland & Jakhu, 2017). For example, Xplornet — which provides satellite internet to more than 300,000 subscribers in rural and remote Canada — will no longer cover some areas in the Yukon and the Northwest Territories due to the advanced age of one of its satellites (Rohner, 2020). While advances in technology, alternative business models, and better access to funding (including government funding) make current LEO satellite projects viable, reducing the range of costs associated with LEO satellites continues to be important for their long-term success (Daehnick *et al.*, 2020b). Further, any advancements in satellite technology do not negate the need for redundancy (Sections 2.1.1 and 5.4).

6.7 Summary

While there are several broadband funds available in Canada, current funding mechanisms are often complex, involve many players, and can be burdensome, particularly to small organizations in rural and remote communities that may have limited resources and capacity. There is competitive funding for deployment and infrastructure projects, but there are very limited funds for local capacity building, organizational infrastructure, community leadership, and internet adoption initiatives. This gap, coupled with short-term funding cycles, impedes a holistic, inclusive, and sustainable approach to broadband connectivity. Overlap and lack of coordination among funding bodies also hinder the deployment of broadband projects in rural and remote regions. The current consultation format for broadband policies, especially those under ISED jurisdiction, is challenging to navigate. Canada's spectrum allocation also creates entry barriers for smaller providers in rural and remote regions. Unlike Mexico, New Zealand, and the United States, Canada does not set aside a portion of spectrum for Indigenous Nations, which is a missed opportunity. While some publicly available data on connectivity exist, information tends to focus on availability metrics (as opposed to adoption rates and economic benefits), and is not collected systematically and in a coordinated fashion. This information gap results in an incomplete picture of Canada's connectivity landscape, and limits accountability and transparency, potentially affecting funding decisions and new policies.

7

Addressing the Charge

7.1 Answering the Questions

7.2 Panel Reflections

High-speed internet access is essential. This report and many before it illustrate a systemic, decades-long neglect of the internet needs of rural and remote communities in Canada. Compared to urban and suburban Canada, the substandard connectivity experienced in rural and remote regions severely limits economic, education, employment, and healthcare opportunities and choices. This connectivity gap is particularly pronounced in Indigenous communities — exacerbating inequities, limiting access to essential services, and hindering self-determination efforts. Ensuring that Indigenous communities have comparable internet access to non-Indigenous communities is an important step in fulfilling reconciliation commitments, since many essential services rely on broadband connectivity. While the connectivity gap has persisted for more than two decades, its impacts are experienced more deeply today than in the past — now that broadband has become inseparable from the economy, and from a wide range of services and daily activities.

Though new technological advancements hold promise, better technology alone will not automatically enhance connectivity in rural and remote Canada. The technology needed to improve internet quality — including future-proof options — is already available. However, the current market-driven approach to broadband deployment and delivery, which often relies on incumbent service providers, has been ineffective at expanding connectivity to many rural and remote communities in Canada, even with government supports.

The Government of Canada's current internet speed targets, set at 50/10 Mbps with unlimited data transfer, are insufficient for many existing applications and are unlikely to meet the needs of rural and remote Canada today and beyond 2030. These speeds are also below the average speeds available in Canadian cities. For these reasons, the Panel believes that, rather than fixed speed targets, rural and remote broadband connectivity projects can be more effective when their goal is to provide service levels comparable to those in urban centres.

A broader set of criteria — speed, reliability, redundancy, and symmetrical or near-symmetrical upload/download speed — are necessary to define the technical requirements of high-quality broadband. Speed is one dimension of quality, but broadband must be reliable to avoid dropped connections that disrupt usage. Redundancy is vital for preventing blackouts and enhancing reliability. The lack of reliability and redundancy has already resulted in severe disruptions during extended outages in northern Canada. Moving forward, aiming for symmetrical or near-symmetrical upload/download speeds would enable users to upload data more easily. Faster uploads are essential for activities such as remote healthcare, videoconferencing, and content creation, which allow those in rural, remote, and Indigenous communities to become active users engaging with the digital society.

Recognizing the essential nature of connectivity and its multiple deployment and adoption dimensions, the Panel examined the impacts of, effects on, and opportunities for people in rural and remote regions, as well as the socio-economic and policy barriers to internet infrastructure and adoption in Canada. Additional focus has been given to rural and remote Indigenous communities, because of the especially large gap between internet services available in these communities and those available in the rest of Canada. To support its analysis, the Panel examined evidence from a diverse set of disciplines, sectors, methodologies, geographies, and worldviews related to connectivity in rural and remote regions, including Indigenous communities. While there are many knowledge and data gaps, available evidence and documented lived experiences enabled the Panel to address the charge, outlined below, and to identify selected key principles for a path toward connectivity equity (Box 7.1).

7.1 Answering the Questions

What are the legal, regulatory, ethical, social, and economic policy challenges associated with the deployment and use of high-throughput secure networks (HTSN) for rural and remote communities, including Indigenous communities, in Canada?

The challenges associated with the deployment and use of high-speed internet in rural and remote communities encompass various regulatory, social, and economic factors. Importantly, the critical challenges are independent of the type of technology or the broadband speeds delivered. For this reason, the Panel focused its analysis on the systemic challenges that have led to the poor levels of connectivity in rural and remote Canada. New technologies alone will not eliminate these challenges and, in some cases, may exacerbate them. In the current system, technological advances can only improve connectivity for those communities and individuals with the resources and capacity to take advantage of them, leaving the most underserviced residents further and further behind.

The current market-based system to fund, deploy, and govern internet connectivity infrastructure has failed to deliver internet service in rural and remote Canada comparable to urban Canada. One salient challenge is the complexity of the funding options created to improve or expand connectivity, which involve many players, cause jurisdictional ambiguity, and make applications and consultations difficult to navigate. It may be unclear to some organizations whether they qualify for funding because of varying definitions of rural and remote in the eligibility criteria of different broadband programs. A competitive application process means that applicants may receive no assistance, even if their communities are the most underserviced. These burdensome processes make accessing funding difficult for small providers and other organizations in rural and remote communities with limited resources and capacity for such an undertaking.

The heterogeneity of rural and remote Canada means that a one-size-fits-all approach to funding broadband infrastructure will not be appropriate for all communities. The unique needs, goals, capabilities, and contexts of rural and remote communities affect the outcomes of different approaches to deploying and adopting broadband. Relevant considerations include distance from population centres, population density, topography, user needs, capacity and experience with broadband projects within a community, and access to other infrastructure services such as roads and reliable electricity. Without accounting for these place-based factors, it is difficult to design and deploy effective networks appropriate for a given region.

Two of the critical challenges hindering the deployment and use of broadband networks across the country are the data and transparency gaps related to rural and remote connectivity. Connectivity data are not collected systematically or in a coordinated and comprehensive manner, which obfuscates the regions that are currently underserved (in terms of both speed and reliability) and impairs the ability to monitor and assess the effectiveness of internet connectivity strategies and programs. The lack of monitoring and evaluation of funding programs limits transparency, as does the limited reporting from ISPs on how public funds are spent. It has been suggested that a single department can be responsible for providing an annual report of universal broadband objectives to Parliament, informed by robust and comprehensive data. This information would help coordinate broadband program design and public spending, as well as enhance accountability.

The connectivity gap between Indigenous communities and non-Indigenous communities is significant. Broadband connectivity is vital for supporting the self-determination of Indigenous Peoples and government-led reconciliation efforts with Indigenous communities. With access to high-quality broadband, Indigenous people would have more opportunities to participate, lead, and innovate in the digital economy. Enhanced connectivity would enable Indigenous people to access essential services more easily (e.g., healthcare, education), participate in governance activities relevant to their communities (e.g., online voting), share and preserve their cultures, and stay in touch with their communities. Meaningful consultations conducted in good faith early in the process, additional and more flexible supports for Indigenous-led broadband efforts, and allocating spectrum rights to Indigenous Nations are some documented promising practices that the Panel believes can empower Indigenous communities to achieve connectivity equity.

What are the potential challenges to deploying and maintaining network infrastructure (antenna, ground stations, 5G and later generation installations) in rural and remote communities, including in Indigenous communities?

The cost of infrastructure — deployment and maintenance — is a manageable but significant obstacle for those seeking to provide internet to rural and remote communities. The choice of technology, climate, distance, and parallel infrastructure projects all affect broadband deployment and maintenance. Providing internet connectivity entails more than laying down the infrastructure; the long-term maintenance of broadband networks requires stable funding and trained local workers. Infrastructure that is not scalable to present and future needs will not be sustainable, jeopardizing the long-term connectivity of rural and remote communities, and risking a deepening of the connectivity gap. Infrastructure that is designed with input from local communities is more likely to better meet their specific needs.

While funding for deployment and infrastructure projects exists, there is minimal financial support for the local capacity building, organizational infrastructure, community leadership, and internet adoption initiatives needed to create sustained connected communities. This gap in support and engagement, coupled with short-term funding cycles, impedes a holistic, inclusive, and sustainable approach to broadband connectivity.

There are several specific challenges that stem from the government of Canada's system for spectrum allocation. These include the length of licence terms, complexity in navigating auction processes, and the geographical size covered by said licences, all of which create entry barriers and disincentives for smaller providers in rural and remote communities. In contrast to some countries, the government of Canada does not allocate a portion of spectrum for Indigenous Nations to enable them to implement their own solutions for connectivity challenges on their land.

What are the challenges associated with the successful adoption and use of high-speed networks in rural and remote communities, including Indigenous communities?

People in rural and remote communities are not simply consumers or passive beneficiaries of connectivity programs. They are innovators, creators, entrepreneurs, and leaders who can be drivers of change if empowered by the right tools that meet their needs. This is particularly relevant for Indigenous people, as high-quality broadband connectivity can support both self-determination and active participation in the digital economy. There is a timely opportunity to empower rural and remote communities to co-create and co-design their digital futures.

To ensure users are empowered and can take full advantage of broadband connectivity, the internet must be adopted and used by those who need and wish to use it. Only through the adoption of high-quality broadband can the positive impacts of connectivity for rural and remote regions be fully realized. There are several socio-demographic factors correlated with lower internet adoption levels, including older age, lower income, and lower educational levels. Limited digital literacy and the high cost of internet services are salient adoption barriers, especially among older adults. In the most remote communities, internet plans are more expensive than in urban areas, there are fewer ISPs to choose from, and people spend a higher percentage of their income on internet services. The high cost of electronic devices is also a factor that limits internet adoption. Notably, a significant adoption barrier is the inability of broadband to meet users' needs.

What models or practices, including business models, have been employed in support of the successful deployment and use of HTSN in rural and remote communities in Canadian and international jurisdictions?

The existing market-based model through which large ISPs deploy and maintain infrastructure has not resulted in sufficient investment in rural and remote communities despite government funding. There is no panacea to address the low quality of connectivity in rural and remote regions and bring universal access to Canada, however. The heterogeneity of communities necessitates place-based policies using diverse technologies, business models, and investments, including community or municipal ownership, regional programs, and hybrid options. These models, when developed with proper consultations, can be designed to best address community needs. Empowering a more diverse set of actors can strengthen Canada's current approach to connectivity.

While deployment and maintenance costs can be significant connectivity barriers, some small ISPs, not-for-profits, municipalities, and Indigenous governments have overcome these challenges using diverse, community-centred approaches — often in partnership with federal, provincial, and territorial governments and private actors — to meet the needs of their communities. More accessible, multi-purpose funding schemes and easier-to-navigate consultation programs can facilitate the inclusion of these groups. Several examples of effective approaches are outlined throughout this report.

Based on the available evidence, the Panel has identified a set of proposed principles for future high-speed broadband connectivity programs and policies (irrespective of the technology used or the ownership model) that can help achieve more equitable outcomes (Box 7.1). Developing programs and policies that consider these principles would entail a necessary change to how broadband infrastructure and adoption initiatives are funded. This approach has the potential to overcome legal, regulatory, ethical, economic, social, and policy (LESP) challenges that have led to the sustained connectivity gap that currently exists in Canada.

Box 7.1 Proposed Principles for Equitable Connectivity

- **Equity:** The full integration of equity dimensions in the design of programs and policies — as an explicit goal — and the creation of provisions to guarantee connectivity services.
- **Universality:** Sufficient funding to provide universal service to all communities as opposed to a zero-sum, competition-based model, which is, by definition, not universal.
- **Future-proof technology:** Networks designed around current and future bandwidth needs.
- **Transparency:** Funding criteria, metrics, and more detailed connectivity data made easily available.
- **Accountability:** A single department consistently responsible for periodic reporting, especially if public funds are used.
- **Competition and redundancy:** More options and backup services for rural and remote regions.
- **Place-based and needs-based approaches:** Differentiated policies and programs built around the specific needs and potential of rural and remote communities.
- **Meaningful inclusion** of, and benefits for, Indigenous communities from the outset, including in program design.
- **Indigenous reconciliation,** including economic reconciliation through the elevation of Indigenous participation, innovation, and leadership in the economy.

7.2 Panel Reflections

The connectivity gap between urban and rural or remote communities has existed for decades, and has not been addressed despite continued calls from those living with underservice. The Panel is frustrated by the persistence of Canada's connectivity gap despite the recognition of the great inequities it has created and perpetuated. Multiple reports and reviews have identified the lack of high-quality connectivity in rural, remote, and Indigenous communities as a critical issue that requires a meaningful and coordinated response. Previous reports have also outlined promising practices similar to those discussed in this report.

Waiting to Connect expands on past reports by focusing on several critical issues and offering unique insights. The report is primarily centred on the inequities experienced by the most underserved communities and the challenges they face as a result of being left behind in terms of broadband connectivity. The report also seeks to highlight the critical role that broadband connectivity plays in supporting Indigenous self-determination while enhancing the ability of Indigenous people to fully participate in and contribute to the digital world. This is critical, as the persistently poor state of connectivity in Indigenous communities reflects, at least in part, a continued reliance on systemic policies and approaches that have led to racist outcomes, while perpetuating the ongoing harms of colonial legacies. Achieving equitable and comparable broadband would bolster the federal government's efforts towards reconciliation in alignment with the Truth and Reconciliation Commission of Canada's Calls to Action.

Relatedly, the Panel's report highlights the importance of recognizing the diversity of rural and remote Canada. Acknowledging this diversity is integral for developing flexible and holistic policies and funding strategies. The report also underscores how substantial data gaps and a lack of transparency limit the effectiveness and accountability of broadband projects. Finally, the Panel emphasizes the role of consultations and early community input into program and policy design, community-based approaches, and business models through examples from Canada and abroad. These strategies demonstrate myriad ways to connect communities successfully.

The lack of high-quality connectivity in rural and remote regions is having devastating impacts on the people living in these communities and necessitates urgent action. The continued reliance on an economic and funding system that has failed to provide internet service to rural and remote communities comparable to urban service highlights the limitations of incrementalism to solve this problem. The Panel's report provides the evidence necessary to better understand the LESP challenges that prevent greater access to connectivity, examples of place-based promising practices, and some proposed guiding principles that help achieve equitable connectivity.

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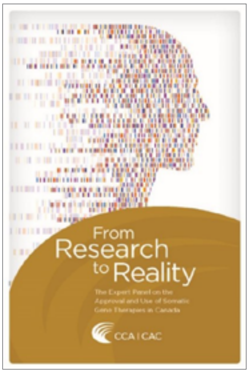
CCA Reports of Interest

The assessment reports listed below are available on the CCA's website (www.cca-reports.ca):



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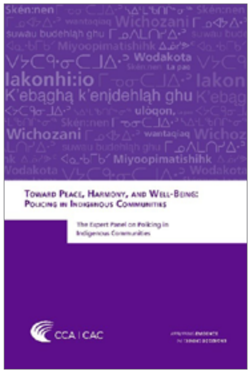

Towards Peace, Harmony, and Well-Being: Policing in Indigenous Communities (2019)

Greater than the Sum of its Parts: Toward Integrated Natural Resource Management in Canada (2019)

Canada's Top Climate Change Risks (2019)

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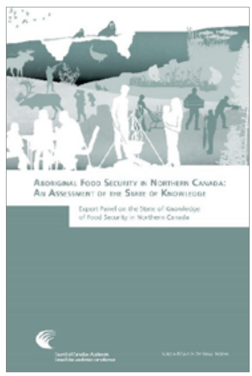

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