Understanding Community Broadband

Alberta Broadband Toolkit

Acknowledgements (2023 toolkit)

The authors of the 2023 toolkit are: Michael B. McNally, Rob McMahon, Dinesh Rathi, and Julia Sieben, with the inclusion of work from the 2016 toolkit from Jennifer Evaniew, Chardelle Prevatt, and Hanne Pearce.

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Image Credits

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Questions

Do you have questions about how to get started with or advance a broadband project in your community? The Alberta Rural Connectivity Coalition can connect you with other community leaders or experts from across the province.

You can get in touch with the coalition at info@abconnectivity.ca.

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Introduction to the 2023 Version of the Alberta Broadband Toolkit

Understanding Community Broadband: The Alberta Broadband Toolkit was first published in 2016, and at the time it noted that broadband was becoming increasingly central to life in the 21st century. Six years later, and after our experiences with the Covid-19 pandemic, it is clear that broadband is not just becoming central, but that digital connectivity is an essential part of life. Access to broadband is comparable to the need for other key utilities such as water and electricity. In 2021, the Organization for Economic Cooperation and Development (OECD), a global leader in studying broadband, stated, "there is broad consensus that a ubiquitous, high-quality broadband infrastructure is essential to the digital transformation." Simply put, a community without a sustainable, long-term connectivity solution is one that will face a challenging future.

The 2023 version of *Understanding Community Broadband* expands and enhances the original toolkit. It features more examples of Alberta community broadband projects, expanded content in areas such as wireless spectrum and policy, and updates about technology. The toolkit aims to contribute to the community of communities, individuals, service providers and others across the province seeking to ensure that digital connectivity is not only universal and that no community is left behind, but also that Alberta can be a leader both nationally and internationally on digital connectivity.

Vision

Vibrant, thriving, enjoyable – these words describe where we all want to live and what we desire our communities to be. But realizing this objective requires many elements, among them a clear, achievable vision.

Infrastructure is a key enabler of vibrant and thriving communities. While we now take for granted that infrastructure like safe roads and clean drinking water are a necessity, one new infrastructure is central to life in the 21st century – digital broadband networks. The Covid pandemic highlighted how those communities and individuals without high-speed, reliable and affordable broadband connections experience significant challenges in multiple ways. Whether it was an inability to conduct business, lack of access to health or education opportunities or simply being cut off from friends and family, the pandemic underscored that broadband is a requirement.

Broadband provides essential connectivity for individuals and organizations.

Whether your community lacks broadband or seeks to improve existing connectivity, a broadband solution is necessary. This toolkit aims to provide information to start and further such discussions. A viable broadband solution consists of many necessary elements – from appropriate technology to an effective business model – but perhaps the most important one is developing a vision that fits the community and can be supported by diverse members of the community. This toolkit provides information and planning tools to help community leaders and broadband champions build a broadband vision within their communities and improve connectivity across the province.

About the Toolkit

The content in the toolkit is organized into three general areas - learning about broadband, thinking about broadband and planning about broadband. It aims to identify the key knowledge and actionable steps that a community and its leaders can use to achieve a broadband solution.

We realize that no two communities in Alberta are the same. Factors like population size, geography, demographics and more reflect the diversity of rural Alberta. In this regard, the toolkit does not offer a “one size fits all” approach. Instead, it identifies the range of options available, and aims to empower community leaders to identify the technologies, policies, issues and steps necessary to achieve a broadband solution that best fits local needs and desires. Realizing the importance of learning from others, the toolkit also highlights several solutions that communities around the province have implemented in their own broadband development journey.

Learning About Broadband

Broadband Basics and Background

What is Broadband?

Broadband is often used as a synonym for the internet; however, the two are not the same. A more accurate, inclusive description of broadband is connectivity. That is because connectivity transmits all kinds of data beyond web pages or streaming videos on the Internet. Whether it is used for doing homework online at home, having a business meeting using video conferencing or remotely managing farm sensors from across the field or across the globe, broadband connectivity increasingly impacts more aspects of our lives.

For example, one use of broadband that does not involve the internet is digital municipal services. Broadband infrastructure can be used to connect traffic cameras and lights, water meters or facilitate communication between government facilities without routing data through the broader internet. This allows local governments more control over how municipal data is captured, stored, measured and reported. At the outset it is important to keep in mind the differences between broadband and the internet. Some critics may suggest that the time, cost and effort of installing community broadband infrastructure is not worth it, if it only means more people watching Netflix or playing faster online games. In fact, broadband use goes much further than entertainment, and for this reason, the toolkit addresses the full range of uses and benefits.

Sometimes broadband connectivity is defined by various speeds (e.g., 5 Mbps (Mbps stands for "megabits per second"), 25 Mbps), but it is better understood as an always-on, high-capacity data transmission connection that facilitates a range of uses and services of which the internet is just one element. Furthermore, broadband involves both upload and download speeds. In this regard broadband can either be symmetrical – the maximum speed for upload and download is equal, or asymmetrical – the maximum speed is different for upload and download (usually with higher download speeds). Symmetrical speeds are important because they ensure users can send and receive information at equal speeds. Asymmetrical connections, or connections where upload and download speeds differ, that prioritize download speed can make it more difficult to produce and share information. The Canadian Radio-Television and Telecommunications Commission (CRTC) defines the basic speeds needed to participate in society and the digital economy as 50 Mbps download and 10 Mbps upload, which is sometimes called "50/10."

In the *Alberta Broadband Strategy*, the Government of Alberta has set a goal of having **all** Albertans connected at these speeds by Mar 31, 2027. While there are both federal and provincial broadband plans, communities cannot rely on these alone to get connected.

Broadband connections are sometimes contrasted as a choice between wireless or wired technology; however, this is a false dichotomy. Ultimately wireless connections rely on wired infrastructure - a wifi signal in your home and a tower providing wireless access to a whole community both require a connection to a wired point-of-presence. The relationship between wired and wireless networks is explored more later on in the toolkit.

Even if your community already has broadband, this toolkit may prove useful for fostering a conversation about what next steps might be taken to improve connectivity. While the government defines 50 Mbps download as a basic connection speed, business uses may require a 100 Mbps or even 1,000 Mbps. A connectivity solution today may or may not be scalable for future needs. As discussed below, due to ongoing innovation and increasing usage, the demand for greater broadband capacity is consistently rising. Now may be the time to start a discussion within your community about how to address future needs in ways that best meet locally-determined development goals.

At a national level, Canada was once a world leader in terms of broadband. In fact, we were the first country to connect all our public schools and libraries to the internet. Provincially, Alberta's SuperNet, which facilitated connections between schools, libraries and government offices, had world-leading potential. However, over the past 20 years many other countries have outperformed us. In 2001 the OECD found that Canada ranked second in terms of broadband subscriptions per 100 inhabitants, but by 2021 we had fallen to 10th. More importantly, Canada is closer to the bottom (29th out of 38) when it comes to percentage of fibre connections (the fastest connection type) in total broadband connections. According to the CRTC, over 13% of Albertans still lack broadband access at the target speeds of 50 Mbps download and 10 Mbps upload. The situation is even worse for rural Albertans where only one third have access at the target speed, putting Alberta ahead of only Manitoba and the territories.

According to the United Nations' International Telecommunications Union, broadband is crucial for countries to stay competitive in a global economy. Broadband also expands the ability of governments to offer citizens services, and can improve quality of life for individuals.

The following section expands on the numerous benefits that broadband can provide for communities.

Post Covid Broadband Reports and Recommendations

When the Covid-19 pandemic hit, many groups across Canada undertook studies of what needed to be done to solve Canada's connectivity challenges. While each report had some unique recommendations, some of the common calls included:

- Shifting approaching service objectives from set speed benchmarks to viewing them as dynamic targets that would mandate rural and remote service to be comparable in quality and price to services available in urban centres
- Recurring recommendations to consolidate access to federal funding into a 'single window' for applicants
- Setting aside funding specifically for groups facing more challenges to access, such as Indigenous-owned businesses and smaller service providers
- Reinvesting revenue from spectrum auctions back into broadband initiatives and 'dig once' policies are other tools governments can use to maximize efficiency and stretch existing public funds as far as possible

Specific policy recommendations related to the wireless sector included:

- 'Use it or lose it' policies,
- Re-evaluating re-allocation, resale, and sub-licensing policies,
- Differentiation of policy allocations and deployment conditions between rural and urban contexts,
- Reduction of tier size and license length in auctions; and,
- Auction set asides, fee reductions, or partial reimbursement for Indigenous or smaller providers

For a complete list of the reports, see Further Resources – Post Covid Broadband Reports and Recommendations.

Key Resources for Broadband Statistics and other Information

Provincial:

- Cybera: *State of Digital Infrastructure in Alberta report* - 2021.
  - https://www.cybera.ca/wp-content/uploads/2021/07/State-of-Alberta-Digital-Infrastructure-Report-2021.pdf
- RMA Speed Testing Report - 2022.
  - https://rmalberta.com/news/rma-speed-testing-summary-report-available/

National:

- Canadian Radio-television and Telecommunications Commission (CRTC): *Communications Market Report - High Speed Broadband* - 2022.
  - https://crtc.gc.ca/eng/publications/reports/PolicyMonitoring/ban.htm
- Innovation, Science and Economic Development (ISED). National Broadband Internet Service Availability Map.
  - https://www.ic.gc.ca/app/scr/sittibc/web/bbmap
- Canadian Internet Registration Authority (CIRA). CIRA Internet Factbook (2021).
  - https://www.cira.ca/resources/factbook/canadas-internet-factbook-2021
- CIRA. Internet Performance Test.
  - https://performance.cira.ca/
- Government of Canada – National Broadband Data
  - https://open.canada.ca/data/en/dataset/00a331db-121b-445d-b119-35dbbe3eedd9

International:

- Organisation for Economic Cooperation and Development (OECD): *Broadband Portal*
  - https://www.oecd.org/sti/broadband/broadband-statistics/
- International Telecommunications Union (ITU): *State of Broadband 2021*.
  - https://www.itu.int/dms_pub/itu-s/opb/pol/S-POL-BROADBAND.23-2021-PDF-E.pdf

Important Broadband Related Organizations in Alberta

As your community progresses in developing a broadband solution(s) you may wonder what other organizations in Alberta may be able to provide valuable insight or help you get in touch with experts in the area. Key groups within the province include:

- The Alberta Rural Connectivity Coalition (ARCC)
- Cybera
- Rural Municipalities of Alberta (RMA)
- First Nations (Alberta) Technical Services Advisory Group
- Regional Economic Development Alliances (REDAs), and in particular broadband specialists within various REDAs

One of the key strengths that Alberta has is a "community of communities" that have grown together in terms of developing different broadband solutions. No matter where you are, there are experts all across the province who can assist your community in everything from figuring out how to start, to considering business models, and even potentially working together on a broadband solution.

The Alberta Rural Connectivity Coalition and the Alberta Rural Connectivity Forum

In response to the Covid-19 pandemic, organizations and individuals from across the province have come together to form a united broadband advocacy network - the Alberta Rural Connectivity Coalition (ARCC). The ARCC includes a range of members including Cybera, RMA, Alberta Municipalities, CIRA, several REDAs, a variety of post-secondary institutions, along with counties, school divisions and others. The broad-based coalition aims to provide its members with information and engage in advocacy to the federal and provincial governments.

One major undertaking of ARCC is the hosting of the annual Alberta Rural Connectivity Forum. The first forum was held virtually in 2021, and the second forum was held in person in Sylvan Lake in May 2022. The forum provides an opportunity for learning about current developments in broadband in the province. Videos from the 2021 forum can be found here: https://abconnectivity.ca/forum21/ and slides from the 2022 forum here: https://abconnectivity.ca/forum22/.

The National Broadband Internet Service Availability Map and the Eligibility Mapping Tool

One of the key parts of planning for broadband in your community is determining where broadband services may be available and determining what parts of your community may be eligible for funding. ISED provides two key resources in this regard – the National Broadband Internet Service Availability Map, and the Eligibility Mapping Tool. The Availability map provides a range of information including information that maps government funded broadband projects and rural road coverage. The Eligibility map has been specifically created to assist with Universal Broadband Fund applications. Both of these resources are useful for determining what availability exists in your community or nearby. The data sets that inform the maps are also available from the Government of Canada's National Broadband Data Portal.

- National Broadband Data
  - https://open.canada.ca/data/en/dataset/00a331db-121b-445d-b119-35dbbe3eedd9
- National Broadband Internet Service Availability Map
  - https://www.ic.gc.ca/app/scr/sittibc/web/bbmap?lang=eng#!/map
- Eligibility Mapping Tool (requires registration)
  - https://ised-isde.canada.ca/app/scr/sittibc/web/?lang=eng

Broadband Benefits

In the same way that electricity and roads were key drivers of community development in the 20th century, broadband is the new infrastructure paradigm shaping the growth and sustainability of communities,households and businesses in the 21st century. Broadband connectivity is crucial at three levels: it is essential communication infrastructure, it is an enabling technology that can be used in all sectors, and it is critical as the economy and society transform from the industrial era to the information age.

Broadband technology is not only a catalyst, but also increasingly essential for economic and social development to sustain thriving communities. The benefits of broadband extend across all aspects of life, from improving economic competitiveness to enabling enhanced opportunities for learning, health delivery, and overall improvements in quality of life. The following sections outline some of the key benefits of broadband in different domains.

Broadband technology is not only a catalyst, but also increasingly essential for economic and social development to sustain thriving communities. The benefits of broadband extend across all aspects of life, from improving economic competitiveness to enabling enhanced opportunities for learning, health delivery, and overall improvements in quality of life. The following sections outline some of the key benefits of broadband in different domains.

Economic Growth

Broadband has the capacity to drive and/or sustain economic growth in a number of ways.

- Communities with broadband infrastructure may find it easier to attract investment and information technology intensive jobs, particularly in the midst of increasing global competition
- Broadband can be crucial for retaining current employers, who may find the cost of relocating less than developing their own broadband-enabled remote work solution
- Broadband is especially appealing to attract information and communications technology (ICT) and digital media industries since they are prone to utilizing small businesses, independent contractors, and remote workforces
- In 2021 the OECD noted that a 10% increase in broadband subscriptions led to an average increase of 2.8% GDP growth (over 21 different countries), and more broadband connections are associated with higher GDP per capita
- A recent Government of British Columbia study of broadband in the Kootenay region found a 14-fold return on investment from broadband and over $14,000 in economic benefits for each person connected
- Broadband improves productivity by promoting the adoption of more efficient business practices (e.g., marketing and inventory optimization)

Business

Broadband helps businesses to remain competitive by reducing costs, optimizing performance and enhancing customer services.

- Automates and streamlines business operations and transactions, reducing procurement, warehousing, labour and administrative costs
- Enhances management and operational efficiency by improving internal and external communication among stakeholders
- Increases revenue streams by providing opportunities to expand into new global markets

- Increases customer satisfaction and loyalty by improving customer services and identifying valuable customer insights
- Provides opportunities for use of cloud computing
- Connectivity is increasingly important for business travelers whether insurance agents, sales representatives or long-haul truck drivers updating log books
- Facilitates work from home, which has grown markedly since the pandemic, with Cisco estimating nearly 5 times as many employees working remotely than before the pandemic

Agriculture

Broadband increases agricultural productivity by supporting real-time communication and remote monitoring.

- Increases communication and business opportunities in agricultural communities
- Helps to eliminate the distance between producers and commodity markets, allowing producers to obtain real-time information on prices
- Fields and equipment can be monitored remotely using connected devices and applications
- Precision agriculture technology enables agriculturalists to collect data on weather variability, crop yields, soil moisture levels, plant health, insect damage, and weed competition per acre of land
- When an issue arises, text messages, e-mails, or other electronic alerts can be generated, removing the need for regular on-site inspections
- Enables the collection and transmission of a wealth of real-time data that farmers/agriculturalists can use to make better management decisions
- Broadband enabled farm automation can offset labour shortages and the limitations of the Temporary Foreign Worker Program

Government

Broadband helps improve communication and collaboration.

- Encourages interaction between residents, businesses, and the municipal government
- Increases the efficiency of municipal operations and management, improving decision-making
- Enhances government performance at various levels and locations, improving coordination across local, provincial, and federal levels
- Network municipal services and facilities

Health

Broadband allows a range of health and medical services to be delivered remotely allowing greater access to healthcare.

- Creates a more efficient and potentially cost-effective way to deliver health care
- Improves speed and access to health information, including the transmission of high-quality images and videos (e.g., X-ray images and CAT (computed axial tomography) scans)
- Remote consultations allow rural residents to consult with medical professionals from distant medical centres, avoiding the expense and inconvenience of hospital visits.
- It can support aging in place, and reduce the need to place seniors in urban long-term care facilities.

Education

Broadband provides innovative and cost-effective ways to remotely access online courses.

- Offers increased flexibility and access to learning
- Removes time and location constraints on learning and studying
- Reduces the cost of producing, updating, and distributing course materials
- Facilitates collaboration and interactivity among students
- Educational opportunities include K-12 and post-secondary remote learning, formal opportunities through online courses (e.g., MOOCs (Massive Online Open Courses)) and self directed learning or professional development (e.g., YouTube)
- The COVID-19 pandemic caused 91% of children around the world to lose access to their physical schools, and nearly one third of those children were unable to access distance education because of the lack of broadband
- Students without broadband have GPAs on average of 0.4 percentage points lower than students with broadband, and this results in 4 to 6 percent expected lower incomes

Public Safety

Broadband technologies present novel ways to inform, access and respond to public safety issues.

- Provides the public with new ways of seeking help and accessing emergency information
- Enables public safety personnel to prevent or respond swiftly to emergencies
- Allows first responders anywhere in the country to send and receive critical data (audio, image, and video) to save lives and prevent acts of crime
- Well-structured and protected (secure) broadband options could reduce threats to e-commerce and online applications

Transport

Broadband helps improve the efficiency and management of transportation services.

- Modernizes transportation systems, increasing driving efficiency, and reducing greenhouse gas emissions
- Through access to online scheduling and real-time transit information, broadband can make public transit more attractive
- Improves transport management via more detailed and more frequent traffic information. This is useful for route planning and congestion avoidance. For example, shifting from still images to videos and from hourly reports to second-by-second updates

Teleworking

Broadband helps facilitate the seamless transfer of data, creating employment opportunities and other advantages.

- Improves the ability of employees and entrepreneurs to connect remotely using video conferencing and transferring large files. This has the potential to increase teleworking, reduce travel time and expenses as well as lower stress
- Reduced traffic congestion helps to eradicate the environmental impacts associated with travel
- Offers employment opportunities and improved access to services at home for people with disabilities

Entertainment

Broadband contributes to the high quality and speed of online entertainment services.

- Greatly improves the quality of online audio and video
- Considerably reduces the time required for downloading music or movies on the Internet
- Facilitates a range of new media and entertainment services such digital movies and multi-player interactive video games
- Reduces movie distribution costs by replacing costly traditional methods of sending celluloid film prints across nations to transmitting digital copies
- Broadband is transforming the creation and marketing of entertainment. The cable company no longer has control of your options. Small production companies or even individuals, can post their art on streaming services like YouTube. They don't have to wait to be "discovered". The best TV programming is now available from streaming services

Tourism

Broadband helps to promote and support tourism services to consumers.

- Information is key to supporting tourism. Within a fiercely competitive global tourism environment, accurate and timely information relevant to consumers' needs is often crucial to satisfying tourist demand
- Broadband options help to attract and retain tourists in rural areas. Customers expect high-speed internet even while camping
- Faster and more reliable broadband services allow businesses to operate consistently and efficiently, delivering a world–class visitor experience

Communication

Broadband is also increasingly essential to all forms of communication

- Traditional landline phones can be replaced with Voice Over Internet Protocol (VOIP) phones
- Email and cloud-based file sharing allow for exchange of everything from short messages to large images, audio files or videos
- Broadband enables access to social media, which can be used to connect with friends or family, stay informed, or connect with others with similar interests
- Video based communication platforms such as Zoom provide a key way to stay in touch and are increasingly important for work and business purposes

Olds Economic Benefits

Olds, known as Canada's first community owned Fibre-to-the-Premises network, has demonstrated proven benefits for the local community and economy since the $13 million dark fibre network started in 2009. As an initiative of the Olds Institute, the fibre network was the answer to their question from a 2004 workshop with city leaders, business people and senior government ministers "what do we need to do to make our community sustainable, vibrant, and what is in the future for us to gain a competitive edge?" and reflects the institute's philosophy that economic development should be driven by the community. O-Net, the network service provider, offers free Wi-Fi access in the hospital and throughout the community with over 80 hotspots. This network granted Olds College the distinction of the first gigabyte campus in the nation, and enables the use of cutting edge connected technologies to support teaching and learning. In addition to uptake by major public institutions, the network and O-Net has enabled the retention of major employers such as Olds Soft Gels (previously Banner Pharma Corps), the attraction of new engineering firms and professionals, companies including Mistras Canada and Mountain View Credit Union, and Internet cost savings for local small businesses of 40% or approximately $300,000 in total for the first 75 that signed up.

Considering Future Use and Demand

When considering a broadband solution for your community, think beyond current uses to consider future use and demand. Over the last two decades demand for broadband capacity has grown steadily as more devices and uses have become available - from the need to send email and visit simple web pages to demands for multiparty video-conferencing and high-definition streaming video. It is already evident that in the near-to middle-term there will be substantial demands for much greater broadband capacity at household, community service and business usage levels. The OECD reports that as of 2020, more than 42% of fixed (non-mobile) broadband connections have speeds in the range of 100 to 1,000 Mbps, and a further 4% are at speeds greater than 1,000 Mbps. Those speeds are double or more than our national and provincial target speeds. It is estimated by Cisco, a leading global information services company, that as of 2023 the global average wired broadband speed will be 110 Mbps.

While current speed targets may meet the demands of today, new technologies will require even more capacity. Cisco estimates self-driving vehicles will require a steady connection of 20 Mbps, HD (or high-definition) virtual reality will require 167 Mbps, and while it may be a way off, ultra high-definition (UHD) virtual reality will require 500 Mbps.

One key trend driving future demand is the emergence of the Internet of Things. The Internet of Things (or IoT) describes an environment where not only individuals connected through computers or smartphones are connected to the internet, but so are billions of networked 'smart' devices exchanging information. Connections between devices, also known as machine-to-machine (or M2M) connections will soon make up half or more of the network connected devices.

Some of these devices are already available, such as smart thermostats that can be managed remotely. Many more connected devices are coming online in all sectors including home and household use, health and medical devices, building infrastructure, agricultural equipment and municipal infrastructure. Having the broadband capacity to ensure that households, businesses and farmers can take full advantage of the Internet of Things is important, and the IoT also offers municipal governments new ways to manage public infrastructure that can lower costs and improve services and safety. For example, the U.S. White House estimates that with LED bulbs and smart lighting systems, communities can save as much as 70% on outdoor lighting costs.

Further into the future, new technologies such as quantum computing and quantum networks will also require ultra-fast broadband networks. Quantum networking, where photons are used as data bits, is expected to be commercially available in 20 years. It is predicted these networks will enable one thousand times current data throughputs. Only fibre optics will be able to support this technology.

Beyond Short Term Thinking

Moving forward on a broadband solution requires long-term thinking. This can be particularly challenging if a community already has some sort of broadband infrastructure in place. Many residents may be pleased with existing service levels, and short term planning around four-year election cycles can often drive decision making. Along with understanding growing demands for broadband capacity, vision and community engagement are also key factors. See the section on Community Engagement for more information in this regard.

Engineers, researchers, policy-makers, community champions and others who work on broadband are often thinking ahead. While in Canada there is a lot of attention on meeting the current speed targets - 50 Mbps download and 10 Mbps upload - networks with speeds of 10,000 Mbps are already being deployed. On the wireless side, while 5G, or fifth generation wireless, is in the early phases of being rolled out in Canada, research is already taking place with regard to 6G (sixth generation) networks that are predicted to be developed in the 2030s. Keep in mind that faster wireless speeds ultimately require connections to wired networks. To get the potential of 5G (or even 6G) networks, an underlying fibre optic network will be needed, which highlights the limitations of relying on wireless only approaches.

Faster networks will facilitate potential services such as immersive extended reality (XR), holograms, digital twins, 3D calling, haptic communication (transmission of touch and motion), autonomous vehicles and nano-technology based internet-of-things sensors. Although these technologies may seem like science fiction or something not needed, remember that in 2000 Google was a relatively brand-new company, Facebook hadn't even been created and Tik-Tok was the sound a clock made. No one knows where the next big tech company or idea will come from, but if your community doesn't have sufficient broadband, chances are it will be somewhere else.

Communities are at different stages of broadband development. Your community may already have one or more internet service providers and you may be trying to assess how broadband connectivity can be improved. Or, you may be starting with little in the way of existing service providers and infrastructure. The following section outlines various broadband technologies that you can consider when planning a broadband solution for your community.

Technology Background

With regards to broadband technologies, there are two important types of connection that a community must consider as part of an overall broadband solution. Your community must have a connection to the broader internet infrastructure (backhaul), and specifically an interconnection with an Internet Exchange (IX) or with another third-party network through a transit, peering or interconnection agreement. This backhaul connection provides the link between your community and the rest of the world.

Your community will also need a means of connecting the individual households and businesses within the community (last/final mile). This connection serves to link buildings inside your community with one another, and with the backhaul infrastructure. The point at which these two connections link is known as a Point of Presence (POP) (Note that for some communities in Alberta the SuperNet provides "Meet Me Facilities (MMF)" instead of POPs). For more information on SuperNet see the "Misunderstandings about SuperNet" section.

Connecting Your Community to the Rest of the World

In Alberta there are two IXs - one in Calgary (YYCIX) and one in Edmonton (YEGIX) (though in some cases Alberta internet traffic is ultimately routed to the internet exchange in Seattle). Both of Alberta's IX's are operated on a not-for-profit basis, though YYCIX offers higher connection speeds than YEGIX. Your community must have some means of connecting to either one of these two exchanges, or an agreement to connect with a third-party transit network. For many communities across the province there is potentially a SuperNet connection in place that may provide a community connection to YYCIX internet exchange. In addition, incumbent telecommunications service providers (TSPs), namely Rogers, Bell and Telus, may be able to provide a leased connection to connect an ISP to an interconnection point in Calgary (or Edmonton). Since much of the traffic routes through YYCIX, getting to an internet exchange in Alberta is sometimes referred to as "Getting to Calgary."

Connecting Inside a Community (Household, Business, Community Anchor Institutions)

The second type of connection is determining how to connect the households and businesses in your community to the community POP (which then connects, or backhauls, to the larger internet exchange (IX)). Connections come in two major types - wired (e.g., copper, coaxial cable and fibre) and wireless (fixed wireless, mobile wireless and satellite). Each of these different connection types has various advantages and disadvantages (discussed further below).

Broadband Connection Types Inside a Community

Type	User Types	How it Works	Cost Factors	Advantages	Dis-advantages
Fixed Wireless	Households; small businesses	Transmission by tower to fixed points, using wireless spectrum	Costs include tower deployment and maintenance and radio antenna infrastructure	Less intrusive to deploy; doesn't require wired connections with each home/business	Requires line of sight to receiver; can face capacity constraints with multiple users; signals can face interference from a variety of factors
DSL	Households; small businesses	Transmission over copper telephone lines	Requires access to copper telephone lines	Uses existing and ubiquitous infrastructure	Slowest of the wired broadband connection types; performance declines with distance
Coaxial Cable	Households; small and medium sized businesses	Transmission over coaxial cable	Requires access to coaxial cable lines	Fastest of legacy wired connection types (copper and coaxial cable)	Performance declines with congestion from multiple users
Fibre	Households, businesses (all sizes), institutional users (hospitals, schools, libraries)	Transmission over fibre optic cables	Costs include fibre deployment (trenched or aerial); potentially electronics at ends of fibre cables	Fastest of all connection types; allows symmetrical connections (same upload and download speed)	Expensive to deploy at first (compared to fixed wireless towers); however, operationally and on a per Mbps basis fibre is less expensive

Fixed Wireless

- Also called Fixed Wireless Access (FWA)
- Speed: Can range from <20 Mbps to up to 100 Mbps on new 5G fixed wireless connections (which are currently being developed/deployed)
- Newer FWA connection types make use of higher frequencies resulting in higher speeds, but over shorter distances
- Most FWA connections are multipoint, or in other words, the tower serves multiple fixed locations, which means that the overall speed of the connection has to be divided among the number of connections (e.g., a 100 Mbps wireless connection serving 10 homes would provide 10 Mbps to each home)
- Dedicated FWA connections for business are possible which result in no splitting of the connection speed and can facilitate symmetrical connections
- Typically, not as fast as wired connections; however, in some cases wireless can out-perform DSL
- Wireless Broadband is a system that transmits information via radio waves from towers to fixed points
- Receiver must be within line-of-sight of the tower to connect
- Towers connect to backhaul infrastructure either through microwave (more common) or by wired connections (ideally fibre) (less common)
- Ideal for remote and sparsely populated areas
- Signal quality can be negatively impacted by both interference from other signals and degradation from a variety of factors including hills/valleys, trees and even weather
- While newer 5G FWA networks may offer significantly higher speeds than previous FWA technology, the OECD in 2022 still notes that viewing them as a viable alternative to fibre is “premature”

DSL

- DSL stands for Digital Subscriber Line - newer technologies include “very high-speed rate DSL” or VDSL
- Speed: up to 100 Mbps per user with VDSL technology; however, performance deteriorates depending on the distance between the end user and the DSL Access Multiplexer (usually a telephone exchange centre)
- Developed by phone companies to replace dial-up; unlike dial-up phone line can be used for both internet and voice calls at the same time

- While both DSL and dial-up use copper phone line technology, note that dial-up is capable of only very limited speeds (56 Kbps) and as such dial-up is considered a "narrow-band" rather than broadband technology
- DSL is no longer considered a viable long-term solution as the technology cannot scale to higher speeds
- Newest DSL technology - G. Fast - can provide speeds up to 900 Mbps; however, it requires connection to a node (i.e., a telecommunications connections cabinet) that is just 100m away. If the node is 200m away speed falls to 600 Mbps, and at 300m to 300Mbps

Coaxial Cable

- Speed: typically, in the 100+ Mbps range but can decline with higher numbers of concurrent users
- Newest cable standard offers potential speeds up to 10 Gbps download and upload; however, deployment of this standard (DOCSIS 4.0) will not take place for at least two to four more years, if at all in Alberta
- Based on Data Over Cable Service Interface Specification (DOCSIS)
- Modem separates the internet signals from the television signals
- Faster than DSL
- Speeds can suffer from high numbers of concurrent users at peak times

Fibre

- Sometimes also called fibre-to-the-home/business/premises (FTTH/B/P)
- Speeds: New deployments such as those in Vermilion and Brooks are based on XGS-PON standards and support services up to symmetric 10 Gbps.
- Though still not cost reduced, the newer NG-PON2 standards support four (eight are planned) wavelengths, each of which can support 10/10, 2.5/2.5, or 10/2.5 Gbps connections which can be split amongst anywhere from 1 to 64 premises.
- Research trials are working on even faster fibre technology (XGS-PON) which has produced test speeds of 400 Gbps (or 400,000 Mbps) symmetrical upload and download speeds
- Signals travel through fibre optic cable
- Allows symmetrical (equal) upload and download speeds, but most implementations tend to be asymmetrical
- Future-proof – speeds of fibre connections are limited by the electronics attached to the end of the fibre optic cables, not by the network infrastructure itself

- Fibre lasts – some cables from 40 years ago still in operation, and life expectancy of the infrastructure is commonly estimated at a 25-year minimum, with some suggesting cables may remain useful for up to 50 years
- The OECD in 2021 noted that there is widespread recognition that fibre is "the most capable and most future proof technology available today."
- Environmental benefits - fibre networks are more energy efficient than traditional copper networks, and fibre connected buildings can make better use of smart sensors that can optimize energy consumption

Fibre to Home/ Business/ Premise v. Fibre to the Node (FTTN)

One important distinction to keep in mind is the difference between Fibre to the Home (FTTH) and Fibre to the Node (FTTN). In FTTH situations fibre optic cable is run directly into the home or premise. With FTTN fibre is run to a local cabinet, but the end connections may be made via copper (DSL) or coaxial cable. Since FTTN shortens the length of copper or coaxial cable it can increase speeds on DSL and capacity on coaxial cable. FTTN can also allow symmetric coaxial cable speeds, but DSL speeds will remain asymmetric.

Understanding Spectrum

Spectrum is the lifeblood of wireless communications. Spectrum, or more formally radio-spectrum, is a subset of frequencies of the electromagnetic spectrum, which includes the frequencies by which visible light travels along with the frequencies for x-rays. Spectrum enables a range of wireless communication from our cell phones, wifi and fixed wireless networks and satellite communications. In Canada spectrum is managed by ISED, and globally the International Telecommunications Union works to ensure that spectrum policies are coordinated around the world to minimize interference.

As part of spectrum management, ISED determines which frequencies will serve what purposes. For example, some spectrum frequencies are used for 5G cellular signals, while home wifi networks use other frequencies, though in some cases a frequency may have more than one use. Most spectrum in Canada is licensed - meaning that you need permission (in the form of a licence) from the government to make use of the spectrum. The major exception to this is the use of unlicensed spectrum for wifi.

The licensing system is one reason why wireless connectivity solutions can be more challenging than wired connections (which are regulated by the CRTC). To operate a wireless service, one typically requires a licence to operate in specific frequencies and in a specific geographic area from the government. These licences are often sold at auction, and in some cases for significant sums. For example, the last auction for 5G spectrum licences raised a total of $8.9 billion for the federal government. Spectrum licences are not permanent, but over the past several years may have been auctioned on 20-year terms.

Other Connection Types

Terrestrial Geostationary Satellite

- It can be done in two forms – direct-to-home (DTH) or the community aggregator approach
- DTH model provides direct connections between individual households/organizations/businesses and the satellite
- In the community aggregator model, a connection is made between a single point of presence in a community and the satellite (satellite 'backhaul'), allowing for local distribution of connectivity (and associated community control and management opportunities) through wireless or wired last-mile infrastructure
- In some cases, satellite may be the only feasible method for reaching some very remote and isolated users
- However, satellite does have several drawbacks. Limitations of satellite solutions include low quality of service, latency issues ('time lags'), inability to support private networking and symmetrical bandwidth, high costs, restrictive data caps, and long wait times for installation and repairs in remote regions.

Low Earth Orbit (LEO Satellites)

- LEO satellites rely on a larger number of lower orbiting satellites (typically called constellations) than older geostationary satellites
- Commercial providers such as Starlink have been launching satellites with the aim of providing connectivity in not just rural and remote areas
- Although several companies are aiming to develop satellite constellations including Canada's Telesat, Starlink's prominence has resulted in several notable findings:

- While Starlink has promised speeds up to 1 Gbps (1,000 Mbps), test from Germany in 2021 reveal significantly lower speeds (100 Mbps download and 25 Mbps upload)
- Starlink subscriptions and equipment are quite expensive for end users, and there are also concerns if the launch of satellites (by SpaceX) will result in limited capacity for Starlink
- The American Federal Communications Commission (FCC) has cancelled rural broadband grants to Starlink on mathematical proof that the required service level could not be reached. LEO service should only be considered as a long-term solution in very remote areas.
- Although Starlink can provide speeds of 75 Mbps download and 15 Mbps upload, if satellite capacity is outpaced by subscriptions, these speeds will diminish

Mobile Wireless

- Connections provided by licensed wireless spectrum from towers to mobile devices (e.g., smartphones or mobile broadband hubs)
- Range of standards for mobile wireless communication (e.g., HSPA (High Speed Packet Access) LTE (Long Term Evolution)) and 5G (Fifth Generation)
- Speed: LTE advanced technologies can achieve speeds up to 225 Mbps, but actual speeds are much less (<70 Mbps download and 10 Mbps upload at the upper end)
- 5G speeds are considerably higher than LTE; the global average for 5G networks is 184.2 Mbps
- While Canadian operators such as Telus are noting some 5G networks will exceed speeds of 1,000 Mbps; there is only limited deployment at these speeds planned for Alberta
- Requires licensed spectrum and a supporting ecosystem of devices (handsets/mobile hubs)

Local Last-Mile Technology(ies)

While there are six different broadband connection types (DSL, cable, fibre, fixed wireless, mobile wireless, and satellite) a number of factors limit the degree to which communities can develop, implement or rely on these technologies.

Both DSL and coaxial cable require specific types of wired infrastructure (copper or coaxial cable). While this infrastructure may be present in your community, these networks tend to be privately owned and operated by incumbent telecommunication companies (usually Telus or Rogers). Further, copper and coaxial cable are considered legacy broadband infrastructures. This makes fibre the best option for long-term planning for communities considering wired broadband solutions.

You may wonder if your community should develop a solution focused on mobile (cellular) wireless. Though mobile wireless has many advantages, at this point in time, there are several costs making this solution impractical for most community initiatives. Mobile wireless broadband - the type used by smartphones - requires the acquisition and use of specific radio spectrum frequencies (also known as 'licensed spectrum'). These frequencies are licensed by the federal government (ISED) for a fee. Additionally, this solution requires handset infrastructure and transmission towers. The cost of equipment and spectrum licenses place this solution out of reach for most local governments and small telecommunications service providers. While mobile wireless is not a practical solution for community broadband, Fixed Wireless options can be deployed quickly at a community level.

Satellite can be a feasible means of connecting geographically isolated communities that lack a connection to adequate broadband networks; however, satellite-based connections also suffer from a number of limitations (see Traditional Geostationary Satellites above for a review of the limitations). New Low Earth Orbit (LEO) satellites offer significantly improved speeds over traditional satellites. Providers such as Starlink focus on direct-to-home systems. Given the limitations of DSL, coaxial cable, mobile wireless and satellite, communities working towards a broadband solution are left with fibre and fixed wireless as options. Of these two technologies, fibre has some advantages including:

- Enough carrying capacity to meet foreseeable future demands
- Transfer technology that is constantly improving and becoming more efficient, allowing for ongoing improvements
- After capital costs (including conduit deployment), fibre is relatively cheap to install, maintain and upgrade
- Long lifespan - many of the major fibre cables laid in the early 1980s are still operational, and estimates generally put the lifespan of fibre in the 30–40-year range. Cables are more likely to be damaged by humans than they are to fail over their lifespan

- Supports other forms of broadband distribution, such as fixed wireless, and fibre infrastructure is necessary to support the roll out of future 5G services
- Distance does not limit the network - the data transfers just as quickly over long distances
- The upper capacity of optic cables is very much in development. The option to layer new technologies onto existing ones in the same fibre strand means that broadband service can be increased significantly without the cost of replacing the fibre cable itself

That said, a full-scale fibre deployment within a community will initially be more expensive than a fixed wireless solution. Furthermore, with fibre a significant share of the cost is digging or 'trenching' the fibre – the cable itself is comparatively inexpensive. However, these two technologies are not mutually exclusive – it is possible to use fibre to support a local fixed wireless network. The Broadband Best Practices section discusses how a community can adopt a fixed wireless to fibre plan, and also discusses alternatives to trenched fibre.

In addition to different technical elements, the policy and regulatory environment for wired and wireless options is varied. The following section provides a brief overview of the policy and regulatory environment governing broadband in Canada.

Policy and Regulatory Background

Canada's policy and regulatory landscape for broadband is complicated. Two federal departments – Innovation, Science and Economic Development (ISED) Canada, and Rural Economic Development are both involved, and there are two separate regulatory agencies, Canadian Radio-television and Telecommunications Commission (CRTC) (the national regulatory) and the Commission for Complaints for Telecom-television Services (CCTS). On top of these federal departments and agencies, in Alberta, Service Alberta has played a historic role in overseeing SuperNet, while various ministries have had responsibility for the rural broadband portfolio (which as of late 2022 is now with the new Ministry of Technology and Innovation).

Innovation, Science and Economic Development

Innovation Science and Economic Development (ISED) is the primary federal department directly responsible for telecommunications. ISED regulates much of the wireless sector and administers radio-spectrum licenses. It also administers federally funded broadband programs including the current Universal Broadband Fund that will invest $2.75 billion in broadband infrastructure across the country.

ISED works with Rural Economic Development Canada to advance broadband across the country. Rural Economic Development has taken the lead in developing Canada's national broadband strategy, *High-Speed Access for All: Canada's Connectivity Strategy*. Released in 2019, *High-Speed Access for All*, is the first connectivity strategy in the history of the federal government.

In addition to overseeing federal funding of broadband, ISED also manages the radio spectrum system in Canada. Radio spectrum, or simply spectrum, is an essential element in wireless broadband communication. In addition to mobile wireless and satellite uses of spectrum, ISED manages the use of fixed wireless connections from a tower to a point (household or business) and for microwave backhaul between towers.

In regards to radio spectrum management and regulation, a recent notable development is ISED's release of the Spectrum Outlook 2023 to 2027 in August of 2023. The Outlook outlines ISED's plans for supporting wireless telecommunications services within Canada, plans to modernize the license fee policies and framework, and plans for spectrum release between 2023 and 2027. The five main policy themes and foci of the document include spectrum as an economic driver and enabler of Industry 4.0, rural connectivity in the wake of COVID-19, Indigenous connectivity, spectrum, wireless technology, and climate change, and competition and wireless affordability.

Review and reform of licensing processes, structures, and policies aim to increase transparency, clarity and predictability, and responsiveness to dynamic market, technological and social conditions, granularity and diversity of licensing areas, sizes, requirements, and fee structures, as well as reduce barriers and challenges for Indigenous communities and Indigenous and smaller service providers in an effort to encourage competition and innovation, incentivize efficiency, and support the continued improved quality and availability of services across Canada, including rural and remote areas and Indigenous communities.

Canadian Radio-Television and Telecommunications Commission (CRTC)

Although ISED and Rural Economic Development Canada play a key role in policy setting, Canada's arm's length telecommunications regulator, the Canadian Radio-television and Telecommunications Commission, also plays a key role. It has regulatory authority over most of Canada's telecommunication ecosystem and acts as a quasi-judicial independent body.

While the CRTC's regulatory authority is extensive, and a complete discussion of the role of the CRTC with respect to broadband is beyond the scope of this toolkit, communities should be made aware of several CRTC initiatives and areas of focus.

The most important CRTC initiative is the Commission's Basic Services Objective. The Basic Services Objective, or BSO, defines what telecommunications services are essential and as such should be available to all Canadians. The CRTC last reviewed the BSO in 2015-16, with many Alberta voices participating in that consultation. As a result of the BSO decision, released at the end of 2016, the Commission set the current national speed targets (50 Mbps download, 10 Mbps upload) and declared that 90% of Canadians should have access to these speeds with unlimited data caps by 2021 with the remaining 10% to be connected by 2031. As a result of the BSO decision, the Commission has also established a $750 million broadband fund.

A second key regulatory function is the regulation of wholesale internet. Wholesale internet is the market where large ISPs (also known as incumbents, e.g., Bell, Rogers, Telus) provide access to their networks to smaller ISPs that provide retail services. Regulation of the wholesale market aims to facilitate competition for smaller ISPs (such as Teksavvy). Regulation of wholesale internet access has been a complicated and challenged issue in Canada. Although the CRTC introduced a new regulatory framework in 2015 that was intended to eventually provide wholesale access to both transport networks and eventually local networks (e.g., fibre to the home) issues around rates have been hotly contested and involved not only challenges from major ISPs to the Commission's rulings, but also the intervention of the federal cabinet.

It is important to note that while the CRTC has the ability to regulate retail rates – the rates ISPs charge individuals for home/business internet service - the CRTC only does so in the case of Northwestel's terrestrial service areas in the Far North, due to the presence of sufficient competition among service providers elsewhere in Canada.

The CRTC's regulatory power also includes a wide variety of other issues such as provisions around rights of way and pole access, regulation of some aspects of the wholesale wireless market (and the provisions around what are known as Mobile Virtual Network Operators (MVNOs)), and codes of protection for consumers including both the Internet Code and the Wireless Code.

- CRTC Internet Code : https ://crtc.gc.ca/eng/internet/codesimpl.htm
- CRTC Wireless Code: https://crtc.gc.ca/eng/phone/mobile/codesimpl.htm

In February 2023, the federal Cabinet issued a new Policy Direction to the CRTC. The policy direction guides the CRTC on how it should implement Canada's Telecommunication Policy objectives, which are codified in the *Telecommunications Act*. The priorities in the new direction include:

- promoting competition and investment,
- fostering affordability and lower prices,
- ensuring affordable, high-quality and reliable services are available in all parts of Canada (specifically including rural, remote and Indigenous communities),
- protecting the rights of consumers,
- reducing barriers to entry into the telecom market,
- enabling innovation in services, and
- stimulating research and development in the telecom sector

In addition the Policy Direction provides guidance to the CRTC for moving forward on other areas of policy and regulation such as wholesale broadband services and wireless competition (including MVNO regulation). The 2023 Policy Direction repeals two earlier directives from Cabinet from 2006 and 2019.

One area the CRTC is generally not involved in (except for limited exceptions) is dealing with complaints about telecom services. Service complaints are handled by the Commission for Complaints for Telecom-television Services (CCTS).

High-Speed Access for All: Canada's Connectivity Strategy

In 2019, the Government of Canada released *High Speed Access for All: Canada's Connectivity Strategy*. It is the first time Canada has had a federal broadband strategy. The document lays out the government's plans to close connectivity gaps including $6 billion in various funding envelopes. The strategy outlines targets of having 95% of Canadians connected to high-speed internet (defined as 50 Mbps download and 10 Mbps upload) by 2026. The government has since increased this target to 98% by 2026. The strategy also notes that where possible, the government will focus on scalable technologies that can deliver speeds of 1 Gbps (or 1000 Mbps).

The strategy also places emphasis on partnering with provinces. In this regard, in 2022 the Government of Alberta partnered with the federal government to each invest $390 million in the province (or $780 million total) into projects as part of the Universal Broadband Fund. At the time of writing, a variety of ISPs have received funding with some major recipients including Arrow Technology Group, Yellowhead County, Telus, Clearwater County, Switch Incorporated, and Tsuut'ina Nation.

Provincial Departments Involved in Broadband

In Alberta a number of different departments have been involved in the broadband file over the past 20 years. Of these, the most significant is Service Alberta which is responsible for managing the SuperNet portfolio (see more about SuperNet in the "Misunderstandings about SuperNet" section). In 2022, responsibility for broadband, including the *Alberta Broadband Strategy*, has been placed in the new Ministry of Technology and Innovation. The Ministry and Strategy aim to have all Albertans connected to the internet at speeds (of 50 Mbps download and 10 Mbps upload) by Mar. 2027. For more information on the Strategy, see the "*Alberta Broadband Strategy*" section.

SuperNet 2.0

In 2018 a new SuperNet contract, sometimes called SuperNet 2.0, was reached with Bell to manage the network. The agreement with Bell represented a change from the original SuperNet contract, which was managed by Axia. Bell subsequently acquired Axia's assets bringing the era of Axia in Alberta to a close. The 12 Axia Fibrehood communities were sold to Telus. Although the contract has changed, SuperNet's purpose remains to provide backbone connections for provincial and municipal services such as schools, libraries and health centres.The role of Service Alberta in SuperNet is not without criticism. In 2018 the Alberta Auditor General criticized the department for its mismanagement of the $1 billion SuperNet contract. Specifically, the report noted that Service Alberta lacked proper oversight with regard to measuring performance and enforcing compliance with the original SuperNet 1.0 contract. It also found gaps in the interpretation of the contract between Axia and Service Alberta.

Alberta Broadband Strategy

Released in 2022, the *Alberta Broadband Strategy* outlines the province's approach to achieving "universal connectivity" (defined as 50 Mbps download and 10 Mbps upload) in Alberta (by Mar. 31, 2027). The Strategy included a $390 million dollar commitment from the province to fund broadband infrastructure projects in partnership with the federal Universal Broadband Fund (UBF). However, one limitation of this approach was that applications for the UBF had closed by the time the Strategy was announced. The province has since announced $36 million in funding (as part of the $390 million) to go to projects that were deemed ineligible for UBF funding based on ISED service maps.

In addition to funding and the universal connectivity goal, the Strategy notes that the province will rely on a technological mix of fibre, LEOs and fixed wireless. It also includes advocacy to the federal government on spectrum - specifically the encouragement of policies that focus on "use it or lose it" approaches to encouraging the deployment of wireless services. The newly created Ministry of Technology and Innovation is responsible for the strategy.

Misunderstandings about SuperNet

In having a conversation about broadband, one may encounter the belief from some that no action is needed because SuperNet provides broadband service to all communities in Alberta. Below are some common SuperNet misunderstandings.

1) The province already has SuperNet, so nothing needs to be done

No. SuperNet only provides regional middle mile connectivity between the larger internet backbone (at YYCIX) and connection points (either Meet-me-facilities (MMFs) or Points of Presence (PoP) in 429 communities in Alberta. Providers – whether private sector businesses or community networks – still need to provide local access networks that enable local homes and businesses to connect to their local POP (and from there, via the SuperNet, to the global Internet).

2) SuperNet is supposed to connect households/businesses

No. SuperNet only provides a connection in a community (either an MMF or POP). It does not connect individual homes or businesses, nor is it intended to. An ISP can interconnect with SuperNet and the ISP can provide a final mile connection (by various connection types) to a home or business, but on its own, the SuperNet is not an ISP/intended for end users. SuperNet does connect a range of provincial and municipal facilities including more than 1,900 schools or learning centres, 650 government offices, 250 healthcare facilities, 300 libraries, 80 municipalities, and 43 First Nations.

3) The Government of Alberta owns SuperNet

No. It is unclear with the Bell acquisition of Axia if the government retained its Indefeasible Rights of Use (IRU) with Bell.

4) SuperNet is one single asset/network

No. SuperNet consists of two assets/networks. SuperNet is comprised of a base area network which connects larger communities (32) and the Extended Area Network (EAN) that reached just under 400 smaller communities. Bell was (and is) the original owner of the base network, and had an IRU with the Government of Alberta for the EAN.

SuperNet also has two components – one to provide services to public facilities and one to provide commercial services. The commercial services component can be further subdivided into a service that provides backhaul for ISPs and a retail side that provides managed business connections. Community networks registered as ISPs can access lower wholesale rates available through SuperNet.

Thinking About Broadband

Basic Economics of Broadband

Improving broadband service in a community takes both time and money. During the consultations held to inform the development of the original toolkit, participants frequently identified cost as one of the most significant barriers to improving connectivity in their communities. This section of the toolkit aims to introduce major elements in the economics of broadband. It does not serve in place of a feasibility study that will have to be conducted with the help of outside experts; however, it does provide community leaders and broadband champions with sufficient information to initiate conversations around cost and feasibility.

As your community begins to think about various broadband solutions there are several important considerations, which will have implications in areas such as infrastructure, the financial and economic viability of broadband, and the overall quality of access to broadband.

- Technological Consideration – what type of technology do you want to use?
- Ownership – who will own and maintain the infrastructure?
- Service Provision – who will provide services over the infrastructure?
- Business Model – what will be the revenue/cost model to support the broadband system?

In Alberta, there are a wide range of answers to these questions. Some communities have partnered with existing ISPs to undertake the deployment of infrastructure and operation of internet service. For example, Taber partnered with Telus for its fibre deployment. In other cases, communities have decided to do all of this work themselves. In Olds, the Olds Institute undertook a fibre deployment and established its own ISP (O-Net) which provides service in the community.

Other communities have chosen different solutions. In Grande Prairie, the municipality set up a program facilitating tower deployment for Grande Prairie Networks to operate a Wireless Internet Service Provider (WISP). In Waterton Lakes, the community deployed fibre by partnering with Parks Canada and launched internet service through an agreement with O-Net from Olds.

To achieve a broadband solution your community will have to conduct a detailed feasibility analysis. Undertaking this analysis will likely require input from outside experts (consultants), and can be facilitated through a Request for Proposals (RFP) process.

Economics of Technological Considerations

Each technology has its own economic considerations. At the present, there are primarily two approaches for communities to decide between – fixed wireless or fibre. Deploying fibre can be done aerially on poles or underground, usually by ploughing or directional drilling (or via conduits). Aerial deployments are cheaper, and roads are not a barrier but the ongoing pole rent must be considered. Buried fibre can be less prone to disruption of service. Aerial fibre is vulnerable to extreme weather resulting in more cost to maintain. Aerial cable is typically faster to repair than buried cable although you may be dependent on how quickly the utility company can replace damaged poles. However, access to aerial polls can also be complicated by various factors, and, at the time of writing the CRTC is studying how to make poll access more efficient. Costs for either aerial or buried fibre can be reduced through effective planning (see best practices). For example, in Calgary 'brownfield' trenched fibre deployment costs roughly $200/m. In other places, rural brownfield costs can be considerably cheaper, in the $15 to $65/m range. Use of best practices such as a 'dig once' policy (see best practices section for further details) can substantially reduce costs in the long term. A rural installation has less opportunity for 'dig once' savings.

With regards to fixed wireless, a community will have to assess the costs versus benefits for different types of tower construction (e.g., tower heights). You will also have to consider how the tower is connected to your community POP. Backhaul to the POP can be achieved through microwave (wireless) or by a wired (fibre) connection. Generally, fibre fed towers are preferable, but are also more expensive.

In both cases it is also important to consider the costs of the electronic equipment associated with various connection types. Fibre connections require electronics that have to be replaced more frequently than physical fibre but usually less frequently than fixed wireless components. Upgrade or replacement costs are relatively low. For fixed wireless there are costs associated with the various radio/antenna options. Upgrade or replacement costs would be 50% to 100% of the original cost.

Another important set of factors to consider are the density, geographical spread and topography of your community. For lower density communities or communities with considerable spread between residences/businesses, fibre will be more costly. However, fixed wireless solutions can be undermined by topographical factors. It is not uncommon for some fixed wireless subscribers to have their signal impeded by hills, valleys and trees. Some terrains will limit the uptake to less than 30% of the predicted coverage.

Ownership, Service Provision and Emerging Business Model Considerations

Municipal networks have been a growing trend in many places with a variety of business models. Potential models range from utility models (similar to water, sewer and other municipal services) to co-operatives with public involvement and all kinds of different arrangements with respect to who finances, builds and operates the network.

Like all infrastructure projects there are two broad categories of expenses. One time capital costs and ongoing operating and maintenance expenses.

Capital costs: A one-time allocation for capital infrastructure. This includes the procurement and installation of infrastructure required for deployment of broadband services. This can include the costs to build connections to household and/or organizational users. Examples of capital expenditures include: land, building (towers and or exchange infrastructure), fibre deployment, labour, equipment, and materials. In addition, there may be capital costs associated with network and service provision.

Operations and Maintenance costs: The ongoing operating costs required to operate broadband facilities. This includes the expenses to maintain and upgrade equipment and networks as new digital technologies are required, infrastructure ages, or user demand increases. It also includes human resources costs, such as for technical, administrative, marketing and support staff. Depending on the type of business model, it can include costs associated with operating a network, such as purchasing wholesale bandwidth, maintaining fibre splice records, marketing and outreach, locating buried fibre, utilities, tower maintenance, maintaining a help desk, setting up billing systems, and so on.

If your community chooses to build infrastructure, you will have to determine a model for amortizing the capital expense. A key element to consider includes the amortization time frame. Specifically, what time frame do you plan for covering the costs (10 years, 15 years, 25 years)? Another option may be to consider the infrastructure costs as a utility and to pay for the infrastructure from local tax revenues. Note that this may result in some ratepayers paying for service that might not be available to them.

If your community wants to provide service as an ISP, you also need to consider two other factors - cost of the service to users (and more importantly the ratio of average revenue per user (ARPU)), and what share of your community will uptake the service. The latter ratio is known as take rate. Take rate and ARPU are inversely related - the lower the cost of the service the greater the take rate, but the ARPU will fall. A higher ARPU will reduce take rate. Note that any delays in deployment can create a need to revise the broadband network's revenue structure. For example, Olds assumed a 30% take rate and amortized their build over 10 years; however, initial delays meant that they needed a higher take rate to meet the 10-year amortization.

Alberta Broadband Ownership and Business Models

Ownership and Risks

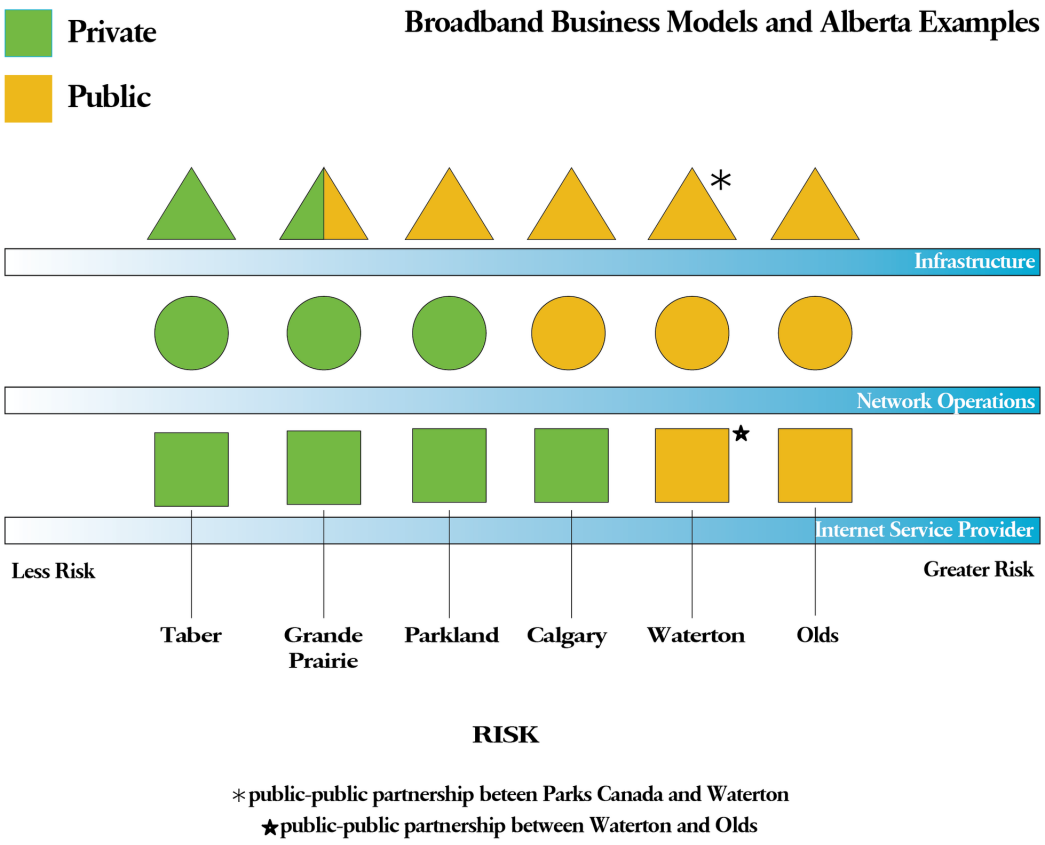
A wide range of business models have developed for both fibre and wireless networks across Alberta over the past decade. The information in the following section includes the original 2016 business models (including both the diagram and descriptions) along with updated information on the state of business models in 2022. As one can see, the past several years have further diversified the ways communities develop connectivity solutions.

Broadband systems can be conceptualized as consisting of three layers: infrastructure; network operations; and Internet Service Provider (ISP). Infrastructure refers to the physical components of the network, such as fibre optic cables or wireless towers. Network operations refer to provisioning the network electronics and then managing the operations and administration of the combined infrastructure - which entity has control over the data flowing through the network. The ISP layer refers to which entity is providing retail telecom services such as Internet, telephony, and television.

The visuals in the 2016 Business Model Diagram illustrate different approaches to owning and operating broadband networks using examples from communities in Alberta. With respect to risk, the diagrams indicate who bears the major risk. As shown, approaches with greater private investment result in risk primarily borne by the private service provider, while in community owned initiatives the risk is borne by the community.

The three layers of broadband system are separated out to indicate whether ownership is public (indicated in yellow), private (indicated in green), or a public/private partnership (indicated with green/yellow). The 2016 Business Model Diagram is technology agnostic; that is, it can be applied to any kind of broadband technology, including fibre or fixed wireless, but the updated 2022 diagram is specific to the technology indicated within the diagram. Regardless of technology, it is important to remember that each layer (infrastructure, network operations, and internet service provision) can be separated.

2016 Business Model Diagram



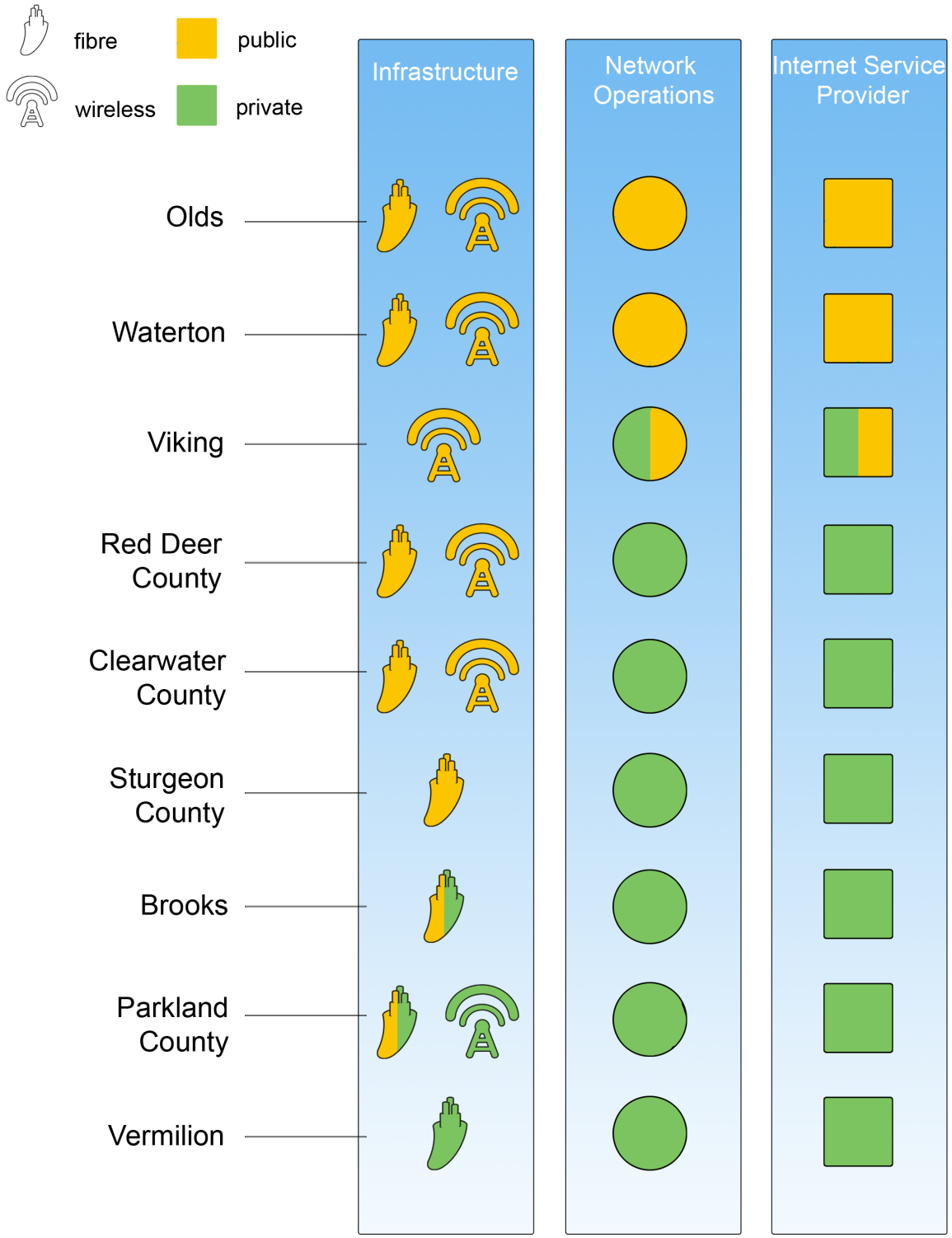
Private sector entities include telecommunications and cable companies, while public sector entities include municipal governments and community owned groups (e.g., the Olds Institute for Community and Regional Development). In some cases, different public sector entities have partnered to support shared ownership of components of a network. For example, in Waterton Lakes, Parks Canada and the local municipal government partnered to set up the network infrastructure, while the Waterton Lakes municipal government partnered with O-Net to provide internet service to residents (note that while O-Net is a for profit company, its sole shareholder is the Olds Institute). For an example of a public-private partnership we look to Grande Prairie. Here the county partnered with Grande Prairie Networks to assist in the development of tower infrastructure by coordinating development approvals (see more on the Grande Prairie example in the vignette).

The diagram also illustrates the risk/reward for communities involved in these ownership choices. The ownership structure on the far left (private sector) represents less risk for municipal governments, but also less potential reward. The far right represents the opposite: community owned and operated infrastructure presents potential revenue streams, but also introduces more risk to local leadership. For these reasons, it is important to carefully consider what degree of ownership works best for your community.

2022 Business Model Diagram

The updated diagram (next page) indicates how different communities split ownership for fibre and/or wireless infrastructure required for their broadband solution.

Broadband Business Models and Alberta Examples



*Note that some of the above models have been simplified to allow for visual representation in this diagram

These nine communities have business models ranging from fully public to almost fully private (and the table omits the many fully private networks operated by traditional ISPs such as Telus). Public infrastructure ownership is more common, but private provision of internet service is still seen. In terms of the overall models, mixing a combination of public and private ownership across the layers is most common.

Since the first iteration of the toolkit/diagram in 2016, these approaches have gained traction in other municipalities and across various layers of the model. The City of Brooks is a more recent example of shared ownership of infrastructure assets. The City invested around $5.4 million and owns the feeder portion of the network, while funding partner Crown Capital funded and owns the $15 million distribution network. Brooks fibre network will be able to offer symmetrical 1 Gbps (or 1,000 Mbps) speeds to residents. Brooks is an example of a three-layer model. Crown Capital and Brooks own the infrastructure, Community Network Partners Inc (CNPI) operates the network, and O-Net provides the services (initially – after a grace period service provision will move to an open access model).

Vermilion is another example where the Town contracted with private groups to facilitate deployment and operations. Although there were some changes to the initial approach, the network is now operated by Digital Infrastructure Group with the Town contributing capital. In return, the Town gets a share of revenue and the network will be open access.

There is also diversity among models considered 'public'. The Town of Olds consolidated Olds Fibre Ltd. (OFL) into a Municipally Controlled Corporation (MCC) in 2021 in order to reduce complications of splitting ownership between the OICRD and OFL, create more opportunities for financing O-Net going forward, and separate the remaining debt for the network from the Town's total debt calculation. Red Deer County has also proposed a Municipally Controlled Corporation business model to realize their network. These types of arrangements allow the corporation to exist as a separate legal entity, borrow and incur debt servicing costs, and make and distribute profits while the municipality acts as shareholder.

Business Operation Models

In addition to the issues of ownership and risk, a second major consideration is what operational model a community network adopts. Over the past several years, there have been a variety of approaches in Alberta in this regard including the utility approach and the private equity approach.

Utility Networks Model: In the past, each network supported a single application such as telephony or TV, with current technology, all services can be provided over one network. This opens the door to (structurally separated) utility networks wherein one (fibre) network is deployed in an area and made available on a wholesale basis to all service providers interested in providing retail services (e.g., Internet, TV…) over it. Calgary's network is based on dark fibre which is available on a wholesale basis to all; Brooks, Beaumont, Vermilion, and Sturgeon are all to be open access utility networks.

Private Equity Model: As Covid laid bare the value of broadband infrastructure, serious private equity is now being invested in this sub-asset class and several large funds are now investing in Alberta. Private equity, for example, is behind the builds in Beaumont, Brooks, Red Deer County, and Vermilion as well as the acquisitions of Xplornet and Zayo. While the investment models vary, most have minimum deal sizes (greater than $20 million), prefer fibre, and require significant investor control (for risk management). With the latter comes longer term operations and management contracts and sometimes a single retail provider, but also the opportunity for revenue sharing with the communities served. Typically, the private capital firm will run the numbers for a municipality and if their financial hurdles are met, they may elect to proceed with or without municipal support. If the numbers don't quite work – as with smaller and more rural communities, the firm will require a capital contribution. While communities are often very happy to receive the funding, the business models vary so they need to be aware of what they are getting into. In the Regional Municipality of Wood Buffalo, the municipality is contributing $13.2 of the 21M required for the Telus build, but will receive neither control nor a revenue share. In fairness, they assume none of the risk either. Other communities, such as Vermilion, are contributing some capital and for that will receive an ongoing share of the net revenue.

Regardless of which ownership and business model is chosen, communities need to ensure that they have stable, medium to long term (at least longer than four-year election cycle) guidance for the project.

Technology Specific Considerations

Fibre optic networks can be either 'open' or 'closed', meaning that owners can choose to lease access to third-party entities on a wholesale basis, or not. Open access ensures non-discriminatory/transparent access for all services providers desiring to make use of the network. One way to help understand open access is to compare a highway with a railroad – the highway is open access as anyone with a car can use it, but the railroad is closed and only the railroad owner determines whose railcars can use the line. The OECD notes that if well managed and designed, open access networks provide wholesale capacity fairly and enable competition and innovation at the retail service level (i.e., allowing various providers to compete on what kinds of services are available over the network). Open access community networks have become more common in recent years.

Access to fixed wireless towers is similarly starting to be regulated by government (specifically ISED). Whether constructing a new tower or aiming to use an existing one there are several factors that need to be considered. Further information on tower sharing and construction information can be found in ISED's Client Procedures Circular: *Radiocommunication and Broadcasting Antenna Systems*.

There are two important concepts associated with fibre-based infrastructure - 'lit' and 'dark' fibre. If a fibre network is 'lit', the fibre cables are connected to electronics that allow traffic to flow through the network; if it is 'dark' there may be no electronics and traffic is not moving through the network. An entity like a municipal government can own 'dark' infrastructure and generate revenue by leasing it to a third party. However, a municipality can also lease 'lit' fibre infrastructure to a third party, presumably for a higher rate, so that third party can use it to sell Internet service.

Fixed wireless solutions use another key distinction: licensed versus license exempt (unlicensed) spectrum. Licensed spectrum is sold at auction by ISED and provides the successful bidder with exclusive use to a specified block of spectrum. When developing a fixed wireless solution, the WISP (wireless internet service provider) will have to ensure that it either has a license for the spectrum being used or ensure that its use of unlicensed spectrum complies with ISED requirements.

Regardless of connection type and business model, there are several common strategies central to ensuring a successful broadband solution. In the next section, the toolkit outlines the importance of community engagement and highlights some key challenges and best practices for all kinds of broadband solutions.

Importance of Community Engagement in Broadband Decision Making

Community engagement is central to decision-making about local broadband initiatives. By working with residents to identify development goals through structured planning and dialogue, engagement initiatives can help communities shape broadband projects to enable widespread adoption and effective use.

Through a "whole community" approach to broadband decision-making, local leaders and administrators can engage in strategic planning regarding how bandwidth is paid for, distributed, and managed in each community. This approach to broadband planning enables local residents to make decisions on how infrastructure and bandwidth is made available to deliver essential services such as e-health, e-learning and so on.

Engagement holds a number of benefits for community broadband initiatives:

- It supports leadership by providing information from constituents on local needs and priorities
- It enables strategic planning, research and business support
- It helps build technical capacity and digital literacy through targeted training initiatives
- It educates residents on the benefits and uses of broadband
- It helps identify community champions

It is important that community engagement initiatives involve a diversity of users. These include individuals, businesses, and organizations - local services such as schools, health centres, and non-profits. This whole community perspective aims to ensure that development projects address the needs of a range of community members.

Engagement initiatives should consider both the social and technical components of broadband. This includes discussing the underlying local and transport infrastructure that enables individuals, households and organizations to connect, along with the various uses of connectivity. Consideration should also be given to factors including: availability, price, quality of service, interoperability, ownership, and accessibility.

The process of engagement can take a variety of forms, including surveys, focus groups, and planning circles. One example of community engagement in broadband decision-making was a citizen planning circle on effective use of rural broadband held in Spring 2014 in the town of Olds. the initiative provided participants with background information about broadband, and offered them an opportunity to contribute to policy development. In a series of facilitated discussions, 13 community members from a diverse range of backgrounds jointly developed action proposals to inform broadband development and use in the agriculture, business, education, and healthcare sectors.

This initiative was facilitated by the Centre for Public Involvement (CPI) at the University of Alberta, and supported through a partnership between Alberta Agriculture and Rural Development, the Olds Institute for Community and Regional Development, and CPI.

Sturgeon County also makes available information from their own consultation process available at: https://www.sturgeoncounty.ca/sturgeon-county-administration/public-engagement/broadband/. Seeing what other local governments have done can be a great way to inform community consultation processes in your own community.

Community engagement is central to any successful broadband solution. It is also a key means of addressing many of the common pitfalls and challenges that befall communities discussed in the next section.

Community Profiles

Olds

The Town of Olds has become somewhat of a poster child for rural Albertan broadband, as Canada's first community-owned fibre-to-the-premises network. The network was originally envisioned in 2004 by the Olds Institute for Community and Regional Development as an open access network owned by the Town and used by private Internet Service Providers, and as a solution to questions surrounding community sustainability, vibrancy, and competitiveness. After the desired partnerships with private ISPs failed to materialize, the O-Net was established by the Olds Institute in 2013 to provide internet, telephone, and TV services over the network. O-Net also offers free wifi at the Olds Hospital and Care Centre, as well as over 80 other community hotspots. By 2017, O-Net was providing service to 40% of the Olds market with speeds ranging from 140 to 2400 Mbps, and benefiting the Town in a myriad of ways, including providing access for residents and businesses to internet-based services, delivering personal and business savings, and encouraging economic growth and competitiveness in contributing to retention of existing employers and attraction of new firms.

A major change to the business model materialized in October of 2021, with Olds Fibre Ltd., which operates as O-Net, becoming a Municipally Controlled Corporation of the Town of Olds. The Town of Olds support of the network was largely providing loans to the Olds Institute to finance the construction of the network and creation of Olds Fibre Ltd./O-Net. As the amounts owed to the Town represent over half of the Town's legislated debt limit, concerns over the Town's financial stability and resources available to address other community needs grew. After considering numerous options, the Town decided to consolidate OFL assets, operations, revenues, and debts into a Municipally Controlled Corporation, which allows the OFL to carry its own debt and reduces complications of split ownership between the Olds Institute and OFL, provides more options for financing O-Net, and creates a business structure better suited to seeking and accommodating potential investors. In the summer of 2022, the Town also announced partnership with Four Networks Inc. and Nation Fiber Corp. for the management and expansion of O-Net.

Red Deer

In addition to Olds, Red Deer County is another example of a municipality establishing a Municipally Controlled Corporation to facilitate deployment and operation of a community owned open access network. After receiving a Community and Regional Economic Support program grant in the Fall 2018 intake of the program to complete a study supporting establishment of high-speed internet to rural communities within the County, the County began a phased roll out of a fibre network in partnership with Canadian Fiber Optics/Valo Networks Ltd. in 2019, though subsequently Canadian Fibre Optics has left the project. The County has to date received no financial support from higher levels of government for deployment, yet is still moving ahead to invest in infrastructure in the construction of a community owned end-to-end fibre network while contracting out all other operational services. Under the initial terms, the county would pay for and own the dark infrastructure and Valo would own and operate the lit infrastructure over a long contract term. The network will be a hybrid fibre/wireless one operated on an open-access basis. In May of 2022 the County is projecting by the end of the year to have spent a total of $18 million, and to have 1880 subscribers, with operational break even at 3000, and hopes for future expansion ideally aided by grant funding from the Universal Broadband Fund.

The proposed business model is as a Municipally Controlled Corporation. While it does require government approval for establishment, a MCC can exist as a separate legal entity from the County, and can borrow and incur debt servicing costs, as well as make and distribute to members a profit. Other aspects the County considered carefully in regards to governance models include operational autonomy, borrowing ability, legal powers, liabilities and risks, potential for long term expansion, ownership of assets, mandates, and relationships with partners and other stakeholders.

Vermilion

While many broadband initiatives seem to favour models of community owned open access networks that leave service provision to private companies, Vermilion, like Olds, is another example of a Town registering with the CRTC as its own ISP to combat the lack of private provider investment and interest in the area. The Town of Vermilion has shown serious interest in improving connectivity with specific points dating back to its 2018-2021 Strategic Plan on improving broadband quality in the community. 2020 saw these ambitions come to life, with a pilot project in partnership with Hook'd and Connect Mobility that worked to install fibre fed wireless units spaced throughout the community to provide improved speeds to local businesses.

Unfortunately, the Hook'd platform did not work out. When the town then started to evaluate a Hook'd approach, Digital Infrastructure Group became interested and the option to jointly fund a full Fibre to the Premises (FTTP) build became possible. The ribbon cutting ceremony took place in early November 2022. It will be an open access network with Primus being the initial/anchor ISP. The town will receive an ongoing share of the operation's net revenue.

Sturgeon County

2022 also saw Sturgeon County getting the Villeneuve area pilot project of their proposed phased Broadband Strategy off the ground. After years of struggling to access national funding under the Universal Broadband Fund due to service mapping that poorly reflects actual access and speeds, and with access to funding expected to become even more limited with provincial disbursement of funds under the Government of Alberta to be facilitated through the UBF application process, the County is partnering with Canadian Fibre Optics Corporation to install fibre to residents and businesses throughout the County.

As one of the first steps in developing a Broadband Strategy, Sturgeon County underwent a thorough consultation and engagement process with both the community and industry. This included business and resident surveys to confirm community support of the County's involvement in the project, as well as market research and sounding, connecting with ISPs, interested parties, and potential vendors, and careful contract negotiation to ensure viability.

With the initial ~$7.5 million County investment and additional $1 million from CFOC for phase one, residents and businesses along the Core Service Area will have the option of County funded extension of fibre, and the County notes that while it is not economically feasible for the County to provide service to every home, Extended Service Areas will have the option to extend fibre to their home or business on a cost-shared basis with the County.

The proposed ownership and business models for this network see Sturgeon County owning the fibre line, with the County and CFOC sharing risks and rewards; both parties will contribute financially to development and operation of the service, as well as share revenue. Initially, residents will have to sign up with Northern Lights Fiber (a division of CFOC) for service, with the aim of allowing other providers access to the network in the future.

Waterton

Waterton is a testament to the value of both the "dig once" approach, and to using local cooperation and resources. Waterton leveraged a Shared Services Canada project that upgraded water facilities throughout the Waterton townsite to deploy fibre to every premise in the town, allowing provision of both fibre and wi-fi internet services throughout the town and campsite. In tandem with a Parks Canada funded initiative requiring fibre connections to all Parks Canada offices, Telus fibre cables that reached the entrance of the park were extended to near the town, enabling backhaul linkage to Calgary through TELUS. The town partnered with Olds based O-Net as its service provider to deliver internet, telephone, and TV services.

Parkland County

Parkland County used provincial and federal grants to construct a wireless communications open access network of 20 towers, providing infrastructure for use by wireless internet service providers in return for rent to cover operating costs of the towers. The County's SMART Parkland initiative recognizes internet connectivity as key to promoting residential and employment growth within the area, and considers itself a leader in recognizing broadband as an essential utility.

In late 2021 SBA Communications Inc. purchased the tower assets from Parkland County, as the County felt that an independent, specialized organization could better manage and operate the existing infrastructure. The County's Municipal Development Plan mentions that the County will continue to promote and evolve the broadband network through the combination of tower and fibre expansions on an open access model, and has plans to include up to $8 million in the 2023 budget for Phase 1 of their broadband fibre strategy, with Council having carried a motion in 2022 to submit application to the Universal Broadband Fund for additional funding.

Calgary

Since 2001, The City of Calgary has deployed fibre not with the aim of providing Internet to residents and businesses, but for connectivity to support municipal services, a mentality that is applicable to communities both large and small elsewhere in the province. Often, councils will disprove of a municipal broadband infrastructure case when broadband is perceived as a retail service. Calgary's strategy was not about broadband, but about developing sustainable communications infrastructure for the delivery of next generation municipal services. The City is deploying fibre down almost every avenue downtown to enable traffic controllers and intelligent intersections, and leverages large infrastructure projects to install conduits when the roads are being built – reducing the costs and preserving the roads from being dug up in the future.

The City is also deploying fibre down major roads in greenfield communities and business parks to ensure City services can be delivered deep into the community while providing Network/Operator neutral fibre that is attractive for high tech businesses and the providers that serve them. The City has also licensed its fibre to other carriers to prevent duplicate overbuilds and reduce infrastructure costs to smaller ISPs.

This 650km fibre network reaches all quadrants of Calgary allowing The City to operate roughly 20 different networks for applications by water services, public transit, police, fire, parks, roads, etc. Isolating the networks on different fibres combats cyber security threats. The City of Calgary's aim is to have ownership control over their infrastructure in order to protect the public interest and effectively support municipal services in a cohesive manner, such as traffic camera footage that can be accessed for crime investigations. Users of the City's fibre network include Cybera, Calgary Public Library, the University of Calgary, businesses, and utilities.

No matter their size, government agencies need to think about outcomes such as delivering next-generation municipal services, building safe communities, and ensuring digital inclusion. Municipalities should recognize the importance of choice, competition and inclusion when evaluating connectivity models for their community. In Calgary, The City builds in excess capacity in its fibre infrastructure to enable SmartCity technologies and applications and The City is bringing together each business unit to discuss future utilization of these technologies.

Small Scale/Grassroots Solutions

Many of the recent and more prominent broadband initiatives involve large scale fibre projects with multi-million-dollar price tags. These kinds of high initial costs, as well as resource intensive application processes and prohibitively selective eligibility criteria of government funding programs can make improving connectivity feel like a pipe dream for smaller communities. Although perhaps not permanent or perfect solutions, several communities have come up with innovative, smaller scale, more immediately feasible remedies to improve local connectivity.

Viking

After struggling to access federal and provincial support and being quoted with out-of-reach costs from major telecommunications providers, the Town of Viking took the initiative in 2019 to establish their own municipal wireless broadband network to provide higher internet speeds and better service to the small community of around 1100 people. Through partnership with the Camrose-based company Nutec Electro Tel the Town has installed wireless equipment on a local grain elevator, later added a second broadcast site on a tower belonging to Enercapita Energy Ltd., and has its eye on six more towers in the area for future expansion.

The Town is registered with the CRTC as a service provider, and leverages an existing connection to the Alberta SuperNet coming in through the main town complex for backhaul and bandwidth. According to 2021 numbers, the Town spends around $800 per month on bandwidth and sees revenues of around $2500 per month, with $1000 of that going to Nutec Electro Tel, and the remainder staying within the Town. Using existing infrastructure, both in terms of buildings for hosting equipment and the SuperNet connection, as well as piggybacking off existing municipal utility billing systems has helped keep costs relatively low and provision relatively simple for the Town. This home-grown solution has helped save the town tens of thousands of dollars from the major telecom provider's quote, provided a new source of income for the town, and most importantly delivered immediate connectivity improvements for residents.

Maskwacis

The Community known as Maskwacis is made up of Four separate First Nation Bands. Ermineskin, Samson, Montana, and Louis Bull. All four have different levels of connectivity thanks to the efforts of leadership and funding through the Universal Broadband Fund.

Before Maskwacis was provided with funding each Nation worked with different organizations to get the very minimum of service. One organization was Mamawapowin Technology Society, a non-profit that worked to create a First Nations based solution.

MTS received funding and/or other support from ISOC (The Internet Society), IEEE (Advancing Humanity Through Tech), CIRA (Canadian Internet Registry Association), VortoVia, Accelerate Okanagan, Maskwacis Cultural College and individual donors. As an organization it made efforts to close the gaps in service in Samson and Ermineskin Cree Nations until its closure in 2022. Many contributors have gone into ensuring the legacy of MTS will go on.

Now, Smoke Signal Communications Inc. has replaced its predecessor to provide service and solutions to Maskwacis. It is expanding its service offering from Radio Frequency Wifi to include Fiber connections, VoIP, and looks to the future when a First Nations company will be able to provide Cell Phone services to all Nations. It is still the only 100% First Nations owned Telecommunications business in Maskwacis.

Co-op Models

Recent years have seen the mention of various innovative strategies to improve connectivity, including some communities looking at models for provision inspired by a co-operative structure. Co-operatives are generally made up of community members that collectively elect a board of directors and have say in the direction and activities of the co-operative. Focusing more strongly on member needs than shareholder priorities, co-op models can be a solution to enabling the long-term commitment needed to build reliable and sustainable networks that can often be disrupted by changing governments or private industry focus on short term shareholder payout.

Equis Connect

As a Rural Electrical Association (REA) serving 12,000 members in 26 Alberta MDs and Counties, Equs is the largest member-owned utility co-operative in Canada. With a view to use its resources to improve broadband services to rural communities across Alberta, it has established Equs Connect and partnered with Valo Networks. Under the current model, a community is required to cover 25% of the required capital, Equis Connect provides the remaining 75%, and Valo Networks provides engineering, Procurement and construction services as well as operations and management support ro establish a turn-key deployment. A synthetic co-op structure to house the assets that the community members eventually own and operate.

Cardston County

In the mid 2010's Cardston County was involved in the Alberta SouthWest Regional Alliance, a strategy involving a handful of surrounding Municipal Districts, Towns, and Villages aiming to improve regional connectivity. The County also took part in meetings with private companies such as Axia and Shaw to consider all options to find a solution to Cardston's high speed internet needs. When these relationships largely failed to materialize for Cardston, local community members formed the Southwest Connect Coop, and hope to leverage membership fees to fund laying of fibre cables of what will be a co-op owned network that allows private ISPs to provide services over the network for small access fees.

Foothills Fibre Cooperative

Incorporated in 2021 and still in early stages of development, Foothills Fibre Cooperative seeks to provide access to high-speed broadband communications services to rural areas west of Calgary. The co-op is envisioning an open access fibre network maintained and operated by a contracted Network Operator and supportive of increased service level competition, niche fixed wireless ISPs, and industrial users. A corporate model would focus on member return on investment and quality of service, as well as creating an investable entity attractive for government grants as well as community development focused external investors willing to make long term investments.

Challenges and Pitfalls in Broadband Planning

As your community works towards a broadband solution, a number of challenges and pitfalls can encumber the process. Below, the toolkit identifies several common challenges communities face as well as some mitigating strategies.

Lack of Community "Buy-In"/Defining the "Why"

Lack of buy-in from the community can arise for a number of reasons. There may be insufficient support from major stakeholders for a broadband implementation project, a project may lack a clear champion, or there may be communication challenges between leaders, champions, and residents. A successful project will require communities to have conversations around "why" they need broadband. When planning this work, involve a diversity of groups and individuals in discussions as early as possible.

Mitigating Actions

- Identifying businesses and community organizations and approaching them for their support in the project
- Identifying community leaders who can serve as champions for the project
- Preparing a proper strategic communication plan for how the project will be presented to the community
- Where possible, learn from and leverage the expertise of other communities in your area/across the province, and invite community experts to share their knowledge and experiences with your community

Achieving a Proper Needs Assessment

Determining what type of connectivity needs exist in a community is difficult. It can be particularly difficult to assess future needs of both residents and business. While it is clear that global demand for broadband will rise consistently, determining what kinds of future uses your community will require in the next 10-25 years can be particularly challenging.

Mitigating Actions

- Develop awareness of emerging trends in broadband usage, in particular the Internet of Things (IoT)
- Consult with residents and businesses about future uses
- Make use of outside expertise – an RFP for a needs assessment and feasibility study is an essential part of a successful broadband solution
- Champions and community leaders should stay engaged on emerging trends, which can be done through attendance at relevant conferences (e.g., Alberta Rural Connectivity Forum) and/or through monitoring information sources such as Broadband Communities magazine (see: http://www.bbpmag.com/).

Implementation Costs

Cost can be a key barrier for any broadband project. It is certainly easy to envision a community where every household and business has a fibre connection. However, after a feasibility study the cost may be beyond what a community can afford. As a point of reference, in Olds the cost of fibre deployment totalled $13 million in that rural community of roughly 8,200 people.

Mitigating Actions

- Use best practices such as a 'dig once' policy (described below) to defray costs over time
- Examine opportunities for regional partnerships – it may be the case that as demand is aggregated over a larger geographic area and population base costs become more manageable
- Stay aware of granting opportunities whether federal (Infrastructure Canada or ISED) or provincial
- Seek guidance and expertise from other communities about how to manage implementation costs
- Consider setting up revenue streams such as leasing community-owned infrastructure to third-party providers, or partnering with an ISP to sell internet service
- Consider partnering with an ISP during implementation

Escalating/Unplanned Additional Costs Because of Inflation and Supply Chain Issues

The global surge in broadband investment driven in response to the Covid-19 pandemic along with supply chain challenges and inflation has resulted in many key inputs, such as fibre optic cables, costing more and resulting in orders that are taking longer to fill. In some cases, materials may not be available for 18 to 24 months after order.

Mitigating Actions

- Where possible, develop relationships with suppliers to avoid unexpected instances where lead times are overly long
- Use capital cost structures to structure payments to reduce costs - paying up front for materials may result in lower costs than paying upon delivery if prices cannot be locked in
- Partner with other communities to aggregate orders or leverage buying power to obtain better prices
- Examine options to sourcing materials broadly, and speak to those who've undertaken similar, previous builds to determine where cost-effective vendors may be found

Competition or Uncooperative ISP

While partnering with an ISP can be an effective way to reduce costs, it also reduces community control over broadband assets and limits the potential for revenue streams that can come from locally-owned and/or operated infrastructure. However, it is also important to be mindful of fine print in contracts. In some cases, sunset clauses in agreements with ISPs may result in ownership of the infrastructure reverting to the ISP after a certain term (e.g., after 10 years).

Mitigating Actions

- See if other communities in your region have partnered with ISPs and contact them to see what the experience was like and what advice they have
- Have a dedicated staff person, ideally within the local government, who can act as be a primary point of contact with the ISP
- Connect with technical experts and other communities to exchange information about regulatory and policy issues, legal agreements and undertakings, and contract limitations and term lengths

- Remember that your community holds many valuable assets that benefit third-party ISPs, such as customers (residents), rights-of-way and granting opportunities associated with municipal governments. Identify these assets and use them in your negotiations
- Consider the long-term impacts of contract terms – how will the partnership address future needs? Will the contract allow for increased local ownership and/or management of infrastructure over time?

Remember that infrastructure is only one element of an overall broadband solution. If your community decides to develop/deploy infrastructure (towers or fibre) you will still need an ISP to provide service to residents and businesses (unless your community also wants to start an ISP, which several communities in Alberta, such as Olds and Waterton Lakes, have opted to do). The type of infrastructure technology you choose will shape which ISPs can and want to provide services over your infrastructure.

These represent some common challenges communities face in developing a broadband solution. In many cases proper planning can help mitigate these issues and make broadband more achievable over time. The next section addresses broadband best practices.

Broadband Best Practices

In developing a broadband solution there are a number of steps a community can take to either mitigate costs over the long term, or strategically deploy and develop infrastructure assets that support the solutions that meet future as well as current needs.

Dig Once

- Adopt a "dig once" policy whereby fibre conduits are installed any time other municipal infrastructure (road, water and sewer) projects are undertaken
- Dig once policies can reduce the cost of future fibre deployments by as much as 90% in those sections.
- Adding fibre conduits as part of another construction project results in cost increases of just a few cents for every dollar spent
- Dig once policies can also be coordinated with building codes and development plans so that fibre is put in place in new communities and business parks
- Dig once policies have been used in many countries with a track record of cost reductions

Aerial Fibre Deployment

- To defray the cost of trenched fibre, consider aerial deployments (such as on utility poles). Remember to include the pole rent cost in your feasibility study.)
- Depending on ownership and existing contracts it may be possible to coordinate the use of existing utility poles for aerial fibre
- Where possible ensure that deployment of new utility poles includes space for future attachments including fibre lines

Fibre Fed Towers

- Towers used for fixed wireless still require a connection back to the community POP
- Fibre fed towers are more expensive to build than microwave backhaul, however they do not suffer the same issues around capacity and line of sight. They also have other advantages (as discussed in the Technology section)
- Fibre fed towers also put in place fibre infrastructure that can be used for future fibre deployments

Transition Planning

- If a full fibre deployment is too expensive, consider using a combination of the above strategies along with municipal strategic planning to develop a transition strategy whereby fixed wireless is used in the short term with a longer-term goal of deploying fibre

Protect Your Assets

- A fibre optic network will continue to evolve past the initial build as the uptake rate grows and the community develops. Good, current records of the interconnections on the fibre optic network is essential to maintaining the value of that investment
- Fibre networks will require upgrades to the electronics that send signals through the fibre optic cables
- Wireless networks also require ongoing upgrades to the radio equipment

Demand Aggregation

- When planning for community broadband engage in exercises to determine demand – even if you partner with an ISP, they may require some evidence of demand within the community
- Demand aggregation can serve as a way of engaging the community – you can even have neighbourhoods hold friendly competitions to see where demand (and therefore first deployed service) is greatest
- Depending on the size and scope of the deployment consider using demand aggregation software
- Software is available to assist and enhance this activity. One vendor is COS Systems (http://www.cossystems.com/)

Thinking and Working Regionally

- Always consider what neighbouring communities and regions are doing
- A choice of a specific type of broadband solution in one community may have impacts on its neighbours – how can communities collaborate on a regional basis?
- Regional coordination on broadband best practices (dig once, demand aggregation) may result in cost savings over the long term

Planning Broadband

Action Plan - Environmental Scanning and Steps

With an understanding of the various broadband technologies, the policy environment, the economics of broadband, and best practices and pitfalls, developing an action plan is the next step. The following section of the toolkit addresses two key elements in achieving a broadband solution – conducting an environmental scan and a series of action plan steps to achieve a broadband solution.

Environmental Scanning

Environmental scanning involves collecting and analyzing information to identify potential issues, trends, factors and challenges that may have impact on an organization and its functioning. Environmental scanning becomes even more relevant when there is complexity and uncertainty in the environment by helping mitigate challenges and better plan and manage the future. Environmental scanning involves investigating key trends and issues in different areas as relevant to broadband and they are:

1. Geographical - The examples of key trends and issues to investigate in scanning geographical landscape that are relevant for broadband include:

- Distance to POP/availability of backhaul/connection to YYCIX
- Density and geographical spread
- Topology and line of site, climate (fixed wireless solutions)
- Trenching considerations (fibre solutions)

2. Community and Socio-cultural - The examples of key trends and issues to investigate in scanning community and social-cultural landscape that are relevant for broadband include:

- Community demographics and trends (aging in place, youth retention, family attraction)
- Attitude toward community/municipal ownership (history of cooperatives)
- Cultural nuances - attitudes towards bootstrapping
- Local priorities
- Community engagement

3. Regulatory - The examples of key trends and issues to investigate in scanning the regulatory landscape that are relevant for broadband include:

- ISED broadband programs (e.g., "Connecting Communities" and "Connecting Canadians")
- CRTC decision on wholesale access (CRTC Telecom Policy 2015-326)
- CRTC review of basic telecommunication services (CRTC 2015-134)
- SuperNet
- Economic Development and Trade (AB) Broadband Preparedness Studies
- Other federal/provincial policies
- Municipal governance, rights of ways and bylaws

4. Economic - The examples of key trends and issues to investigate in scanning the economic landscape that are relevant for broadband include:

- Employment patterns/major employers and industry
- Diversification
- Considering small business use/advantages
- Financials including local municipal budget, funding support, grants, amortization models, willingness to pay

5. Technology - The examples of key trends and issues to investigate in scanning the technology landscape that are relevant for broadband include:

- Existing broadband infrastructure and service providers (especially existing dark fibre)
- Backhaul to YYCIX or YEGIX
- Asset Mapping
- Potential uses/demands of broadband
- Both current and future technology trends

6. Partnership and Competition - The examples of key trends and issues to investigate in scanning the partnership and competition landscape that are relevant for broadband include:

- Thinking and looking regionally - what are other communities doing; how can we work together
- Existing service providers (within and outside) - partnering with ISPs
- SuperNet
- Negotiating with ISPs/ previous best practices

7. Human Resource - The examples of key trends and issues to investigate in scanning the human resource landscape that are relevant for broadband include:

- Identifying expertise in different areas relevant for broadband projects such as financial, technical, policy and planning, administration, and community outreach
- Determine areas of internal knowledge and capacity and areas for seeking expertise from external sources

Steps for Developing a Community Based Broadband Solution

The following section provides a roadmap for achieving a community broadband solution that is broken down into eight steps. While these actions are provided in a step-by-step order, it is important to note that they are not necessarily discrete or linear, and can occur at the same time. For example, step five, Community Engagement, can begin at the outset. Therefore, think of this road map as a flexible tool to support planning, rather than a fixed plan.

1. Create Cross-Functional Team

- Mobilize broadband champions within the community
- Build cross functional team with requisite skills (e.g., financial, technical, policy/planning and community champions)

2. Scanning and Assessment

- Community Needs Assessment (consider both current and future needs)
- Asset Mapping. Are there community organizations or infrastructure in the community that can be leveraged to reduce costs? A Rural Electrical Authority (REA) may have poles for an aerial build. A Gas Co-op has expertise and equipment to put cables in the ground. Abandoned pipelines may offer benefit

- Identify best practices (e.g., dig once)
- Learn from other communities (local and abroad)
- Policy and Regulatory scanning and assessment (both internal and external)
- Socio-cultural assessment (internal)
- Economic assessment (current and future) (internal and external)
- Competition and Partnership (internal and external)
- Geographical assessment (internal)
- Human resources (internal and external (outside experts/consultants))
- Technological assessment (both current and future)
- RFP for Feasibility study

3. Create Vision

- Cross functional team generates vision for broadband solution within community
- Consider potential linkages with neighbouring communities/broadband initiatives

4. Planning Processes

- Timelines (with goals) and costs;
- Identify key responsibilities and roles;
- Choosing connection type;
- Selection of business and ownership/governance models;
- RFPs for feasibility assessment

5. Community Engagement

- Buy in, promotion;
- Town hall meetings
- Surveys/focus groups
- Consider take-rate - demand aggregation

6a. Internal Implementation

- RFP Review and Evaluation
- Identify financial resources;
- Internal approvals (bylaws and permits (rights of way))
- Transition strategies (e.g., for FWA to Fibre (over time))

6b. External Implementation

- Acquiring materials,
- Engaging w/ external partners;
- Grants and financing;
- Policy and regulatory considerations and clearances

7. Roll-Out Roadmap

- Construction planning and scheduling
- Testing
- Service provision

8. Feedback, Evaluation and Improvement

- Obtain feedback
- Enhance services
- Plan for future

Alberta Broadband Toolkit Design History and Consultations

In 2022 it was recognized that *Understanding Community Broadband* still had value for communities across the province, but an update of the material was required. With the support of the Rural Development Network, the University of Alberta led a process to redesign the toolkit. To help ensure the material reflected the current context, members of the Alberta Rural Connectivity Coalition and other leading broadband experts from the province helped review the material.

The original toolkit was developed to help communities across Alberta start or further conversations about broadband. As part of the design process Economic Development and Trade, in conjunction with Drs. McMahon and McNally from the University of Alberta, conducted a series of workshop consultations in June and July of 2016. During 8 workshops, participants from all regions of the province provided insights on how the toolkit could be most effectively designed and discussed key content to highlight.

One of the key questions that was asked of participants in the consultation workshops was what kind of comparison or analogies they thought were most appropriate for broadband. Repeatedly broadband was compared to other essential infrastructure - electricity, phone lines, water and sewers - and one person went so far as to compare the information providing ability of the internet to the importance of having a set of eyeballs.

We want to acknowledge and thank all workshop participants for their time and insights.

Glossary and Acronyms

5G	Fifth generation technology for wireless (or mobile) broadband networks
Aerial Deployments	Deployment of cables using above ground utility poles
ARPU	Average Revenue Per User
Asymmetrical	Used to describe situations where upload and download speeds are not the same. For example, a 50 Mbps download / 10 Mbps upload connection would be asymmetrical.
Backhaul	Connection providing the link between your community local network and larger network. Backhaul networks are also sometimes called backbone or transport networks
Bandwidth	The capacity of an internet connection, usually measured in megabits per second (or Mbps). For example, a connection of 50 Mbps download can download a maximum of 50 megabits per second.
Broadband	An always-on, high-capacity digital data transmission service. It is provided through different network technologies, including fibre optic cables, wireless towers, satellites, and mobile cellular phone services
Brownfield	Development in an area with existing infrastructure/facilities
BSO	Basic Service Objectives

CAT (CAT scan)	Computerized Axial Tomography
CCTS	Commission for Complaints for Telecom-television Services
CIRA	Canadian Internet Registration Authority
Closed Network	A network that is not provisioned on a non-discriminatory/ transparent basis. Includes proprietary networks.
Coaxial Cable	Cable used for TV networks and now broadband networks. Offers faster speeds than copper cables but slower than fibre optic cable.
Copper	Cable used for telephone networks and now used for broadband (DSL). The slowest of wired connection types.
CPI	Centre for Public Involvement
CRTC	Canadian Radio-television and Telecommunications Commission
Dark Fibre	Fibre optic cable that does not have a signal passing through it. Fibre is 'dark' because there are no electronics at the ends of the cables putting a signal through
Dig Once	A policy mechanism that requires the construction of conduit for fibre cables when other construction is undertaken. Note that dig once involves the construction of conduits; however, the actual fibre cable may not be deployed in the conduit at the time of construction

DOCSIS	Data Over Cable Service Interface Specification
Download Speed	Speed at which data transfers from the internet (down) to a device. Usually measured in Mbps.
DSL	Digital Subscriber Line
DTH	Direct to Home
Fibre / Fibre Optic	Cable used for broadband networks. Offers the fastest connection speeds and symmetrical connections.
Fibre-to-the-Home (FTTH)	A last mile connection where fibre is deployed all the way to customer premises (including homes, business and institutions)
Fibre-to-the-Node (FTTN)	A last mile connection where fibre is deployed to a local telecommunications cabinet, but the final connection to customer premises is made using coaxial or copper cable
FTTH/B/P	Fibre-to-the-home/business/premises
FTTN	Fibre-to-the-node
FWA	Fixed Wireless Access. Refers to wireless connections where the receiving connection is fixed (e.g., a home/business).
Gbps	Gigabits Per Second

Greenfield	Development in an area without existing infrastructure/ facilities (new development)
HSPA	High Speed Packet Access
ICT	Information and Communication Technology(ies)
IoT	Internet of Things
IRU	Indefeasible Rights of Use
ISED	Innovation, Science and Economic Development
ISP	Internet Service Provider
ITU	International Telecommunications Union
IX	Internet Exchange. An internet exchange is a place where networks can connect to the broader, global internet.
Kbps	Kilobits Per Second
Last Mile	The final portion of the infrastructure that deliver telephone/ broadband services to end-users (e.g., individual households and businesses)
Latency	The amount of delay in sending information, measured in milliseconds.
LED	Light Emitting Diode

LEO / LEO Satellite	Low Earth Orbiting Satellites
Lit Fibre	Fibre optic cable that has a signal (light) passing through it. Lit fibre requires electronics at both ends of the fibre.
Local Network	A network in a community that connects homes, businesses, and other institutions. A local network must be connected to backhaul/a transport network to have provide an internet connection
LTE	Long Term Evolution
M2M	Machine-to-Machine (communication)
Mbps	Megabits Per Second
MCC	Municipally Controlled Corporation
Middle Mile Connectivity	Connectivity between internet exchanges and points of distribution (e.g., Meet-me-facilities or Points of Presence)
MMFs	Meet-me-facilities
Mobile Wireless	Formal/technical name for cellular/cell phone networks
MOOC	Massive Online Open Course
MVNO	Mobile Virtual Network Operator

OECD	Organisation for Economic Cooperation and Development
OFL	Olds Fibre Ltd.
OIRCD	Olds Institute for Regional and Community Development
POP	Point of Presence
REA	Rural Electrical Authority
REDAs	Regional Economic Development Alliances
RFP	Request for Proposal
Spectrum	Spectrum, or more formally the radio spectrum, is a portion of the electromagnetic spectrum used for sending wireless communications of all kinds
SuperNet	An Alberta fibre optic and wireless network connecting over 4,200 schools, hospitals, government and municipal offices in 429 communities.
Symmetrical	Used to describe situations where upload and download speeds are the same. For example, a 50 Mbps download / 50 Mbps upload connection would be symmetrical.
Take Rate	The number of subscribers (measured as a percentage) that have subscribed to a service

Terrestrial Geostationary Satellite	Older satellite communication systems based on high orbiting satellites. Associate with very slow speeds and performance issues.
Trenched Fibre	Fibre deployed through underground conduits
TSP	Telecommunications Service Provider
UBF	Universal Broadband Fund
UHD	Ultra High Definition
Upload Speed	Speed at which data transfers (up) from a device to the internet. Usually measured in Mbps.
Wholesale Basis/Services	Wholesale services are distinct from retail services. Wholesale services are regulated by the CRTC
Wireless	Refers to networks making use of spectrum. Includes Fixed Wireless Access, mobile wireless and satellite connections
Wireline	Refers to networks making use of wires/cables. Includes copper, coaxial cable and fibre-optic connections
WISP	Wireless Internet Service Provider
Terrestrial Geostationary Satellite	Older satellite communication systems based on high orbiting satellites. Associate with very slow speeds and performance issues.
VOIP	Voice Over Internet Protocol

YEGIX	Edmonton Internet Exchange
YYCIX	Calgary Internet Exchange

Further Resources

Note on sources: This list of further resources includes many materials that were used in the 2016 Toolkit, some of which are no longer available. For resources no longer available on the internet, website links have been removed.

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