Review of Alternatives for Rural High Speed Internet

Department of Business

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Building a better working world

NOVA SCOTIA

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1.0 Executive summary

The Province of Nova Scotia ("PNS" or "Province") launched the Broadband for Rural Nova Scotia ("BRNS") project in 2007 to address the lack of access to broadband internet service. The BRNS project made thousands of connections across the province, but in 2016, some Nova Scotians remain without service, or with service that does not meet the demands of current internet use. Given the rate of change of technology innovation since 2007, the Province deemed that it was an appropriate time to assess the current state of rural broadband service in Nova Scotia.

The objective of this undertaking was to investigate worldwide leading practices, the current technology options available, the potential roles that the Province could consider taking to support rural broadband deployment and to consider appropriate speed goals.

In order to identify worldwide leading practices, a broad global jurisdictional scan of both national and sub national rural broadband initiatives was undertaken. The findings from the analysis highlight that a variance between rural and urban areas' broadband access and speeds in Nova Scotia are common across both Canada and many other parts of the world. In many rural areas, broadband customers face connectivity challenges, higher costs and lower average speeds. Also notable is that a significant barrier to providing rural broadband service is an economic one and the investments required to implement, maintain and effectively upgrade networks is substantial.

For example, in rural United States, an upgrade to the Kentucky "Middle-Mile" fibre network, which would involve similar distances to that of rural Nova Scotia, required an investment of $325M USD excluding the cost of upgrading the "Last Mile" which itself could represent a multiple of the middle-mile investment. The time needed to deploy the middle mile network is also considerable. The Kentucky wired network started in 2015 and has estimated completion dates into 2018. Given the low-population density and lower broadband adoption rates as compared to urban centers, investments in rural broadband networks may not be feasible, with or without, economic support.

An analysis of current technology options indicated there are three available to provide fixed internet services to rural areas. Fixed wireless, wired (cable and fibre), and satellite. The wired fibre technology offers the greatest speed and longest lifespan, however it is the most costly option to implement and therefore could be challenging to deploy to all of Nova Scotia. A viable alternative may be satellite technology. Offering reasonable speeds with the ability to grow over time, it provides an alternative for the more remote or harder to reach areas of the province.

Research was also undertaken to understand the relationship between internet accessibility and bandwidth requirements and the current trends in consumer, business and government digital adoption and innovation.

A significant challenge faced by the majority of the population is that the term "Broadband" is continually evolving. In 2007, BRNS adopted the definition of broadband service as being "1.5Mbps download speed". Given the state and availability of the technology at that time this seems appropriate. However since that time, with the advancement of technology, the proliferation of services and applications that require significant bandwidth (i.e. video) and the ever increasing expectations of broadband customers in general, the definition of broadband speed has meaningfully evolved. The Canadian broadband speed goal, set by the CRTC, has increased to 5Mbps for download speeds, and in 2015, the US Federal Communications

Commission voted to change the minimum required download speed to 25 Mbps for any internet service to be defined as “broadband”. Consumers and businesses are consuming greater amounts of data and driving demand for high-bandwidth internet connections.

The review of the current state in Nova Scotia suggests that the reliability and speed of broadband solutions could be negatively affecting social and economic opportunities for residents in rural communities. In areas that lack reliable broadband service access, possible impacts may include; decreased home values, limited opportunity to access online educational resources, challenges in recruiting and retaining employees within rural areas and challenges accessing government services via electronic channels.

Increasing the availability and accessibility of broadband service within Nova Scotia will likely mean that broadband solution deployment will take various forms in different communities and the initiatives will require the participation and collaboration of private sector companies, municipalities, community based cooperatives and various levels of governments.

We recommend that the Province could consider taking an active role in engaging and coordinating local, municipal, federal, and business stakeholders to establish aspirational broadband goals.The province could consider the following actions:

- Development of provincial goals for broadband access;
- Coordination of Municipal, and Community based initiatives that would advance progress toward provincial broadband goals;
- Development of a community based solution evaluation framework;
- Coordination of provincial telecommunication procurement, and infrastructure investment activities, to advance the deployment of broadband technologies.

Market forces alone will not ensure that rural communities have access to the educational and economic benefits that broadband internet services can provide. Solutions should be sustainable over the long term and therefore require a strategic approach to development and deployment. The Province and other levels of government will need to consider playing an active role in assuring rural communities’ access to sustainable broadband internet services.

2.0 Introduction

The Province of Nova Scotia ("PNS" or "Province") launched the Broadband for Rural Nova Scotia ("BRNS") project in 2007 to address the lack of access to broadband internet service to approximately 93,500 Nova Scotian homes and businesses (civic addresses). Significant progress has been made since that time, and estimates indicate that only approximately 1,000 customers across eight counties remain unserved. This number primarily reflects rural citizens living in affected regions who self-identified as not having had broadband access in 2010; however, the actual number of unserved homes and businesses remains indeterminate and may be somewhat higher. In addition, there is also a segment of the currently serviced population in rural regions who are served today but who may be experiencing challenges with the quality and the speed of the service that is currently offered.

EY was engaged by the Nova Scotia Department of Business to assist with identifying the barriers and challenges affecting the availability of broadband services in rural Nova Scotia, and to identify potential roles that the Province could play to contribute to an increase in access to high performing broadband Internet services in rural Nova Scotia.

This project was undertaken in order to;

- Develop an understanding of broadband speed requirements
- Appreciate the barriers to providing broadband to rural customers
- Identify potential service providers,
- Identify potential stakeholder partnerships,
- Identify some of the possible technical solutions that could address the needs of the rural population
- Highlight potential roles for government to support rural broadband deployment

The project team performed a quantitative and qualitative analysis of potential private sector and community led solutions options. This analysis included the following:

- A jurisdictional scan of rural broadband solution approaches used in other provinces and countries
- Technical solution considerations
- Interviews with interested vendors and solutions providers

Based on this, a series of potential next steps have been established taking into consideration rural broadband speed targets, the barriers to providing high-speed broadband in rural areas, and the potential actions that the Province may want to consider in support of increasing rural broadband access.

3.0 Broadband definition and technologies

Definition of broadband

Broadband is a term used interchangeably to define both broadband networks and broadband Internet. In general, broadband refers to telecommunication in which a wide band of frequencies is available to transmit information. Because a wide band of frequencies is available, information can be multiplexed and sent on many different frequencies or channels within the band concurrently, allowing more information to be transmitted in a given amount of time[1] (much like having more lanes on a highway allows for more cars to travel on it at the same time). In the context of Internet access, the term broadband, in lay terms, has come to mean - always on, fast Internet access. Customers perceive broadband as “high-speed” network access.

For broadband internet customers, two elements contribute to what they perceive as the speed of a network:

1. **Bandwidth**. Bandwidth is the capacity of the network connection. Typically, higher network bandwidth translates to improved performance, although overall performance also depends on other factors. Higher bandwidth means faster perceived speed.

2. **Latency**. Latency refers to various delays incurred in moving data across a network. Excessive latency creates bottlenecks that prevent data from filling the network pipe. When this occurs the effective bandwidth decreases. This results in slower speed.

These two terms are important when broadband technologies are considered. Some technology alternatives have greater bandwidth availability and can provide greater speed. Other technology alternatives have inherent latency issues, which may not meet customer needs.

There are five major technologies used to provide access to broadband.

- Fibre
- DSL/Cable Modem
- Mobile
- Fixed Wireless
- Satellite

Each of these technologies options has advantages and disadvantages when considered for rural broadband service delivery.

Fibre

Fibre solutions are a method of transmitting information from one place to another by sending pulses of light through an optical fibre. Thin glass pipes known as fibre optic cables carry signals transmitted using waves of light. Fibre technology is generally regarded as the successor to DSL broadband solutions that phone carriers provide.

Fibre to the cabinet (FTTC) and fibre to the home (FTTH) are the two main methods of fibre broadband deployment in Nova Scotia. Current fibre services on the market offer speeds

1 Best Business Practices for Global Competitiveness, Dr. Prashant Salwan, 2007

ranging from 100/50 Mbps to 950/100 Mbps. It should be noted that FibreOP is a marketing brand used by BellAliant for their fibre to the home solution. It is not an industry term.

Fibre is considered the gold standard in broadband technology to the home because of its capability to transmit data at high speeds over long distances.

Pros	Cons
► Bandwidth capacity/speed. ► Long lifespan. ► Service reliability. ► Size and weight of the cable. ► Ability to access more services (TV, Phone, Internet, more).	► Cost per home. ► Physical constraints (glass wire).

DSL/Cable Modem

DSL and Cable Modems are one of the original technologies used to provide high-speed Internet access. They had their start in the 1990s and has since evolved into a very stable and capable platform. DSL/Cable modem uses existing copper telephone or cable coax wiring deployed to most homes. Deployment of network terminals in local neighborhoods enables broadband speeds. The terminals shorten the distance from the subscriber to the central office, enabling higher speed delivery over copper wires. The neighborhood terminals are typically connected by T1, T3 or Fibre based connections, which are connected back to the provider's main method of delivering broadband. Achievable bandwidth is typically limited by the distance the home is from the neighborhood terminal.

Pros	Cons
► Availability. ► Cost per home. ► Service reliability.	► Performance (distance-based issues). ► Speed (Current available services in Nova Scotia advertise speeds up to 7 Mbps downstream).

Mobile

Mobile broadband is the term for wireless Internet access through a portable modem, mobile phone, USB wireless modem, tablet or other mobile devices. Delivery of this type of broadband is enabled by the mobile (cellular) phone network. Nova Scotia currently has a mix of 3G and 4G networks. The "G" is short for generation, so 3G and 4G represent the third and fourth generations of mobile broadband Internet. Performance speed varies by operator, 4G networks average download speeds of 18/9 Mbps, while 3G networks average 3.5/1 Mbps[2].

Pros	Cons
► Mobility. ► Service reliability.	► Package pricing is high for primary internet use.

2 Open Signal, www.opensignal.com

	► Limited to areas with cellular network coverage.

Fixed Wireless

Fixed wireless broadband is technology that provides high-speed wireless Internet access over a wide area. With this technology, broadband capacity is delivered through radio waves. A small transmitter in your local area broadcasts wireless signals that are picked up by a small antenna on your house, which channels the signal to a router or connection point inside the house. Developments in fixed wireless access are concentrated on WiMax (Worldwide Interoperability for Microwave Access) technology. WiMax technology is currently technically capable of speeds up to 75 Mbps, but in practice, the speed performance varies based on the way the network is engineered, and the equipment utilized. In Nova Scotia, commercially available services based on this technology advertise speeds of 1.5/.5 Mbps. Latency and over subscription are the most common issues affecting the speed of fixed wireless solutions.

Pros	Cons
► Cost per home.	► Connection affected by adverse weather and foliage. ► Limited by line-of-sight access to tower. ► Latency.

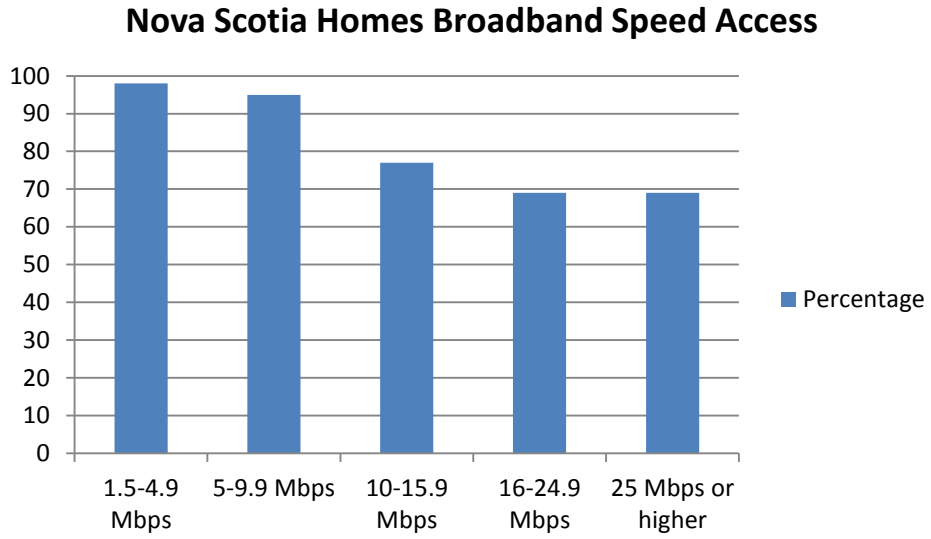
Satellite

Satellite Broadband is Internet connectivity provided via satellite avoiding the use of telephone landlines, cables or other fixed wire means. Satellites in orbit around the earth deliver broadband service via a satellite dish on the customer's premises. The capability of current satellite broadband service available to Nova Scotia is around 10/1 Mbps. Next generation satellite technologies could potentially deliver speeds of 25 Mbps. Satellite connections have both high bandwidth and high latency. The latency is due to network requests having to travel at the speed of light to a distant satellite and back to earth. Once the data arrives back on earth via the home satellite dish, data is transmitted with similar premise based wiring solutions to cable, DSL, or FTTH services. Satellite broadband internet is not considered optimal for services such as online gaming, VoIP or VPN connections due to the latency. Satellite transmission has inherent delays due to the transmission distances involved; however, once a connection is established, services requiring large volumes of downstream data transfers perform well (e.g. video streaming).

Pros	Cons
► Globally accessible.	► Connection affected by adverse weather. ► Latency.

4.0 Current situation in Nova Scotia

The CRTC is the federal regulator responsible for setting speed targets for broadband internet access across Canada. Their data indicates that 99% of Nova Scotians have access to internet speeds of at least 1.5 Mbps, the consultation with community groups and review social media sites suggests that numerous service issues exist and are being reported.



Sources: Industry Canada and CRTC data collection; Digital Canada 150

Based on input received from rural communities, they have cited a number of challenges, real or perceived, resulting from lack of broadband service, including:

- Difficulty in establishing internet connections with existing provider services,
- Extremely slow download speeds relative to advertised speeds,
- Unreliable internet connections.

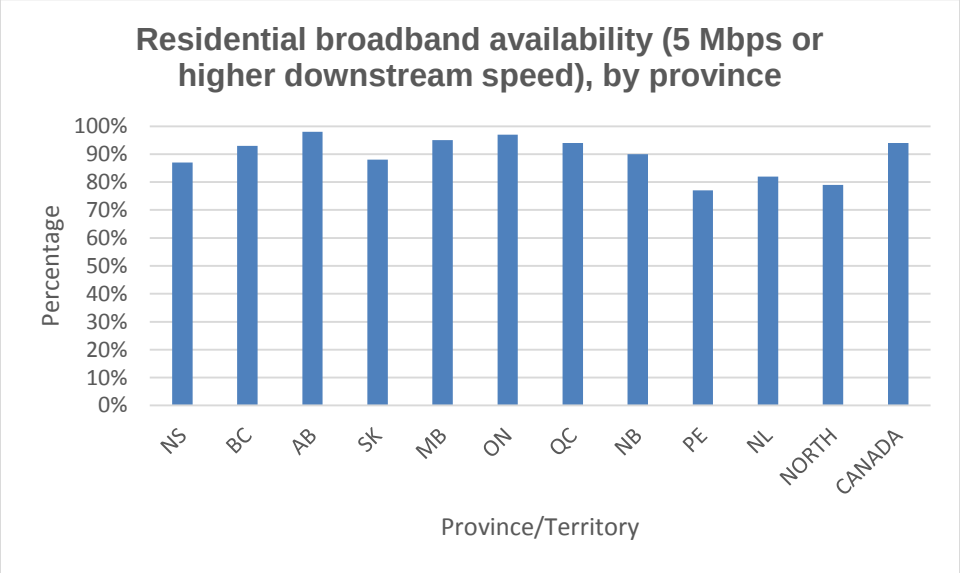
These service issues are having an economic and social impact on citizens. The following comments were received during the consultation/review process:

- Business is experiencing loss of staff, and facing challenges attracting staff due to quality of life issues. Business noted the inability to work from home due to lack of internet connection as a concern.
- The lack of high-speed internet options for tourists is considered detrimental to attracting and retaining tourists in rural regions. Customers expect high-speed connection options when camping and exploring tourism attractions.
- Inability to develop land purchased due to lack of broadband internet services.
- Additional costs incurred to send staff to internet connected areas to complete business tasks (e.g. Mandatory internet based lottery training).
- Additional costs incurred for hard copy (printed documents, creating and mailing DVD's) because download speed and reliability were inconsistent.

- Impediment to starting home businesses due to the inability to participate in on-line e-commerce supply chain activities.
- Negative educational impacts for K-12 and post-secondary students. The lack of high-speed internet access is placing rural students at a disadvantage relative to their urban peers.

By the end of 2015, the CRTC expected all Canadians to have access to broadband speeds of at least 5 Mbps downstream and 1 Mbps upstream. Based on CRTC and Industry Canada data collected in 2014, eighty-seven percent of Nova Scotian houses have access to internet download speeds of 5 Mbps or more (excluding satellite services).

Some areas of rural Nova Scotia that were provided access with 1.5 Mbps internet services under the BRNS program are being upgraded to the CRTC 5 Mbps speed target under the Canada 150 program. However, some areas of the Province with the 1.5 Mbps technologies do not have any clarity with respect to an upgrade path to higher speeds in the future.



Sources: Industry Canada and CRTC data collection; Digital Canada 150

Compared to other Canadian Provinces, Nova Scotia compares reasonably well when considering Industry Canada's 5 Mbps speed standard. When looking beyond Canada, regions such as the US and EU have much higher broadband speed targets. A deeper investigation of broadband internet speed availability in Nova Scotia demonstrates that approximately 15-20% of homes lack access to download speeds of 10 Mbps or more. These thresholds are important to note, if we are to compare Nova Scotia against US and EU aspirational speed standards.

In March 2016, the CRTC released the "Broadband Survey" results from a national representative, and opt-in survey. The results demonstrate the rural and urban broadband divide and some unique attributes of the Atlantic Canadian internet market. The survey results

indicate that Atlantic Canadians have the highest usage of fibre for home internet services at a level of double or more than most regions in Canada. In addition, the adoption of satellite services in Atlantic Canada are lower than other regions.

Type of Home Internet Service for Key Segments (Representative and Open)

	Representative Survey (n=1,488)					Open Survey (n=27,152)				
	Telephone Line (DSL)	Cable	Satellite	Fibre Optic	Fixed Wire-less	Telephone Line (DSL)	Cable	Satellite	Fibre Optic	Fixed Wire-less
Overall	20%	42%	5%	17%	8%	25%	45%	8%	9%	6%
Urban/Rural										
Urban	17%	48%	2%	19%	7%	23%	56%	3%	10%	3%
Rural	33%	18%	19%	8%	12%	29%	17%	20%	4%	15%
Region										
British Columbia	21%	51%	5%	12%	7%	25%	57%	5%	5%	3%
Alberta	18%	36%	9%	10%	15%	24%	49%	6%	8%	7%
Saskatchewan & Manitoba	24%	35%	2%	13%	13%	38%	30%	8%	7%	9%
Ontario	20%	46%	5%	13%	8%	26%	47%	6%	6%	6%
Quebec	13%	47%	3%	25%	3%	20%	45%	11%	11%	5%
Atlantic	18%	23%	3%	44%	6%	25%	24%	8%	21%	13%
Territories	48%	24%	20%	0%	6%	33%	35%	18%	1%	3

Note: Survey response percentages may not add up to 100% because respondents that answered the survey with the responses: ‘mobile wireless’, ‘other’, ‘don’t know’ or did not respond, were not provided in the CRTC data.

5.0 Broadband Speed Considerations

Defining Nova Scotia broadband goals

The Nova Scotia Government may wish to consider establishing broadband speed goals for the Province. To do so, a number of broadband speed goals from other jurisdictions and anticipated growth in network usage may provide useful context.

A review of numerous national broadband initiatives and their speed objectives was undertaken as part of the jurisdictional scan. National regulators set speed targets, but it is also important for the Province to consider global competitive factors as they assess their broadband strategy. Findings indicate that numerous countries are currently establishing broadband speed goals higher than Canada. In particular, many European countries, and the United States are targeting broadband speed goals in the range of 25-100Mbps. Factors such as this could be an important consideration for global businesses looking to establish or relocate existing company operations.

Industry Canada goals – Connecting Canadians

Connecting Canadians is a federal government initiative with an objective to provide high-speed Internet services to as many Canadian households as possible. Once the Connecting Canadians program is completed in 2019, coupled with investment from the private sector, Industry Canada anticipates that 98% of Canadian households will have access to high-speed Internet at speeds of at least 5 Mbps.

The Connecting Canadians program aims to provide broadband access to approximately 280,000 Canadian households that previously did not have access to high-speed Internet at 5 Mbps.

For the purposes of Connecting Canadians, the high-speed Internet gap is the gap between those areas of Canada that have access to high-speed Internet connectivity at 5 Mbps and those that do not. For Nunavut and the Nunavik region of northern Quebec, the gap is determined by those areas that have access to high-speed Internet connectivity at 3 Mbps.

In the spring and summer of 2014, Industry Canada conducted an extensive mapping exercise to update its data on the current state of high-speed Internet connectivity across Canada. The information received from provincial and territorial governments, Internet service providers and Canadian citizens was used to define the geographic areas that do not have access to service at 5 Mbps (rural component). This mapping data has been placed into a Tableau format and provided to the Province as part of the current review.

United States Federal Communications Commission (FCC)

In 2015, the FCC, tasked with overseeing the rules that govern the Internet, raised the standard for broadband to 25 Mbps from 4 Mbps, while raising the upload speed to 3 Mbps from 1 Mbps. (https://www.fcc.gov/reports-research/reports/broadband-progress-reports/2015-broadband-progress-report)

The change to their broadband standard occurred after publishing their 2015 Broadband Progress Report. The agency's report found that 55 million Americans, or 17 percent of the population, lack access to advanced broadband services. The bulk of Americans who do not have access to such speeds are in rural areas. The report indicated that 53 percent of rural Americans lack broadband with download speeds of 25 Mbps. This is compared to 8 percent of Americans living in urban areas. The report also indicates that 20 percent of rural Americans do not have access to the previous standard of 4 Mbps downloads.

In the January 2016 progress update, the FCC reported that 39 percent of rural Americans (23 million people) lack access to 25 Mbps/3 Mbps broadband services. That represents a 26% improvement since the last report. When this number is broken down to broadband services via fixed terrestrial infrastructure like fibre, cable, DSL, etc., the rural areas lag far behind urban centres. Twenty percent of rural Americans lack access to service even at 4 Mbps/1 Mbps, down only 1 percent from 2011, and 31 percent lack access to 10 Mbps/1 Mbps, down only 4 percent from 2011. The report concluded, “The FCC will continue working to accelerate broadband deployment and to remove barriers to infrastructure investment, in part by direct subsidies, and in part by identifying and helping to reduce potential obstacles to deployment, competition, and adoption.” The progress on speed made to date is indicative of the magnitude of the challenge of providing broadband service to rural regions.

Broadband Trends

When considering the development of aspirational targets that will guide the deployment of future broadband access and services, it is very important that appropriate consideration be given to the evolving consumer and business behavior with respect to the usage of internet services. Based on the technology changes that have taken place since the Province last set broadband targets, the demand for internet speeds continue to increase. This created an additional challenge for service providers of rural broadband networks.

This observation results from a review of consumer, government and business application trends, which provide insights into the bandwidth requirements that rural customers, may require in the future. No distinction has been made between internet usages of urban or rural citizens.

The following table demonstrates the estimated bandwidth requirements to enable consumer, government, and business services.

Application	Download Speeds	Upload Speeds
► Basic email ► Voice over IP ► YouTube Video	786 kbps – 1.5 Mbps	256 kbps – 896 kbps
► Remote surveillance ► Telecommuting ► Streaming Music ► Standard Definition Video	1.5 Mbps – 3Mbps	356 kbps – 1 Mbps
► Internet protocol television (IPTV) ► File sharing (small/medium files)	3 Mbps – 6 Mbps	356 kbps – 1 Mbps
► Video on demand ► Remote diagnosis (basic) ► Online gaming	6 Mbps – 10 Mbps	768 kbps – 2 Mbps
► IPTV high definition (HD) ► Telemedicine ► Remote education	10 Mbps – 25 Mbps	2 Mbps – 5 Mbps
► HD Video surveillance ► Smart/intelligent building control ► Educational services	25 Mbps – 50 Mbps	5 Mbps – 10 Mbps
► Video conferencing ► Multiple educational services ► Research applications ► Remote super computing	50 Mbps – 100 Mbps	10 Mbps – 25 Mbps
► Real-time data collection ► Real-time medical image consultation	>100 Mbps	>100 Mbps

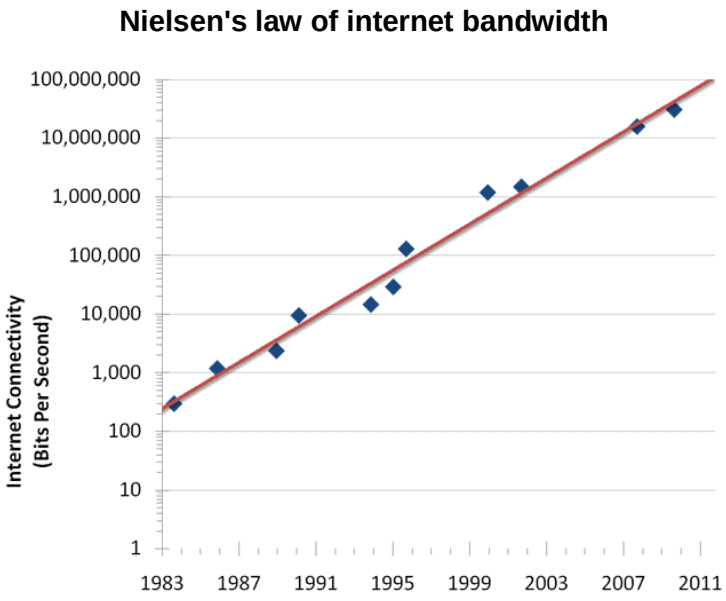
Source: 2013 Broadband in Maine Update

Consumer broadband trends have been driven by dramatic technological changes that have taken place in the delivery of video services over the internet. Trends such as 'cord-cutting' (canceling or forgoing a cable television subscription or landline phone connection in favor of an alternative Internet-based or wireless service), and new ultra high-definition standards will continue to drive consumer bandwidth demands.

Businesses continue to increase their trends of having customers service themselves through electronic channels, and continue to increase their supply chain integration by integrating systems and real-time communications with suppliers. Businesses increasingly subscribe to "Cloud" based services to gain access to software that improves the competitiveness of their business. Cloud based services require broadband connections. Rural businesses with global markets will require the same level of connectivity to compete effectively.

Finally, the government, in an effort to improve the effectiveness and efficiency of service delivery continues to expand healthcare, educational, and general services over internet based channels, which requires effective connections and bandwidth to access them.

This increase in internet traffic is further supported by Nielsen's Law of Internet Bandwidth that states that the average consumer bandwidth grows by 50% per year with a compounded growth of 57x over ten years[3]. This law is supported by actual internet bandwidth data from 1983 to 2014, as seen in the figure below.



Source: Neilson Norman Group; Growth in internet connectivity from 1984 to 2014 plotted against Nielsen's Law growth curve

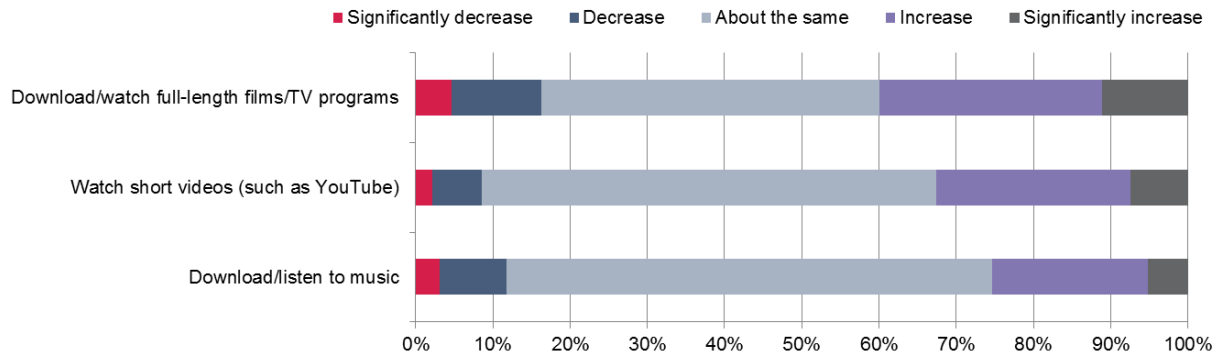
3 Nielsen, J. (2014). Nielsen's Law of Internet Bandwidth. Nielsen Norman Group. Retrieved from https://www.nngroup.com/articles/law-of-bandwidth/

The BRNS speed objectives of 2007 were directly in line with the projected growth curve at that time. The growth in network bandwidth demand that we have subsequently experienced continues to track well against this model's predictions. This represents a challenge for rural areas where the population density, and the corresponding potential subscriber base, do not necessarily support an economic model for network providers to upgrade services to maintain pace with higher bandwidth demands.

Consumer broadband trends

Canadians lead the world in internet usage having the most web pages visited per month (3,731 pages) and are a close second to the United States for the average number of hours spent online (41.3 per month)[4]. Between 2012 and 2013, the top activities Canadians accessed the internet for were gaming, social media, general browsing, banking, hobbies/interests and news. Videophone services, such as Skype and FaceTime, have also emerged as one of the fastest growing reasons for using the Internet[5].

Canada is also the second highest ranked country in average monthly hours of video consumption, with each viewer watching on average 291 videos per month, totaling 24.8 hours of viewing[6]. In Nova Scotia alone, 19% of the population subscribed to Netflix in 2014 and overall subscribers to streaming services are expected to rise dramatically as more services become available[7]. Globally, the predictions indicate that 40% of broadband users expect their streaming activities to increase over 2016, with 12% predicting the increase to be significant[8].

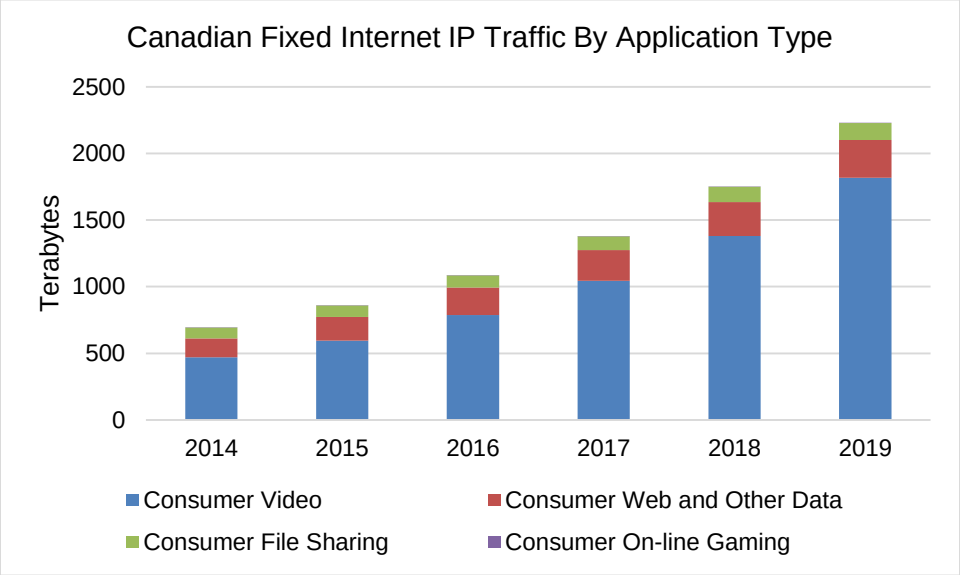


Source: Ovum; Usage expectations of popular digital media applications over 2016

Historically, the downstream growth rate has been around 1.5 times per year and as new applications continue to be developed, it is only natural to expect that this growth will continue. In the year 2000, broadband growth was driven by the increase in web surfing, followed by the rise of peer-to-peer networking growth in 2008 and it is now driven by internet protocol video (IP

4 Canadian Internet Registration Authority. (2014). The 2014 CIRA Factbook: The Canadian Internet. Retrieved from https://cira.ca/factbook/2014/the-canadian-internet.html
5 Canadian Internet Registration Authority (2014)
6 Canadian Internet Registration Authority (2014)
7 Canadian Internet Registration Authority (2014)
8 Philpott, M. (2016). 2016 Trends to Watch: Connected Home. Ovum.

video)[9]. This type of video, which includes internet video, IP video on demand (IP VoD), video files exchanged through file sharing, video-streamed gaming and videoconferencing, will continue to be in the range of 80 to 90 percent of total IP traffic[10]. It is also important to note that the steady stream of traffic that the internet has historically seen will likely change due to the dramatic traffic pattern change related to the growth of IP video traffic[11].



Source: Cisco; VNI, Feb 2016

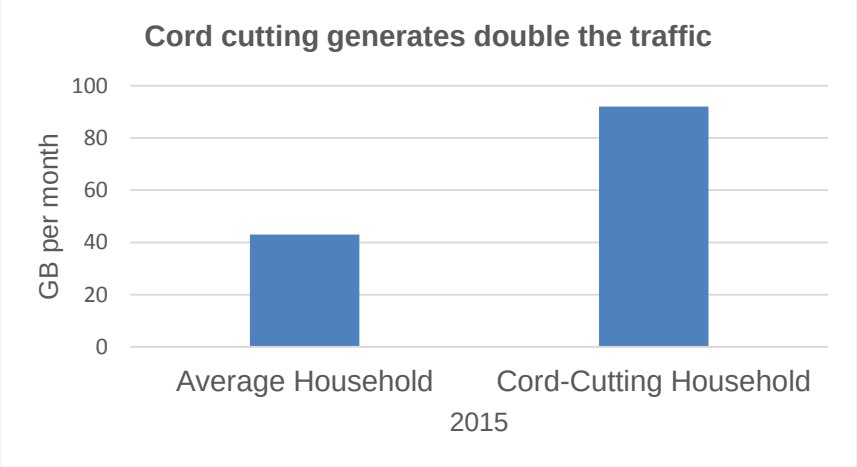
It is also important to note that yearly broadband growth could be larger as computer technology is doubling in capability every 18 months while the infrastructure needed to support this speed of growth is lacking[12]. Adaption of technology by consumers is most rapid when the mechanisms for its use are available; therefore, broadband speed is a crucial enabler for IP traffic.

Growth in video consumption over IP networks is driving the greatest increase in bandwidth requirements. This trend will continue with the adoption 4K or Ultra-High-Definition (UHD) streaming, as 0.2 % of the population globally were using the technology in 2014 and it is predicted to grow to 21% by 2019[13]. These traffic and bandwidth requirements will have a dramatic effect on internet traffic, as the bit rate for 4K video is about 18 Mbps, which is more than double the bit rate for HD video and nine times more than the bit rate for standard definition video[14].

9 Cloonan, T. (2011). Bandwidth Trends on the Internet… A Cable Data Vendor's Perspective. Arris. Retrieved from http://www.ieee802.org/3/ad_hoc/bwa/public/sep11/cloonan_01a_0911.pdf
10 Cisco. (2015). The Zettabyte Era- Trends and Analysis. Retrieved from http://www.cisco.com/c/en/us/solutions/collateral/service-provider/visual-networking-index-vni/VNI_Hyperconnectivity_WP.html
11 Cisco (2015)
12 Cisco (2015)
13 Cisco (2015)
14 Cisco (2015)

Entertainment media is also evolving into more streamed programming. Increasingly, consumers are cancelling their subscription television services in favor of streaming content over broadband internet connections[15]. Usage data collected by Cisco demonstrate that as broadband speeds increase in each country covered in the study, the number of internet video minutes per viewer also increases.

In 2015, this resulted in an average increase of 2.14 times more GB usage per household. A key driver of increased usage are the number of video connected devices in each household. Rather than watching one television, each individual is streaming content to smart TV's, tablets, and computers simultaneously.



Consumer internet usage is also increasing due to the gaining popularity of online education. Online education is increasing in popularity in rural communities, as educational institutions are not always in close proximity. As industries, businesses and other workplaces look for more educated and trained employees, an increasing number of people are turning to online education to become more employable or to maintain their professional status[16]. Consumers that are attending educational instructions are also depending upon the internet to help with their studies and management of school administration.

Although connection speed enables technology use, Statistics Canada found that speed of connection alone was insufficient in explaining the range of internet usage activities that individuals were engaging in. Instead, users with a low connection speed were engaging in the same types of internet activities as those with higher speeds, although to a lesser extent due to connectivity limitations[17].

All trends indicate that consumer demand for network bandwidth is rapidly increasing, and will continue to increase, as new services become available.

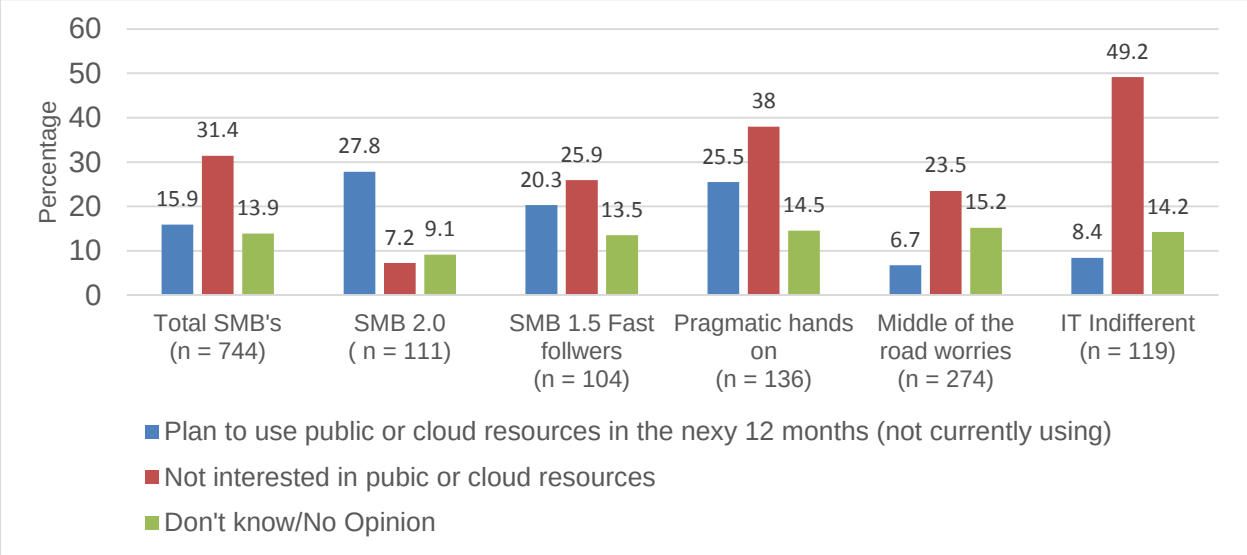
15 Cisco (2015)
16 Alberta Association of Municipal Districts and Counties. (n.d.). Post-secondary Education in Rural Alberta. Retrieved from http://www.google.ca/url?sa=t&rct=j&q=&esrc=s&source=web&cd=5&ved=0ahUKEwidtY_U4rvKAhVMMyYKHTPuAjoQFgg6MAQ&url=http%3A%2F%2Fwww.aamdc.com%2Fdocman%2Faamdc-issue-briefings%2F1384-post-secondary-education-in-rural-alberta&usg=AFQjCNG4DqqBG-287bcqEieLkNW3XJ4UTg&sig2=fGQeCYR6TSwxuuDbCw1q7w
17 Statistics Canada. (2008). Understanding Internet Usage among Broadband Households: A Study of Household Internet Use Survey Data. Government of Canada. Retrieved from: http://www.statcan.gc.ca/pub/88f0006x/2008003/part-partie1-eng.htm

Business broadband trends

Information and communication technologies that require broadband are being utilized by businesses for a wide range of activities including internal business systems, business-to-business communication, research activities, and business to consumer electronic commerce. Forty-five percent of all Canadian businesses and 41.1 percent of all small Canadian businesses have a website, which is on par with American statistics[18].

Businesses are turning to external "Cloud" based business systems to help manage documents, human resources, customer relationships and other internal processes. These systems support efficiencies in communication and collaboration among employees. This allows managers to streamline operations reducing costs and increasing speed of development. Data surveys of Canadian Small Medium Businesses (SMB's) use of cloud based services is limited; however, a 2014 IDC survey of US SMB's demonstrated that over 25% of early adopters (SMB 2.0) and one fifth of SMB fast followers (those who adopt technology after the initial innovation adoption by early adopters) were planning to adopt Cloud based services in 2015. It is safe to assume Canadian SMB's will follow similar adoption trends as US based peers.

U.S. SMB Planned Use of Cloud Resources by Cluster, 2014



Source: Source: IDC, SMB Cluster Analysis: IT Spending, Cloud Engagement, and Online Promotion/eCommerce, #US40635915

18 Canada Business Network. (2015). Using Technology in your daily operations. Government of Canada. Retrieved from: http://www.canadabusiness.ca/eng/page/2768/

Electronic commerce through business-to-business, business to consumer or internet marketing is becoming a way of life for businesses. Increased productivity and savings are resulting from deploying of business systems that work together to share information and interactions. More businesses are turning to e-marketplaces to expand their reach to new customers in a variety of locations and an increased number are relying solely on online marketplaces to sell their goods and services instead of brick and mortar locations[19.] This is specifically important for rural entrepreneurs who may not be in close proximity to the population needed to support their business, but have skills and services that can be sold through ecommerce. Ecommerce sales by Canadian businesses were valued at $7.7 billion in 2012[20] and ecommerce spending in Canada was valued at $21.1 billion. This gap between sales and spending highlights the large opportunity for online businesses, as online spending is only predicted to increase.

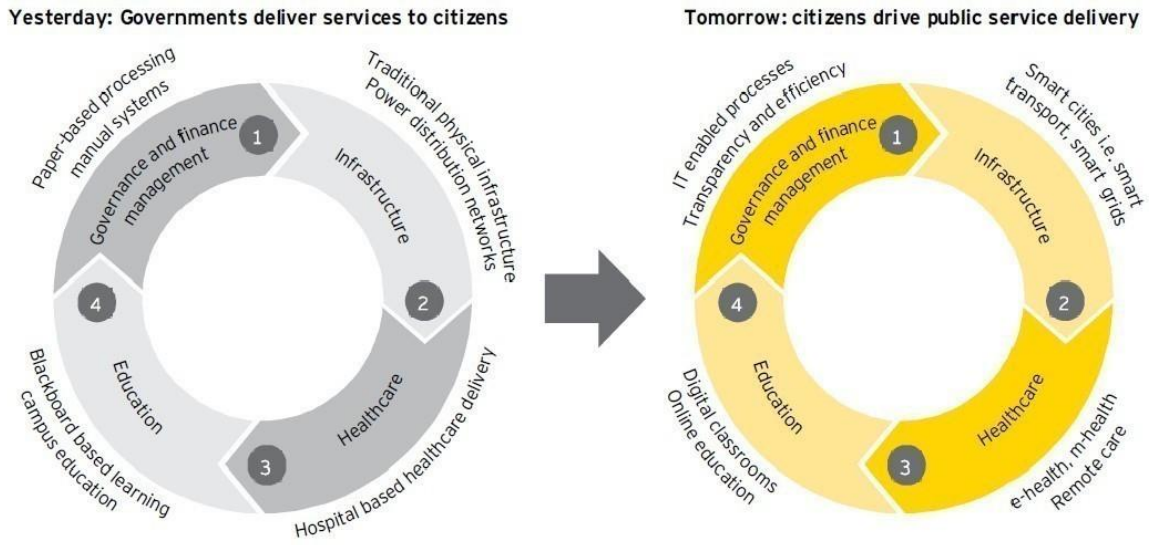
Commercial activity is increasingly dependent on broadband networks as well. Broadband networks are critical enablers to Nova Scotia's efforts to foster economic growth in sectors such as financial services, digital media, and information communications technology (ICT). Widely available broadband services could serve as an enabler for all regions of Nova Scotia to participate in the benefits of these economic development efforts.

The requirement for broadband internet connectivity varies by business type and need. Some businesses require symmetrical internet connections, with the same download and upload speeds, while others require the typical connection used by most residential internet consumers. Overall, most users are still downloading more information than uploading to the internet[21], but some businesses are regularly uploading large files or more frequently uploading files, such as when using shared sites for collaborating, where symmetrical traffic is needed[22].

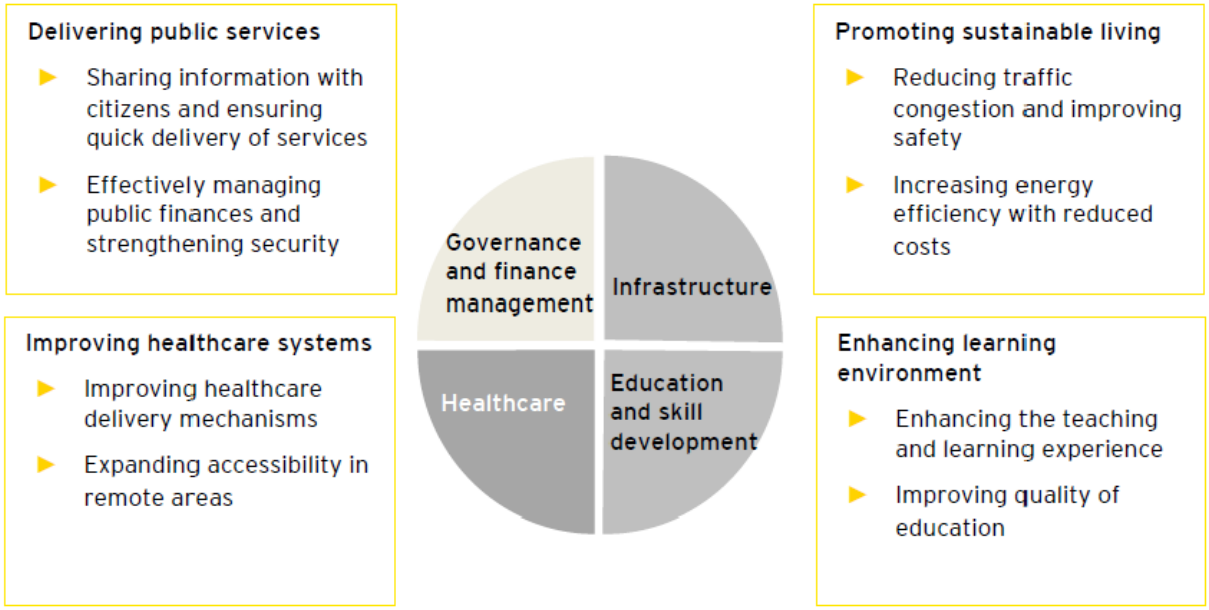
Government broadband trends

The fast changing technology landscape has made it necessary for governments to leverage social media, mobility, analytics, the cloud and the internet of things (SMACi technologies) in order to create and nurture an effective and efficient ecosystem[23]. Governments' ability to incorporate information and communication technology into its operations helps to generate sustainable public value. Within governments, digital transformation is specifically being seen in the areas of governance and finance management, healthcare, infrastructure and education and skill development.

19 Canada Business Network. (2015).
20 Statistics Canada. (2014). Retail at a glance: E-commerce sales, 2012. Government of Canada. Retrieved from http://www.statcan.gc.ca/daily-quotidien/140708/dq140708b-eng.htm
21 Pesovic, A. (2012). Is Symmetrical Bandwidth a Myth or a Must? Techzine. Retrieved from https://techzine.alcatel-lucent.com/symmetrical-bandwidth-myth-or-must
22 TDS Business. (n.d.). The Ins and Outs of High Speed Internet Access. Retrieved from: http://www.tdsbusiness.com/Resources/white-papers-the-ins-and-outs-of-high-speed-internet-access.pdf
23 EY. (2015, Feb). Imagining the Digital future. How digital themes are transforming companies across industries.



Source: EY; Technologies impact on the change in delivery of government services



Source: EY; Areas of digital transformation across the government/public sector

Digital technologies are transforming government service delivery. Governments will have to continue to modernize their operations to achieve greater efficiency in this area and embrace emerging technologies that enable public finance management procedures to be more transparent and efficient.

The Internet of Things (IOT) and smart infrastructure has the potential to revolutionize the management of resources for a sustainable future. Advances in sensor technologies are changing the manner by which we manage water and waste, agriculture, public transportation and other government related services. Broadband network services will be part of the fabric required to knit these solutions together.

Citizens are more engaged on social media, changing the way they communicate, interact and mobilize, making it important for governments to ensure they are responsive. Innovative governments are moving away from specialized agencies and discrete services towards more streamlined, citizen-centric processes and big data is being used to enhance and improve operational efficiencies and services.

The Nova Scotia government currently has numerous services available via digital channels. Businesses can renew and pay for licenses and permits online. Individuals can change their addresses, apply for birth, marriage and death certificates, renew their vehicle permits, pay motor vehicle fines and tickets and make payments for various provincially monitored services. Government provides courses for high school students through The Nova Scotia Virtual School and Professional Communities of Practice provides online support for professional development.

The drive for greater government efficiency and broad availability of services over digital channels will continue to drive the need for all citizens to have high-speed internet access. Broadband networks will increase the quality of the service experience and increase adoption rates of the government's digital services.

Broadband and healthcare

The combination of broadband networks and health IT is expected to transform health care with better outcomes and lower costs[24]. Nova Scotia has numerous examples of leveraging technology to improve the access to health services. The majority of these innovations require broadband networks.

Some examples of healthcare solutions that will drive network requirements are:

Telehealth - through video conferencing communication, Nova Scotia has become a well-established Canadian leader in delivering innovative healthcare resulting in improved access for patients, families and healthcare professionals.

Healthcare professionals are also adopting electronic medical records (EMR). The technology allows them to better track health data over time, identify patients who are due for preventative visits or screening, monitor how patients compare to guidelines and improve overall quality of care[25]. One of the main goals of deploying the technology provincially is the ability to put patient's records online throughout the province[26]. Full adoption of this technology would require health professionals to have broadband access.

Broadband and education

Technology and the internet are transforming education by improving learning through distance education, digital simulations and models, storytelling and multimedia, e-books and gaming. Unesco has identified that deploying broadband throughout communities enables fair access to education[27]. Internet access allows students to have access to teachers worldwide and enables educators to better assess how individual students learn so that teaching techniques can be tailored specifically to their needs. The internet can also be an effective way to increase

24 Broadband.gov. (n.d.). Broadband & Health Care. National Broadband Plan, Connecting America. Retrieved from http://www.broadband.gov/issues/healthcare.html
25 HealthIT.gov. (2014). What is an Electronic Medical Record (EMR)? Retrieved from https://www.healthit.gov/providers-professionals/electronic-medical-records-emr
26 Tunney, C. (2015). Electronic medical record use halted in Nova Scotia hospitals. CBCNews. Retrieved from http://www.cbc.ca/news/canada/nova-scotia/electronic-medical-record-use-halted-in-nova-scotia-hospitals-1.3168769
27 International Telecommunications Union & United Nations Education, Scientific and Cultural Organization. (2013). Technology, Broadband and Education: Advancing the Education for All Agenda. Retrieved from http://unesdoc.unesco.org/images/0021/002196/219687e.pdf

education for students while limiting costs to parents and leveling the playing field of education such as through online tutoring programs. Nova Scotia is leveraging internet-based solutions such as PowerSchool to improve communications between students, teachers, and guardians. Education can no longer be separated from technology, as participation in the global economy is increasingly dependent on skills developed by navigating the digital world.

Broadband networks have the potential to radically alter the educational landscape, extend access to distance learning programs in outlying communities and help smaller regions maintain high-performing students who can help benefit their communities by serving as local entrepreneurs, researchers and policy-makers. This is demonstrated by a recent request for proposal from the Province of Nova Scotia requesting a mathematics support program delivered through an online tutoring platform and homework support service. A learning model like this can be extended to professionals who need continuing education to maintain their professional license or in situations where they seek additional education to maintain or grow their businesses. Broadband access allows education to penetrate communities helping them to thrive[28].

Canadians have demonstrated broad adoption of internet technologies in support of their educational activities. In the recent 2016 CRTC "Let's Talk Broadband Findings Report", forty-six percent of Canadians in the representative survey (65% of Canadians in the open survey) indicated that, in the last twelve months, they have used internet services to access formal education, training, and/or to complete homework. Rural Canadians identified broadband internet as critical to their ability to access educational opportunities, access professional improvement opportunities and to obtain information to support studies.

The OneNS report identified the quality and quantity of Nova Scotia's workforce as a key factors affecting long-term growth. Rural broadband infrastructure could be an important tool in linking the 43% of rural Nova Scotians identified in the OneNS report "as in many ways an underutilized human resource" access to education and employment opportunities.

The internet of things

As people become more connected to and through the internet so are physical objects through embedded electronics, software, sensors and network connectivity which allows them to collect and exchange data to help us make more informed decisions; the internet of things.

As an example, the importance of broadband within rural communities has been highlighted as a way to help farmers progress with advancements in agriculture[29]. Currently, technology is revolutionizing the agriculture industry by helping overcome many of its traditional challenges. For instance, crop sensors can tell farmers precisely what amounts of fertilizers and pesticides are needed, which can be delivered to machines that automatically dispense the correct amount. Sensors placed within soil can also provide data for more efficient irrigation and sensors embedded in equipment can deliver real time data to farmers so they are aware of maintenance needs before vital equipment breaks down. As agriculture becomes a more data-driven industry, access to fast and reliable internet will become more and more important.

28 Procurement Services- Public Tenders Office. (2016). Request for Proposal: Mathematics Online Tutoring Platform and Homework Support Services. Province of Nova Scotia. Retrieved from https://novascotia.ca/tenders/tenders/tender-details.aspx?id=60149239
29 Long, C. (2015). Agriculture: Fertile Ground for the Internet of Things. Governing: The States and Localities. Retrieved from: http://www.governing.com/gov-institute/voices/col-agriculture-internet-things-sensors-automation-rural-broadband.html

The Internet of Things is also being used in health care to improve access to care, increase quality of care and reduce the costs of care[30]. Patients can be monitored remotely through wireless devices that deliver patient data to medical professionals who can then make appropriate health recommendations. For patients, this can reduce the requirement (and cost) to travel to hospitals and potentially enable effective remote treatment of chronic health conditions thus reducing some of the financial strain on the healthcare system itself. Early intervention and prevention is also possible though connected devices. For example, monitoring devices can help seniors stay in their homes longer by detecting falls or other interruptions in their everyday routine and report it to emergency services in order to respond in a timely manner.

Beyond agriculture and health, the Internet of Things can also be used to protect the environment through monitoring air and water quality, monitoring infrastructure from bridges to railway tracks, monitoring wind farms and helping to manage energy consumption by allowing devices to communicate directly to utility supply companies in order to effectively balance power generation and usage.

Aspirational speed targets

According to CRTC data, Nova Scotia ranks as one of the leading provinces with 99% availability of 1.5-4.9 Mbps internet services to the residents. While this metric is something Nova Scotia can and should be proud of, the continual evolution and advancement of technology combined with user demands and behavior requires a concerted effort to strive for higher speed and availability of broadband services.

Nova Scotia comparison against other provinces based on speed availability

	1.5-4.9 Mbps	5-9.9 Mbps	10-15.9 Mbps	16-24.9 Mbps	25 Mbps or higher
Nova Scotia Rank	Tie 1st	10th	5th	Tie 4th	6th

As the chart above indicates, Nova Scotia can become the leading Canadian province in terms of 25 Mbps access or higher by increasing the availability from 81% to 90% of Nova Scotia homes.

Trends in consumer behaviour add support to furthering growth in access to speed levels of 25Mbps or higher. Based on the table of residential internet packages below it can be noted that subscriptions of 9 Mbps or less service packages have been decreasing since 2010. Most growth has occurred in subscription speeds greater than 16 Mbps, and the trends to speeds greater than 50 Mbps have become apparent.

30 Niewolny, D. (2013). White Paper: How the Internet of Things is Revolutionizing Healthcare. Freescale Semiconductor Inc. Retrieved from: https://cache.freescale.com/files/corporate/doc/white_paper/IOTREVHEALCARWP.pdf

Residential Internet service one-month subscriber distribution (%), by advertised download speed - CRTC

Advertised download speed	2010	2011	2012	2013	2014
Lite and wideband up to 256 Kbps	0.3	0.4	0.3	0.3	0.2
Wideband 300 to 1400 Kbps	5.8	4.3	2.9	2.7	1.9
Broadband					
1.5 to 4 Mbps	24.2	24.6	18.2	7.3	3.7
5 to 9 Mbps	45.3	45.6	41.3	32.8	26.9
10 to 15 Mbps	22.4	15.6	10.1	25.6	25.6
16 Mbps and higher	2	9.5	27.2	31.4	41.6
16 to 49 Mbps	1.8	9.2	23.5	26.3	31.9
50 Mbps and higher	0.2	0.3	3.6	5	9.8
Total sample	**8,983.10**	**9,440.30**	**9,761.10**	**9,970.10**	**10,345.10**

All factors in the analysis indicate an ever-increasing demand for bandwidth. Based on the analysis the province should consider working towards aspirational internet speed goals for rural and urban internet access at speeds greater than the CRTC goal of 5 Mbps.

The province could consider establishing two measures to measure and track rural broadband access:

1. Speed – Targets for internet broadband speeds for rural Nova Scotia.
2. Availability – The percentage of homes with the ability to subscribe to the internet service.

The province should revisit and evaluate these goals every 2 years. As demonstrated by the growth of bandwidth demand since the rural broadband speed of 1.5 Mbps was established, technology and usage trends need to be monitored to ensure that the strategy is adapted on a regular basis. Consideration should be given to measuring these parameters for both urban and rural internet subscribers to enable different service strategies for each stakeholder group.

6.0 Economic factors

Broadband and economic development

Many social and economic benefits have been linked to having access to broadband. These include, but are not limited to, access to employment and education opportunities, e-commerce, facilitated communication with municipal, provincial and federal governments and improved access to health care[31]. Broadband networks are a relatively recent innovation and the socio-economic trends related to the impact of these services has yet to be fully documented. As described earlier in the report, broadband networks are fundamental infrastructure for industries like ICT and Digital Media. These industries are open to contracting small companies, leveraging remote workforces and independent contractors. Broadband networks are an enabler for these type of remote work arrangements and therefore the lack of adequate broadband services does represent an obstacle for some people in some regions who could otherwise benefit from such an opportunity.

Even though the types of activities the internet is used for remain the same with varying speeds of connectivity, socioeconomic effects of higher broadband speeds are realizable simply given that greater bandwidth and higher speeds results in a greater transmission of information. Within the Organization for Economic Cooperation and Development (OECD) countries, it was also found that gaining access to 4 Mbps broadband increased household income by $2,100 USD per year and upgrading broadband from 0.5 Mbps to 4 Mbps increased income by around $322 USD per month[32]. Overall several key drivers of household income are believed to be linked to internet access speed including increased personal productivity, access to flexible work arrangements, a larger amount of advanced household businesses and increased education levels ultimately making individuals more successful at their chosen career paths[33].

Real estate values

Research indicates that access to broadband connectivity may also increase property values. Within the United States during the period of 2011 to 2013, single-family homes in areas where gigabit fibre service was available were found to have a median value of 3.1% higher than homes without fibre. Fibre optic connections were found to add up to $5,437 to the price of a $175,000 home and even when gigabit service was not available, home values got a 1.8% increase when a local network operator deployed fibre infrastructure capable of supporting speeds of at least 100 Mbps[34]. Research in this area is new and the impact of broadband on the Canadian market has yet to be investigated but non-empirical evidence presented by the Nova Scotia Realtors Association indicates that lack of high-speed internet access is not only affecting the value of homes in the province, it is actually preventing homes from being sold.

31 Statistics Canada (2008)
32 Broadband Communities. (2013). Economic Development: How Broadband Boosts Household Income. Retrieved from http://www.bbcmag.com/2013mags/november/BBC_Nov13_HouseholdIncome.pdf
33 Ericsson, Little, A.D & Chalmers University of Technology (2013)
34 Fibre to the Home Council. (2015). Study Shows Home Values Up 3.1% with Access to Fibre. Retrieved from: http://www.ftthcouncil.org/blog/study-shows-home-values-up-3.1-with-access-to-fibre

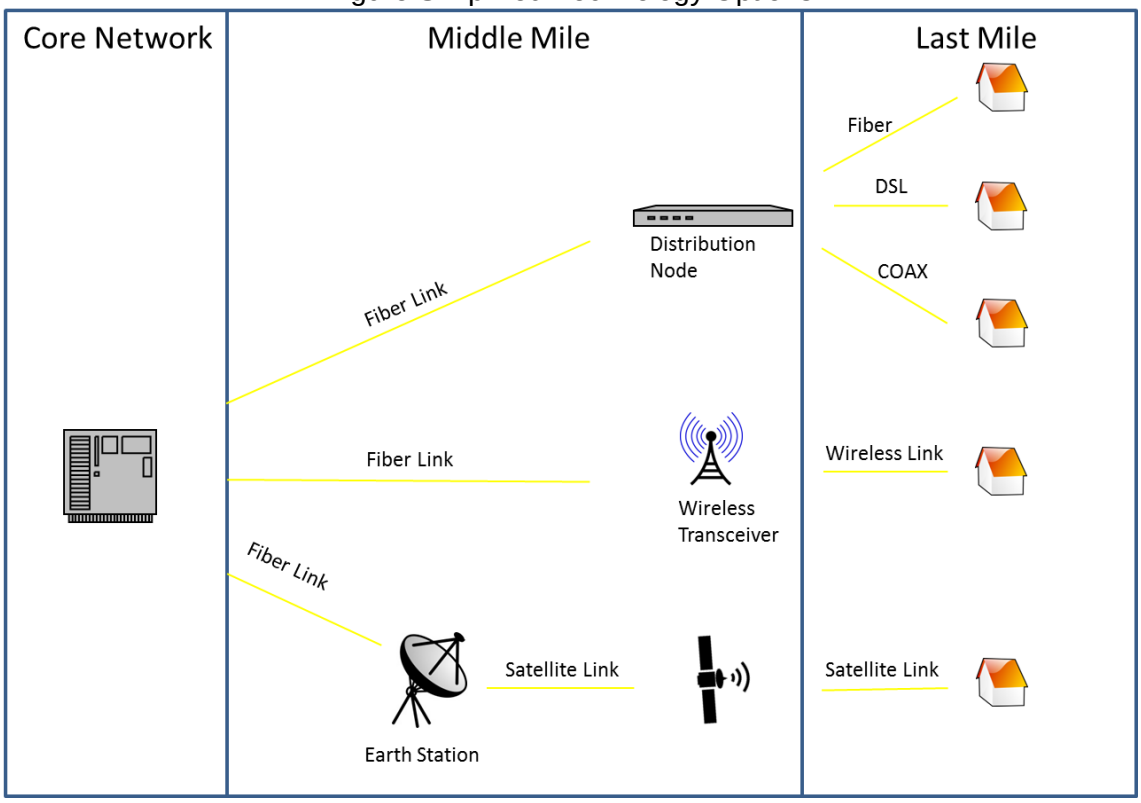
7.0 Technical solution alternatives

There are two major technical factors affecting rural broadband availability:

1. Last Mile –technologies used to connect individual homes and businesses to the network.
2. Middle Mile - the network segment between the core network and last mile providers.

In rural areas of Nova Scotia, the last mile options are typically phone line copper pairs from the telecom, or fixed wireless solutions deployed to enable the 1.5 Mbps service in the 2007 provincial initiative.

Figure Simplified Technology Options



As shown in the simplified technology options diagram there are three options for the last mile:

1. Wired – this could be cable, fibre, or copper pair.
2. Fixed Wireless.
3. Satellite.

Deploying these technologies in rural areas can face a number of challenges. The first potential barrier to providing broadband internet is the availability of last-mile infrastructure to connect homes and business to the internet.

One of the most prevalent connection options for rural homes is the phone network connection (copper pair). The copper pair connection can be used to enable DSL services in some cases, but the speed of the connection is variable based on the distance between the home and the network interconnection point. In rural areas, these distances can be quite long. The highest bandwidth wired solution for network access at this time is fibre, followed by cable, and then DSL services. When considering connecting all rural customers to broadband internet services, fixed wire solutions involve the highest capital costs due to; the distances involved in connecting rural customers, labour costs of installing the wires and the costs related to right of way access, etc.

Fixed wireless solutions require less capital than wired solutions but do not offer speeds that can be achieved by using technologies such as fibre. Wireless transmission speeds may be affected by weather, radio interference, topography issues that may reduce their effectiveness. Fixed wireless solutions are also dependent on the wired network. As shown in the diagram fixed wireless towers must be connected to the core network via a wired link. In rural areas access to “Middle-Mile” network infrastructure to provide this inter-connection can also be a barrier to providing service with this technology. Upgrades are being made to the fixed wireless networks in some regions of Nova Scotia through the Canada 150 program.

Satellite is an alternative option that can currently provide 10 Mbps download speeds, and planned upgrades for 2017 will increase that capability to 25 Mbps. Satellite service can meet the speed requirements for broadband service and is appropriate for applications that are not affected by high network latency. This option may be appropriate for some remote areas. At this time satellite capacity is limited due to the number of subscriber however this should be relieved when a new satellite is brought on-line in the near future.

All of these last mile technology alternatives to connect homes and business to the broadband internet services should be considered in meeting the needs of Nova Scotia’s rural communities.

If the various levels of government decided to subsidize some portion of the costs of connecting rural customers, the various last mile connection alternatives should be evaluated by comparing the total cost of ownership over a uniform timeframe. The lifecycle costs of wired and wireless solutions could vary greatly over a given timeframe due to the anticipated life span of network equipment and assets.

A second potential barrier to the availability of broadband internet in rural areas is the availability of middle-mile infrastructure to connect communities to the internet. Nova Scotia currently has a provincial, circular, redundant fibre optic network however; the fibre routes do not provide sufficient geographic coverage to connect all communities. As an example, these fibre rings do not currently pass through central areas of the province. The cost of extending the fibre to distribution nodes or wireless transceivers for the last mile connection can be an obstacle to connecting rural communities. The province could consider strategies to enhance internet connection options to communities by monitoring the expansion of the middle mile network. As shown by Maine’s example in the jurisdictional scan, a strategy to enhance community

connections by supporting the deployment of middle-mile solutions to connect communities could reduce barriers to rural broadband internet access. Exploration of the development of alternative middle-mile solutions with various commercial entities could prove advantageous in addressing barriers to broadband deployment.

Rural clients could be connected to broadband services through various technical alternatives, and business models. Obviously commercial telecommunication companies and internet service providers will have a role to play but the community cooperative model is one option that may serve rural Nova Scotians. Due to the lack of desired services, communities have begun to look for alternatives to access broadband internet services by forming their own cooperatives. This occurred recently in Lawrencetown, Nova Scotia when The Lawrencetown Village Commission gathered volunteers to set up two 27-metre towers to provide internet signals up to 15 kilometers away for their community[35]. Utility cooperatives are designed to be member-owned and democratic entities that focus on service instead of profits. Members are required to invest initially by paying a fee and then continuously provide capital by consuming and paying for broadband; if a margin is produced, it is reserved as capital credits.

As beneficial as community led solutions can be there are possible downfalls. The energy and enthusiasm that goes into the creation of the local solution must be maintained over time. Owning and operating broadband networks requires technical skills and expertise and ongoing investment. The risk of the solution being abandoned due to a lack of technical skills, operational capabilities, or financial resources must be weighed before any public funding is considered.

The vision for broadband services in Nova Scotia must include various technological solutions and a variety of service delivery models.

Broadband over power line

With the infrastructure already in place, some have proposed to distribute broadband over power lines. Electric current and data signals vibrate at different frequencies in theory allowing them to share distribution technology without interfering with each other. However, several technical challenges exist that have resulted in major barriers to its deployment. Two of these challenges include the noisy harmonics of turning power sources on and off and its effect on broadband. The second includes electromagnetic compatibility as power lines are unshielded and act as antennas for the signals they carry which could cause interference to high frequency radio communications and broadcasting. Additionally the low bandwidth that can be used on power lines does not come close to matching DSL, Wi Fi and even 3G mobile and overall connections can be rather slow (50 Kbps to 350 Kbps). Overall, the use of power lines for broadband has not been shown to be a viable method for rural broadband connections.

35 Markan, Z. (2016). Annapolis valley community close to setting up broadband Wi-Fi service. CBC News. Retrieved from http://www.cbc.ca/news/canada/nova-scotia/lawrencetown-rural-wifi-service-1.3410630

8.0 Potential role of the Province

Market forces have driven the investment in, and deployment of, broadband internet services throughout a large portion of Nova Scotia. In certain instances, such as rural communities, the business case for investing in broadband infrastructure does not meet the thresholds required by private investors. In these cases, all levels of government should collaborate and agree upon what is in its society's and its citizens' best interest and be prepared to support private investment with public funds when necessary. There is a long history of government support of telecommunication infrastructure in Canada through subsidies, regulated monopolies, and other means. The challenges in deploying broadband services to rural Nova Scotians is largely related to the economics of connecting rural communities, and individual homes, to a newer generation of technologies.

The province could support rural broadband access by consider the following:

- Development of provincial goals for broadband access;
- Coordination of Municipal, and Community based initiatives that would advance progress toward provincial broadband goals;
- Development of a community based solution evaluation framework;
- Coordination of provincial telecommunication procurement, and infrastructure investment activities, to advance the deployment of broadband technologies.

The province could also consider the creation of a cross-departmental leadership team to facilitate the development of a strategic plan for the deployment of a provincial broadband infrastructure. Consideration should be given to appointing a broadband stakeholder group who would advise on issues related to promoting and advancing the roll out of broadband services.

There are numerous ways that the rural broadband challenges could be addressed. It is likely that the solutions will take various forms in different communities and will involve private companies, municipalities, community based cooperatives, and government programs. A community-by-community analysis of the current availability and diffusion of broadband services in the province would be useful in order to determine specific technical solutions appropriate for a particular community. This process would foster community and municipal cooperation to enable and improve access to broadband solutions. Such a process could engage the community, as well as technical and business experts in a dialogue to determine the appropriate technical solution based upon the location, demographic, and private and public support available.

The province should look for opportunities to support a strategy that enables scalable infrastructure to be made available to communities that are unlikely to obtain broadband access because of market forces alone. This could involve support for communities to leverage federal investment programs, reviewing and developing middle-mile objectives, and facilitating the linkage between stakeholders.

The province could also consider its role in accelerating investment in rural broadband through direct support or the creation of public private partnerships. One interesting financial support model suggested during this review process was the creation of a bounty model. Such a model would pay service providers when they connect a residence at a pre-determined broadband speed. As such, an incentive model based on post-connection investment by government could be explored as part of future activities.

The provincial government continually makes large infrastructure investments. There is an opportunity to coordinate these investments in a manner that may increase the Province's progress towards broadband deployment goals. For example, as one of the largest purchasers of telecom, network, and mobility services in the province, these procurements could be leveraged to push for the advancement in rural broadband connectivity. Another strategy could be to coordinate road construction activities with deployment of broadband network infrastructure. This may reduce the costs associated with rural broadband deployment. Moreover, social investment in CAP sites can be viewed as opportunities to deploy broadband infrastructure to anchor sites in rural communities. All of these strategies could prove useful in addressing rural internet barriers.

As stated earlier, community led solutions should also be considered in the context of the broadband strategy. To alleviate some of the technical and business risks associated with these initiatives, the province could consider the creation of a team to support community based broadband initiatives. The provincial government can play a leadership role in connecting communities with technical experts to facilitate the development of business cases, implementation, and operational support options that communities should consider. The following tools are examples of what could be considered as part of a support plan for community-based initiatives:

- Business case templates;
- Educational technology overviews;
- Service provider database;
- Education on government support programs for Rural Broadband;
- Education on how to work with service providers;
- A "how to guide" on raising community awareness in terms of the benefits and applications of broadband services to citizens, businesses, social groups and communities.

The provincial government should consider working with, and contributing to, the CRTC processes in determining the appropriate balance between residential access and the ability to provide access for social and economic programs. The province could play an influential role in ensuring individual, community, and municipal voices are heard as part of this process.

From the feedback received during the consultation process, it is equally important to note what the role of the Province should not necessarily play. Many private businesses, municipalities and individuals noted that they do not believe that the role of the government is to actively provide broadband internet services. Stakeholders did not envision the Province, or municipal governments, becoming Internet Service Providers (ISP's) for rural communities. Stakeholders felt that the Province had a role to play in supporting communities, municipalities, and private companies in coming together to provide an economical solution to address rural broad internet services.

9.0 Jurisdictional scan

A jurisdictional scan of national, and sub national, rural broadband initiatives was completed as part of this review. The variance between rural and urban broadband access, and speed, is common across Canada and many other parts of the world. In many rural areas, broadband customers face connectivity challenges, higher costs, and lower average speeds. The findings support the belief that most nations view broadband networks as critical infrastructure that will support future economic growth. Most nations, including Canada, have defined goals for broadband availability and speeds, though the aspirations for speeds goals and universal availability vary. The scan of other jurisdictions demonstrated that sub-national entities (provinces and states) must work within national regulatory frameworks and programs to advance local broadband initiatives.

The states of Kentucky and Maine, were of particular interest as these states have organizations accountable for the broadband strategy creation, monitoring, and execution. They recognized that providing broadband access to rural areas requires large upfront capital investments, and have worked to leverage federal programs and private capital to address fundamental networking challenges that inhibit rural broadband access. The results of the jurisdictional scan show that the evolution of rural networks from 20th century phone networks to advanced broadband networks will take time and significant investment. Sub-national government entities must create support functions to monitor the economic and technical challenges as this evolution unfolds.

Two of the case studies from the jurisdictional scan are highlighted below. The remaining jurisdictional scan information is located in a companion document.

The Commonwealth of Kentucky, USA

The Commonwealth of Kentucky launched their Broadband Outreach and Strategic Planning Project, through their Finance and Administration Cabinet, to help encourage building their last mile infrastructure. Their strategic plan focused on improving broadband adoption rates (increase consumer demand) to demonstrate the benefit for infrastructure providers to extend broadband services to those areas[36].

Two rounds of funding initially supported the project. The first round enabled service provider outreach and data collection, data aggregation to the National Telecommunication and Information Administration(NTIA) data model, verification using multiple validation sources and the creation of a broadband mapping public website with semi-annual data updates.

The second round supported the continuation of mapping and allowed for the formation of The Office of Broadband Outreach and Development. Initially the office was formed to conduct research to enable the achievement of four main project activities: developing a broadband strategic planning process template, engaging communities, training communities and

36 Baughn, P., Landers, S. & Case, D. (n.d.). Introducing the Commonwealth Office of Broadband Outreach & Development. Retrieved from http://media.govtech.net/GOVTECH_WEBSITE/EVENTS/PRESENTATION_DOCS/2011/Kentucky_DGS_2011/Baughn_Phil_Introducing_the_COBOD.pdf

producing community strategic plans[37]. The funding also allowed for two demonstration projects where funding and guidance was provided to selected communities to initiate and provide examples of best practices within the state.

Investing in the development of a broadband strategic planning and process template helped to engage communities to move forward on the last mile broadband infrastructure with a researched and laid out plan. The four-month and eight-step template incorporated the best practices from around the state and country, factored in elements of the National Broadband Plan, and set out a strategic planning and outcome process. The process template was also accompanied by a best practices briefing book. This book provided plan participants with the background necessary to deliberate on policies, actions and directions that their communities could take to positively influence the adoption and utilization of broadband services.

The work conducted by The Office of Broadband Outreach and Development resulted in the formation of best practices in obtaining improved internet access, speed, capacity, affordability and reliability. The Office became the Kentucky Communication Network Authority and to move forward on delivering broadband they issued a Request for Information to assess the level of interest and the capacity to provide enhanced services from incumbent providers and potential partners. They then released a request for proposal for an investment partner and concessionaire arrangement. This resulted in a 30-year public-private-partnership (P3) model to design, build, operate and maintain a middle mile open access physical system of fibre optic cable. Named KentuckyWired, this backbone enables broadband service delivery to communities throughout Kentucky through local public or private internet service providers[38].

The total cost of the project is estimated at $324 million with $30 million from the state, $23.5 million from federal funds and the remaining from consortium partners[39]. Additionally partners in the project have the target of hiring at least 60% of the workers needed for the project from Kentucky, helping to create employment. Those to first benefit from the network include nearly 1,100 government facilities and communities are expected to benefit as they build out the last mile through community led initiatives or private investment.

The Kentucky Communication Network Authority also morphed the broadband strategic planning and process template and accompanying best practices briefing book into a Guide for Fiber Planning for Communities and Utilities[40] and a Guide to Broadband Funding Strategies for Communities and Utilities[41]. An additional Community Broadband Outreach Toolkit, produced by

37 Kentucky Finance & Administration Cabinet. (2016). Broadband KY, About the Project. Retrieved from http://finance.ky.gov/initiatives/Broadband/planning/Pages/About.aspx
38 KentuckyWired. (n.d.). History. Retrieved from http://kentuckywired.ky.gov/about/Documents/About%20History.pdf
39 KentuckyWired. (2015). Kentucky Launches Biggest Public-Private Partnership for Open-Access State Broadband Network. Retrieved from http://www.firstsolutions.org/FirstSolutions915.pdf
40 Commonwealth of Kentucky. (2015). Guide to Fibre Planning for Communities and Utilities. Retrieved from http://finance.ky.gov/initiatives/nextgenkih/Documents/KentuckyWired%20Community%20Fibre%20Planning%20Guidebook%2020150508.pdf
41 Commonwealth of Kentucky. (2015). Guide to Broadband Funding Strategies for Community and Utilities. Retrieved from http://kentuckywired.ky.gov/Resinfo/Documents/KentuckyWired%20Community%20Broadband%20Funding%20Guidebook%2020150508.pdf

The National Telecommunications and Information Administration, also offers additional support to these documents[42].

ConnectME Authority- Maine

In 2007, Maine state government created the ConnectME Authority to promote and extend broadband networks with a goal of enriching communities, and to facilitate expanding broadband availability to all citizens of the state. The ConnectME is primarily an education and grant mediation program. Duties of the Authority include:

- Establishing criteria defining unserved and underserved areas;
- Facilitating enhancements to communications technology infrastructure;
- Monitoring wireless coverage in areas where the authority determines the quality of the coverage is inadequate;
- Expanding the availability of broadband to residential and small business customers in unserved or underserved areas;
- Expanding the availability of broadband with bandwidth, synchronicity, reliability and security adequate to serve business, education and enterprise consumers in unserved or underserved areas;
- Otherwise enhancing the State's communications technology infrastructure in unserved and underserved areas;
- Collecting, aggregating, coordinating and disseminating information and data concerning communications services and advanced communications technology infrastructure in the State;
- Tracking investment in advanced communications technology infrastructure;
- Continually assessing the availability of and need for advanced communications technology infrastructure in unserved or underserved areas within the State;
- Identifying and securing federal and other funding sources for broadband or wireless deployment or education;
- Identifying opportunities for coordination among providers, consumers and state and local governmental entities, including coordination with the statewide emergency radio network; and
- Creating and facilitating public awareness and educational programs to encourage broadband adoption.

Additionally as a sub-initiative ConnectME ran the Maine Middle-Mile Fiber project. As part of the American Recovery and Reinvestment act of 2009, the federal government set aside money to improve access to broadband Internet service in areas where such service has been hard to come by. A coalition of Maine state officials, representatives of the University of Maine System and Maine telecommunications companies got together in early 2009 to determine how Maine might leverage some of the stimulus funds to enhance broadband access. After some

42 National Telecommunications and Information Administration. (2009). Recipient Toolkit: Stakeholder Outreach and Sustainability, Version 2.0. Retrieved from http://kentuckywired.ky.gov/SiteCollectionDocuments/NTIAtoolkit.pdf

discussion, it became clear that the lack of a middle-mile network of high-capacity fibre optic cable - the equivalent of an Interstate highway in a road system - was a major obstacle to improving data transmission in many areas of the state. A middle-mile network design was developed for the grant proposal. The proposal was dubbed the Three Ring Binder because it featured three "rings" of fibre strung through Western, Northern and Down East Maine.

Maine Fiber Company was formed during the grant application process to take charge of the project should it win funding. On Dec. 17, 2009, U.S. Secretary of Commerce Gary Locke came to Bangor to announce that the Three Ring Binder would receive a $25.4 million federal grant. Maine Fiber Co´s private investors provided approximately $7.4 million more in financing to complete the project, without which the grant would not have been approved

Today the ConnectME Broadband Authority consists of a board of five members, an Executive Director, Associate Executive Director, assistance from the Office of Information Technology and an Advisory Council. In 2007 when the authority was formed approximately, 86% of the state had access to high-speed Internet service with an adoption rate of approximately 40%. Since the formation of the Authority, these rates have risen to over 91% of the state having access or availability to broadband and 73% of households subscribing to some type of broadband service (compared to 68% nationally).

National broadband plan- Canadian provinces

Refer to Jurisdictional Scan pdf.

National broadband plan- Emerging markets

Refer to Jurisdictional Scan pdf.

National broadband plan- Developed markets

Refer to Jurisdictional Scan pdf.

Characteristics of a good National broadband plan

Refer to Jurisdictional Scan pdf.

10.0 Appendices

Appendix A- Vendor capability and current pricing

Avon Micro Systems

Avon Micro Systems, based in Windsor, is providing high-speed internet service to Windsor, West Hants and the Annapolis Valley.

Connection Type	Advertised Speeds	Monthly Pricing
None advertised		

Website: http://www.amsystems.ca/

Bell Aliant

Bell Aliant offers DSL Modems in some areas, but this is dependent on whether the local exchange is digital.

Connection Type	Advertised Speeds	Monthly Pricing
DSL Modem	1.5 Mbps / 640 kpbs	$75.45 /month
DSL Modem	7.0 Mbps / 640 kbps	$85.45 /month
FibreOp	100 Mbps/ 50 Mbps	$85.95 /month
FibreOp	150 Mbps/ 50 Mbps	$100.95 /month
FibreOp	300 Mbps/ 100 Mbps	$115.95 /month
FibreOp	940 Mbps/ 100 Mbps	$149.95 /month

Website: http://bellaliant.net/

Cross Country

Cross Country, based in Canning, is currently providing broadband services to Canning, Grand Pre and the surrounding area. They also supply fibre service to the Town of Windsor.

Connection Type	Advertised Speeds	Monthly Pricing
Cable Modem	5 Mbps / 500 Kbps	$49.95 /month
Cable Modem	10 Mbps / 500 Kbps	$55.95 /month
Wireless	1.5 Mbps / 512 kbps	$46.95 /month

Website: http://www.xcountry.tv

Eastlink

Eastlink provides cable modem service throughout parts of Nova Scotia, as well as wireless service to Annapolis, Hants, Digby, Yarmouth, Queens, Lunenburg, Shelburne and Kings Counties. Eastlink has introduced a cap to wireless internet packages at 15 GB a month. Usage beyond 15 GB will require customers to pay $2 per GB used (to a maximum of $20) per month.

Connection Type	Advertised Speeds	Monthly Pricing
Wireless	1.5 Mbps / 500 Kbps	$46.95 (for 15 GB) /month
Cable Modem	50 Mbps / 5 Mbps	$82.90 /month
Cable Modem	100 Mbps /	$100.90 /month
Cable Modem	150 Mbps /	$120.90 /month
Cable Modem	400 Mbps / 10 Mbps	$256.90 /month

Website: http://eastlink.ca/

Mainland Telecom

Mainland Telecom, based in Kentville, is currently providing wireless high-speed to Digby Neck. They are also providing custom point-to-point solutions at higher speeds, as well as providing internet access to other providers. They also have fibre assets in south western Nova Scotia and between Windsor and Halifax.

Connection Type	Advertised Speeds	Monthly Pricing
Wireless	10 Mbps / 5 Mbps	$62.50
Wireless	20 Mbps / 10 Mbps	$79.00
Wireless	25 Mbps / 10 Mbps	$120.00
Wireless		

Website: http://www.mainlandtelecom.com/

NCS Network

NCS Network is providing wireless service in portions of Colchester and Annapolis Counties.

Connection Type	Advertised Speeds	Monthly Pricing
Wireless	15 Mbps	$59.99 /month

Website: http://www.novascotiahighspeedinternet.com/

SeaSide Communications

Seaside Communications is a provider of high-speed wired internet, phone and tv connections to communities in Cape Breton.

Connection Type	Advertised Speeds	Monthly Pricing
Cable Modem	20 Mbps	$50.90 /month
Cable Modem	50 Mbps	$61.90 /month
Cable Modem	100 Mbps	$77.90 /month

Website: http://seaside.ns.ca

SeaSide Wireless Communications

Seaside Wireless is a provider of high-speed internet to rural communities in 10 counties throughout Nova Scotia. Service area currently includes the counties of: Antigonish, Cape Breton, Colchester, Cumberland, Guysborough, Halifax, Inverness, Pictou, Richmond and Victoria.

Connection Type	Advertised Speeds	Monthly Pricing
Wireless	1.5 Mbps / 0.5 Mbps	$49.95 /month

Website: http://www.seasidehighspeed.com

Xplornet

Xplornet offers satellite internet service throughout Nova Scotia with 5 and 10 MB packages available. Xplornet is currently establishing access to a new satellite that will provide higher download speeds (25 Mbps) and greater capacity to add clients. This new service is planned to be introduced in 2016.

Connection Type	Advertised Speeds	Monthly Pricing
Satellite	1.5 Mbps / 700 kpbs	$44.99 /month
Satellite	5.0 Mbps / 1.0 Mbps	$64.99 /month
Satellite	10.0 Mbps / 1.0 Mbps	$84.99 /month

Website: http://www.xplornet.com