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Nova Scotia Department of Business
Middle Mile Strategy

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Disclaimer:

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Executive Summary

Significant parts of rural Nova Scotia are either unserved or underserved with respect to high-speed Internet services. This means businesses, citizens, health and education providers lack the benefits of utilizing the Internet for work or pleasure. The Province of Nova Scotia recognizes access to the Internet is essential to the province's economic and social well-being. Enhancing a connected Nova Scotia, especially in the unserved and underserved communities, will help bring sustainable services to all parts of the province and help grow the local and provincial economies.

Part of the vision for a connected Nova Scotia includes the development of a *middle mile strategy* that will support current and future high-speed Internet infrastructure across the province. The middle mile infrastructure is the segment of a telecommunications network that links the core to local last mile facilities. It is also known as backbone infrastructure and includes fibre and fibre access locations, which are commonly referred to as POPs (points of presence).

After consulting with public sector stakeholders and Internet service providers in the province, the Brightstar consulting team has arrived at speed, coverage, and timeline goals for the middle mile strategy. The middle mile infrastructure that is developed should enable last mile Internet service speeds of up to 50 Mbps download for wireline last mile services and up to 10 Mbps download for wireless last mile services. The 50 Mbps target is consistent with recent Canadian Radio-television and Telecommunications Commission (CRTC) goals for connectivity in Canada.[1] A 10 Mbps download service is appropriate for Internet browsing and video streaming purposes for a typical user. The 50 Mbps target is appropriate for heavier use and can support multiple connected devices simultaneously within a household or business. These speed targets are tabulated below.

Service Type	Minimum Download Speed (Mbps)
Wireline (e.g., Fibre and Hybrid Fibre-Coax)	50 Mbps
Fixed Wireless Service	10 Mbps

In terms of coverage, the public sector stakeholder feedback in rural areas suggested that high-speed Internet services should be available to everyone and that no one be left behind. Through discussion with the private sector, it was determined that implementation of this goal may not be possible, but, the middle mile infrastructure should enable coverage for the vast majority of rural residents, and likely in excess of 95 per cent of populated rural property locations. The majority of the balance of populated rural property locations could then be serviced through satellite technologies, which do not rely on middle mile infrastructure. Satellite speeds of up to 25 Mbps download will be possible with the launch of new satellite services.

Due to the initial expense for expanding the middle mile infrastructure, the timeline for its usefulness must extend several years. Furthermore, it is understood that what is built today needs to work for the

[1] Telecom Regulatory Policy CRTC 2016-496.

future as well. Regarding middle mile infrastructure, the team is recommending a time horizon of 10 years for middle mile electronics. Deployed fibre must have a much longer time horizon because of deployment expense and the expected longevity of the technology. The implication of these time horizon targets is that the middle mile electronics should have the ultimate capacity to meet 10-year demand projections. To save cost and allow for scalability, the initial electronics deployment should be sufficient to meet 5-year demand projections and be scalable up to its ultimate capacity over 10 years. The expanded middle mile infrastructure can be implemented within two to four years of contracts being awarded.

The Brightstar team has developed reference designs for the expanded middle mile infrastructure that can meet the infrastructure performance goals. The reference designs were developed so as to estimate the cost of the expanded infrastructure and to serve as a reference for evaluation of potential applications for funding from the service providers. The reference design for the middle mile infrastructure may not be the actual design implemented by service providers. The reference designs are based on Internet demand maps generated from Property Valuation Services Corporation (PVSC) data and consider existing middle mile infrastructure supply, using confidential service provider inputs.

Using 5-year demand projections derived from the PVSC property locations and published Internet usage forecasts, the reference design shows a need for an additional 174 POP locations, and 1,079 km of fibre. Using 10-year demand projections, an additional 37 POP locations will be needed, along with 561 km of additional fibre, beyond the 5-year design requirements.

The estimated total infrastructure cost to implement the 5-year middle mile reference design is $75–85 million. The annual operating costs for the service provider are estimated to be $6–8 million. As the network continues to grow over a total 10-year time frame, the estimated capital costs are $100–115 million, with operating costs of $7–10 million. The revenue earned from just middle mile infrastructure does not surpass operating costs—meaning there is no business case for industry to build just the middle mile. The province would be required to fund the full capital costs and support operating costs. In order to create a business case for industry to proceed, last mile infrastructure should be included, so that the revenue generated can create a positive return.

Expanding the last mile infrastructure as well as the middle mile will increase the support required. Based on what has been experienced in other jurisdictions in North America, Nova Scotia's public subsidies could potentially reach $300 million to $500 million. A last mile analysis and design study is required to properly estimate total infrastructure costs and public funding requirements.

In conclusion, Brightstar makes the following recommendations to the Province of Nova Scotia with respect to middle mile high-speed Internet infrastructure for rural Nova Scotia:

Speed Targets	Middle mile infrastructure should enable the following speed targets by service type: Wired service (i.e., fibre, cable) – 50 Mbps download/10 Mbps upload Wireless service (i.e., fixed wireless, satellite) – 10 Mbps download/2 Mbps upload

Coverage Targets	Middle mile infrastructure should enable greater than 95% coverage for areas outside of urban Halifax and urban Sydney.
Financial Contribution	Potential contribution from government and partners is as follows: Middle mile alone: $100–$115 million Middle mile and last mile: $300–$500 million (A last mile design is required to refine the potential contribution.)
Timelines	The infrastructure build would likely take two to four years after contracts are signed.

Next steps for the Province of Nova Scotia to undertake:

- commence implementation of the middle mile strategy
- complete the development of the last mile strategy and then implement

Disclaimer: This document provides an overview of the methodology used and high-level results for the reference design. Detailed data and inputs are proprietary in nature, and therefore the appendices in which they appear have been removed to protect the confidentiality of the service providers.

1 Introduction and Background

1.1 Background and Motivation

Statement of the Problem

Significant parts of rural Nova Scotia are either unserved or underserved with respect to high-speed Internet services. This means businesses, citizens, health and education providers lack access to the benefits of utilizing the Internet for work or pleasure. Access to the Internet is essential to the province's economic and social well-being. Enhancing a connected Nova Scotia, especially in the unserved and underserved communities, will help bring sustainable services to all parts of the province and help grow the local and provincial economies.

Part of the vision for a connected Nova Scotia includes developing and implementing a *middle mile strategy* that will support current and future high-speed Internet infrastructure across the province.

Why is middle mile important?

The middle mile is essentially the "backhaul" network that carries information traffic to and from the Internet. It must be scalable to manage the ever-increasing demand for bandwidth, and it must have "on and off ramps" strategically located so that Internet service providers (ISPs) can connect to it and serve their customers in their homes, businesses, or institutions.

The middle mile is analogous to water mains or high-voltage power lines. These infrastructure components are used to carry the bulk of the service, and break-out points are required at various places to connect individual houses. Without the large-scale infrastructure of a water main or high-voltage power line, there would not be sufficient supply to meet increasing demands. Internet services also require the equivalent of the water main or high-voltage power line, and this is called the "middle mile."

Goal and Objective of the Strategy

The overall goal of the Province of Nova Scotia is to develop a strategic direction and accelerate the implementation of high-speed Internet solutions to enhance the service levels across the province and particularly in rural Nova Scotia.

Background

The provincial government recognizes the importance of dependable, affordable high-speed Internet services to the prosperity of Nova Scotia's residents, businesses, and the education and health sectors. A key focus is to ensure sufficient bandwidth is available to meet current and future demand. Government understands that enabling consumers from all sectors to get connected requires effective networks that

- they can reach at work, at home, and in schools, colleges, universities, and health facilities
- provide enough capacity to carry the Internet traffic today and in the future

In 2007, the ambitious Broadband for Rural Nova Scotia (BRNS) project was launched to improve Internet access for thousands of Nova Scotians. BRNS connected 99 per cent of 93,500 residents that were unable to access high-speed Internet services in the province, with a targeted bandwidth of 1.5 Mbps. The 1.5 Mbps service BRNS delivered was considered a high-speed service level given the number of computers and types of Internet services that households used at that time.

Demand for Internet services has continued to grow over the past ten years. Today, the average Canadian household has seven devices connected to the Internet, using bandwidth-intensive service such as streamed audio and video.[2] To ensure that Nova Scotians are able to connect and access the ever-increasing services that are offered online, it is time once again to expand and enhance access to Internet services across the province. A solution is required that anticipates and is planned to accommodate the growth in demand for Internet services over the next number of years.

In 2016 the Nova Scotia Department of Business commissioned a report, “Review of Alternatives for Rural High Speed Internet.” The report outlined the current state of Internet technologies in Nova Scotia and found that

> [t]he 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.[3]

The report also concluded that market forces alone will not drive the necessary investments in Internet infrastructure in Nova Scotia and that the government will need to play an active role in its development and deployment.

The provincial government committed initial funds in 2016 to improve Internet service levels across the province. A request for information was released to gain an understanding of what short-term projects could result in immediate improvements in Internet service to Nova Scotia residents.

A request for proposal was also released in 2016 with the goal of creating a long-term middle mile strategy for Nova Scotia. Upon implementation, this strategy will ensure the necessary infrastructure is built so that both current and future Internet service-level demands can be met.

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[2] http://www.cantechletter.com/2016/08/households-now-use-average-seven-connected-devices-every-day-report/

[3] *Review of Alternatives for Rural High Speed Internet*: https://novascotia.ca/business/docs/Broadband-Deliverable-Report.pdf

As the province was initiating the strategy, the CRTC announced in December 2016 that Canadians should have access to Internet speeds of up to 50 Mbps download and up to 10 Mbps upload, speeds that vastly exceed what many rural residents presently have. This federal announcement is aligned with the work the province has started, and ongoing discussions are under way between the two levels of government to maintain coordination.

Developing the Middle Mile Strategy

Developing an actionable middle mile strategy on a provincial scale is a significant challenge that requires stakeholder commitment, a deep technical understanding of Internet technology, knowledge of market trends, and financial analysis expertise. In developing this strategy, the Brightstar team met with nine service providers and representatives from 50 municipalities within the province. Their input helped shape the goals for the strategy, which in turn formed the basis for the middle mile infrastructure requirements. Based on these requirements, Brightstar engineered an expanded middle mile infrastructure which was in turn costed and tested for market viability on the assumption of no government support.

1.2 Document Overview

This document consists of six main sections: Introduction and Background, Approach and Methodology, Stakeholder Engagement, Engineering Analysis, Financial Analysis, and, finally, Recommendations. The document also contains an executive summary and supporting appendices.

In the introduction, the current problem is defined and some historical context of the problem is provided. A summary of past work that has been done in the province with respect to rural high-speed Internet is also presented, along with the vision, goals, and objectives that the province has for high-speed rural Internet. A List of Definitions and Acronyms (section 1.3) is included to assist with the technical terminology that is used.

The Approach and Methodology section describes the approach taken to develop the middle mile strategy. The key elements of the middle mile strategy are the strategy goals and the financial requirements for implementing the strategy.

The Stakeholder Engagement section identifies who was consulted within the private and public sectors, describes the stakeholder engagement activities, and summarizes the key findings from the consultations.

In the Engineering Analysis section, reference designs for middle mile infrastructure are derived with consideration to the infrastructure performance goals, using last mile sources of Internet demand and existing middle mile infrastructure. The reference designs are useful to estimate the cost to expand the middle mile infrastructure and can serve as a baseline for evaluation of potential applications for funding from Internet service providers.

The Financial Analysis section derives the capital and operating expenses associated with building and operating the expanded middle mile infrastructure. In this section, the market viability of this undertaking in the absence of any government assistance is assessed to determine if a market failure condition exists.

The last section of the report includes the recommendations from the project team regarding the middle mile strategy.

1.3 List of Definitions and Acronyms

Term	Definition
ABC	Activity-based cost
AMP	Amplifier: a device used to boost signal strength, typically used between optical nodes and customers
ARPU	Average revenue per user
Backhaul	See "Middle mile"
Biz	Business
Broadband	A high-capacity transmission technique using a wide range of frequencies, a technique that enables many messages to be communicated simultaneously
BTS	Base transceiver station: a piece of equipment that facilitates wireless communication between user equipment and a network (user equipment includes devices like mobile phones and computers with wireless Internet connectivity)
Cable	In terms of this report, Internet access provided via a cable television provider
Cable company	Traditionally a company that offered cable television services, but now may also refer to one that offers telecommunications and Internet services
CAGR	Compound annual growth rate
CapEx	Capital expenditures: funds used by a company to acquire or upgrade physical assets, such as property, industrial buildings, or equipment; often used to undertake new projects or investments by a firm
Cisco VNI (Visual Networking Index)	Report from a leading Information Technology company, Cisco, on Internet usage
Coax	Coaxial cable, a type of insulated cable
CPE	Customer premises equipment: any terminal and associated equipment located at a customer's premises and connected with a carrier's network
CRTC	Canadian Radio-television and Telecommunications Commission
CTI	Connect to Innovate program
Dark fibre	Unused fibre-optic cable (as when companies install more cable than necessary to allow for growth)
Demand	In terms of this report, the calculated volume of Internet traffic required to support an average household, business, or other site
DL	Downlink, refers to transmissions in the direction toward the end user
Download	Data that is received by a computer or network (see DL)
DSL/ADSL	Digital subscriber line or asymmetric digital subscriber line: defined as the way a computer connects to the Internet at high-speeds using telephone lines

Term	Definition
EORN	Eastern Ontario Regional Network
Eq	Equivalent
FAA	Financial Administration Act
FDH	Fibre distribution hub: where the fibre from the POP is distributed to homes
Fibre	Fibre optic (or "optical fibre") refers to the medium and the technology associated with the transmission of information as light impulses along a glass or plastic wire or fibre
Fixed wireless	The operation of wireless devices or systems used to connect two fixed locations (e.g., building to building or tower to building) with a radio or other wireless link
FTTH	Fibre to the home
FTTN	Fibre to the node
Gap	In terms of this report, the difference between the demand for Internet bandwidth and the potential supply of bandwidth
GB	Gigabyte
Gbps	Giga bits per second or billions of bits per second: a measure of bandwidth on a digital data transmission medium, such as optical fibre
GIS	A system designed to capture, store, manipulate, analyze, manage, and present spatial or geographic data
GPON	Gigabit passive optical network
HFC	Hybrid fibre-coaxial: a broadband network that combines optical fibre and coaxial cable (commonly employed globally by cable television operators to deliver Internet connectivity)
HH	Household
HH-equivalent	Household-equivalent: This represents the expected Internet demand of an “equivalent” household. Based on 5-year demand projections, this equals 2.74 Mbps. The term HH-equivalent is used as a metric for measuring the coverage and unit cost of middle mile infrastructure with consideration to all Internet demand sources. This term does not apply to actual households, because the Internet is used not only by households, but by other property types as well, including businesses, hotels, health care facilities, etc.
IoT	Internet of things: refers to the increasing list of dedicated devices that now connect to the Internet, such as household thermostats, security systems, lighting controls, etc.
IRR	Internal rate of return
ISED	Federal government department: Innovation, Science and Economic Development Canada
ISP	Internet service provider
Last mile	Final leg of a telecommunications network that delivers telecommunication services to retail end-users (customers)
Lit fibre	Fibre-optic cable (used for carrying data between two designated points) that has been installed and activated by carriers (service providers)
LTE	Long-term evolution: a standard for high-speed wireless communication for mobile phones and data terminals

Term	Definition
MB	Megabyte
Mbps	Megabits per second: a measure of data transfer speed (a megabit is equal to one million bits)
Middle mile	The segment of a telecommunications network that links a network's core to last mile local facilities; commonly called the "backhaul" network
Mobile	May refer to portable Internet-capable devices, or to access to the Internet via smartphones or other portable devices
MW POP	A POP, point of presence, that uses a microwave radio usually on a tower to connect remote locations not accessible by a wired connection; microwave POPs are often used to provide bandwidth to islands or mountain locations
NPV	Net present value
OLT	Optical line terminal: the endpoint hardware device in a passive optical network
ONT	Optical network terminal: customer premise equipment (CPE) that can be used to deliver Internet, telephone, and television services
OpEx	An operating expense, operating expenditure, operational expense, operational expenditure: an ongoing cost for running a product, business, or system
Optical node	Electronic equipment that translates a digital signal from a light beam to an electrical signal (found in a hybrid fibre-coaxial, HFC, network)
Pole costs	Cost of connecting cable, fibre, or other equipment to power distribution poles
POP	Point of presence: the local access point for Internet service providers; a facility containing telecommunications equipment that allows ISPs to connect customers to the Internet; often located in a central office but can also be in a field cabinet
PVSC	Property Valuation Services Corporation
RENs	Regional Enterprise Networks: groups of municipalities in Nova Scotia that provide regional economic leadership and help develop regional economic strategies, while supporting small, local businesses
RF	Radio frequency
RFI	Request for information
RFP	Request for proposal
Satellite	Refers to Internet access provided via satellites
SLA	Service level agreement
Supply	In terms of this report, the potential bandwidth available at an Internet connection point of presence (POP)
Service provider	Shortened form of Internet service provider, or ISP
Spare fibre	Unused fibre optic cable (as when companies install more cable than necessary to allow for growth)
SW	Switch: a piece of electronic networking equipment that routes an input signal to an output line
Tap	A passive component consisting of a coupler and a splitter that splits the RF signals for servicing several homes

Term	Definition
Telco	Company that provides telecommunications services, such as telephony and data communications
Triple-play services	Internet, television, and telephone services delivered from a single provider’s connection
UL	Uplink, refers to transmissions in the direction toward the Internet
Upload	Data sent from a computer or network toward the Internet (see UL)
WACC	Weighted average cost of capital
Wi-Fi	Technology for wireless local area networking
Wireless	The transfer of information or power between two or more points using radio technology rather than wire

2 Approach and Methodology

The essential elements of the middle mile strategy include:

1. Project Goals (or Infrastructure Performance Goals): the goals that the middle mile is expected to meet or enable (including speed of service, availability or coverage of high-speed Internet service within the province, and the timeline for the solution)
2. Budget: how much it will cost to implement the strategy, how much of the cost can be covered by the private sector, and how much subsidy would be required

The process for arriving at the middle mile strategy began with consultations with several key stakeholder groups: municipalities and allied agencies, municipal associations, and Internet service providers (ISPs), all of whom have a strong interest in a province-wide middle mile strategy. The objective of these consultations was to inform, educate, and obtain input into the development of the middle mile strategy. ISPs are private sector companies that connect their customers to the Internet. It was important to gather information directly from them, particularly concerning key issues of understanding their middle mile infrastructure, revenue, and costing data, and their views on infrastructure performance goals and governance. The inputs gathered through stakeholder engagement, in combination with global best practices research, and the expertise of the Brightstar team, were then used to establish goals for the strategy. A budgetary design for the middle mile to address infrastructure gaps was then developed based on these goals. The costs required to operate the additional infrastructure was then estimated, along with estimated revenue that could be derived from its use, to arrive at an infrastructure budget and business case.

3 Stakeholder Engagement

3.1 Municipality Consultations

As noted previously, the engagement of a variety of key stakeholders was deemed essential to the development of a middle mile strategy. In its request for proposals, the government identified the following stakeholders to be consulted:

- Municipalities, Regional Enterprise Networks , Union of Nova Scotia Municipalities
- Community groups
- Internet service providers and subject-matter experts
- Relevant provincial departments
- Federal departments and agencies, where appropriate

This section focuses on the consultations undertaken with municipalities, RENs, and the Union of Nova Scotia Municipalities.

3.1.1 Public Sector Stakeholders Consulted

Over the course of six days commencing on November 16, 2016 and ending on November 22, 2016 the Brightstar team travelled across the province and held six sessions, each of approximately 2–3 hours in length. Sessions were held in

- Caledonia
- Kentville
- Truro
- Antigonish
- Iona
- Halifax

Cape Breton Regional Municipality also participated via phone.

A total of 50 municipalities and related agencies represented by 82 individuals participated in the sessions.

A second round of stakeholder sessions was held on March 6 and March 7, 2017 in Truro and Dartmouth, respectively. These sessions provided an update on the overall progress of the work done on the middle mile strategy, an overview of the engineering methodology used to determine network demand, and a summary of the feedback that was received from the first round of stakeholder sessions, held in the late fall of 2016. The sessions were made available to participants via telephone and the web and lasted approximately two hours each.

3.1.2 Session Outline

Each session followed a similar format. A printed questionnaire was distributed to each individual or was completed by an individual on behalf of a group or municipality. A copy of the questionnaire is included in Appendix A – Stakeholder Engagement Consultations.

3.1.3 Summary of Public Sector Feedback and General Observations

Awareness of Gaps

There was strong awareness (nearly 80 per cent) of the presence of significant gaps in both access to high-speed services and the level of service. This is particularly evident in rural areas of the province. Some participants felt that they had adequate access but also recognized that demand was increasing at a rapid pace, and that it might outstrip supply.

Local Broadband Internet Projects

At the time, only a few municipalities identified locally led broadband Internet projects under way or in the planning stages.

Municipal Infrastructure Projects

No local or regional infrastructure projects were noted as either under way or planned that could assist in a middle mile build. Fifty-six percent of representatives, however, did identify that they were planning major water and sewer projects. When asked, they were open to considering placing conduit that could support a middle mile build, but timing and location would be key considerations.

Online Services

Most municipal representatives agreed that online services for the public were important and would be more so in the future. Forty-four percent said they were developing plans to put a variety of municipal services or functions online. However, both the timing and the ultimate effectiveness of online services were dependent upon citizens' access to the Internet. This was seen as a key barrier today.

Funding and Funding Models

At every session, questions were raised about the amount and availability of funding that municipalities might be able to access to support the building of broadband Internet infrastructure. In addition, there were general inquiries related to funding models that might be established to support the builds.

Participants were asked, "What are the most Important Goals to Consider?" (Ranked highest to lowest)

1. Access: No one should be left behind.
2. Speeds: General consensus on 10 Mbps down, 2 Mbps up
3. Price: Reasonable pricing (some rural cost differences may occur)
4. Timing: Recognition building will take time, but 18 months to 3 years was the consensus.

Cell Coverage
Although generally unrelated to the middle mile strategy, many participants raised the issue of inadequate cellular coverage in parts of their municipalities. They see cellular coverage as part of the general issue of good connectivity.

Working with the Province
During our meetings with the municipal groups significant interest was expressed in securing access to high-speed Internet services for their residents and businesses. While they are anxious to move forward quickly, they also recognize that working with the government would be beneficial, as long as the government provides leadership in a timely and efficient manner.

References were made to making municipal lands and buildings available if doing so would support the provision of expanded services. Municipalities are willing to work with both the province and ISPs. A prolonged and lengthy approach would not be acceptable. Many expressed the critical importance to youth retention and business growth that broadband offers.

Developing Information materials
The Brightstar team believes that there is value in producing educational or information communication materials to help inform municipalities and the public about broadband Internet infrastructure and high-speed services. The need for these groups to understand the difference between middle mile and last mile is imperative and to understand why a robust middle mile is needed to ensure the future growth of a sustainable and scalable last mile.

3.2 Service Provider Consultations

Consultations were held with several companies currently offering middle mile and last mile services in Nova Scotia. The primary objectives of these meetings were to solicit input from the private sector on the infrastructure performance goals, project governance structure, and engineering design methodology. An additional objective was to gather service provider input needed for conducting the engineering design and financial analysis work, including fibre and POP locations and capital and operating expense data.

Buy-in and support from the private sector was seen as critical to ensure accuracy in the engineering and financial analysis, as well as to ensure involvement of the private sector in the implementation phase of the middle mile strategy.

3.2.1 Service Providers Consulted

Over the period starting November 14, 2016 and ending November 30, 2016, the Brightstar team met with the following middle mile and last mile service providers:

- Eastlink
- Bell Aliant
- F6
- Mainland
- Rogers

- NCS Networks
- Cross Country
- North Nova Cable
- High Tech Communications (formerly TNC Wireless)

This list of ISPs included all the ISPs in Nova Scotia that own middle mile infrastructure and offer middle mile services, as well as a cross-section of large and small last mile service providers who rely on this infrastructure to deliver broadband Internet services.

A second set of meetings was held with the middle mile infrastructure providers (Bell Aliant, Eastlink, F6, Mainland, and Seaside Communications) from January 30, 2017 to February 2, 2017. The objective of these meetings was to present more details on the engineering approach, get feedback on the preliminary design results and infrastructure performance goals, and validate the financial assumptions used for the business case.

3.2.2 Session Outline

Each session followed a similar format. The Brightstar team presented a series of questions designed to get input from the service providers on matters relating to the project governance structure and infrastructure technical requirements. The team also presented the middle mile strategy technical approach to solicit feedback and requested input relating to design assumptions, as well as financial input required for doing the study. Following each session, the questions were sent out to each service provider for further response. A detailed outline of the session is included in Appendix A – Stakeholder Engagement Consultations.

3.2.3 Service Provider Feedback and General Observations

General observations that resulted from the feedback are summarized below.

<u>Last Mile Targets</u>
There was general agreement that rural broadband Internet access is important, but it was recognized that financial limitations will not enable 100 per cent of residents to have access. Nevertheless, there was consensus that at a minimum 95 per cent of residents should have access to broadband Internet through the middle and last mile. Those unable to benefit from the infrastructure could be able to access satellite technologies.

In terms of data rates, there was no consensus on minimum speed levels. All service providers believed that targeted data rates should be at least 10 Mbps, but others felt that a minimum 100 Mbps service should be made available. Please note that the latest CRTC targets had not been released at the time of this consultation.

There was no consensus on the timeline for achieving these speed targets, but the general timeline ranged from 2 to 10 years.

<u>Last Mile Inputs</u>

At present, wireless last mile providers offer speeds ranging from 1.5 Mbps to up to 50 Mbps, depending on customer location and wireless technology. DSL services are up to 7 Mbps, but fibre and cable services reach up to 100 Mbps.

There was no consensus from within the private sector about whether the middle mile infrastructure in its current state is sufficient to meet the needs of the residents. However, choice, competition, and price were raised as issues by many of the last mile service providers when it comes to middle mile access.

There were several barriers identified that keep last mile providers from adding customers, including middle mile access cost and power pole access and timelines.

Engineering Inputs

There was general agreement that the engineering approach proposed for the middle mile gap assessment and design was valid. The approach involves estimating the demand using last mile sources of Internet derived from PVSC data and Cisco VNI reports, estimating supply based on POP locations and then calculating the supply shortfall. No alternate methodologies were proposed or recommended by any of the service providers during the meetings or during follow-up responses.

Financial Inputs

Information about capital expenses (CapEx) and operating expenses (OpEx) is important for establishing the middle mile infrastructure budget. Detailed financial inputs were collected, including the cost per POP facility, equipment costs, fibre costs, and ongoing operating expenses, as well as expected incremental revenue from middle mile wholesaling services.

4 Engineering Analysis

4.1 Infrastructure Performance Goals Driving the Engineering Analysis

4.1.1 Data Rates

Although end-user data rates are a last mile goal, there is a strong correlation of end-user data rates with aggregated network-traffic-peak data rates, which are critical for middle mile network design and sizing.

Based on the stakeholder feedback, and the recent CRTC target of 50 Mbps Internet service to all Canadians, Brightstar is recommending a speed goal for last mile Internet service of at least 50 Mbps in the download direction. In areas where a wired solution is not practical, a speed goal for wireless last mile Internet of 10 Mbps download is recommended. A 10 Mbps download service is appropriate for Internet browsing and video-streaming purposes for a smaller household. The 50 Mbps target is appropriate for heavier use and can support multiple connected devices simultaneously within a household or business.

It is noteworthy that data-rate offerings have followed an upward trajectory for several years and will continue to do so as demand and the number of Internet-capable devices per household increase. From a middle mile perspective, the critical metric for sizing the infrastructure is the aggregated network-traffic-peak data rate. As described in more detail in Section 4.4, Brightstar used future demand forecasts for sizing the initial network. Service level agreement requirements tied to network utilization can be used for future-proofing services beyond the network's initial capacity.

4.1.2 Time Horizon

There is an urgency to move forward quickly to implement the strategy so that Nova Scotians can take advantage of improved service. It is understood that what is built today needs to work for the future as well. For the middle mile infrastructure, the team is recommending a time horizon of 10 years for middle mile electronics. Deployed fibre must have a much longer time horizon due to deployment expense and the expected longevity of the technology. The implication of these time-horizon targets is that the middle mile electronics should have the ultimate capacity to meet 10-year demand projections. To save cost yet allow for scalability, the initial electronics deployment should be sufficient to meet 5-year demand projections and be scalable up to its ultimate capacity over 10 years.

4.1.3 Coverage Target

Based on stakeholder feedback, last mile coverage targets should be well in excess of 95 per cent of all properties in populated areas. The majority of the balance of populated rural property locations could then be serviced through satellite technologies, which do not rely on middle mile infrastructure. Satellite speeds of up to 25 Mbps download will be possible later in 2018 with the launch of the new satellite service. With this in mind, the middle mile infrastructure should be sufficient to enable these last mile goals to be met.

4.2 Technology Options for Addressing Infrastructure Performance Goals

The middle mile infrastructure for supporting wireless, cable, fibre-to-the-home (FTTH), and DSL last mile services includes fibre and POPs/optical nodes that connect last mile equipment to the core network.

Cable and FTTH last mile technologies are capable of delivering speeds in excess of 50 Mbps. Fixed wireless services, through use of wider licensed channels, may be capable of delivering 50 Mbps speeds, but this target will be difficult to achieve in the near term using unlicensed spectrum However, a 10 Mbps service would be achievable, a service that represents the lower end of the infrastructure speed target. DSL services in Nova Scotia currently top out at 7 Mbps, making the existing DSL infrastructure incapable of supporting the infrastructure performance goals.

The middle mile infrastructure for supporting wireless, cable, fibre-to-the-home (FTTH), and DSL last mile services includes fibre and POPs that connect last mile equipment to the core network.

There are three main components in a POP location—the aggregation switch, the access switch, and the power supply system.

The aggregation switch belongs to the middle mile operator and is usually a powerful switch that can handle 10 to 100 Gbps of data. This switch can combine different services from different service providers. Aggregation switches are modular and the capacity can be expanded.

The name “access switch” is a general term and describes the general functionality of this device. In different access technologies, the access switch is referred to by different names. The access switch belongs to the last mile service provider and serves different functions for the service provider. Other than the standard switching/aggregating function, access switches can be used to apply customer profiles, such as pertaining to upload/download speeds. These switches are selected based on the network requirements.

The power supply and backup system provide a reliable power source to the POP equipment. Depending on the location of the POP, the power supply may include a battery system capable of multiple hours of backup time or a backup generator.

The last mile technologies capable of achieving the infrastructure performance goals are described briefly in the section below, for reference purposes.

4.2.1 FTTH Technology

Fibre technology provides a variety of options to the service providers for last mile service. FTTn or FTTb provides a fibre connection from a POP to the neighborhood or the building. Existing copper lines can then be used to connect the customer to node or building. In a new build, fibre is deployed from the POP to the customer location. This last mile technology scenario is called FTTH.

A popular FTTH architecture is GPON due to its simplicity and price. Below is a schematic of a FTTH GPON network with its components.

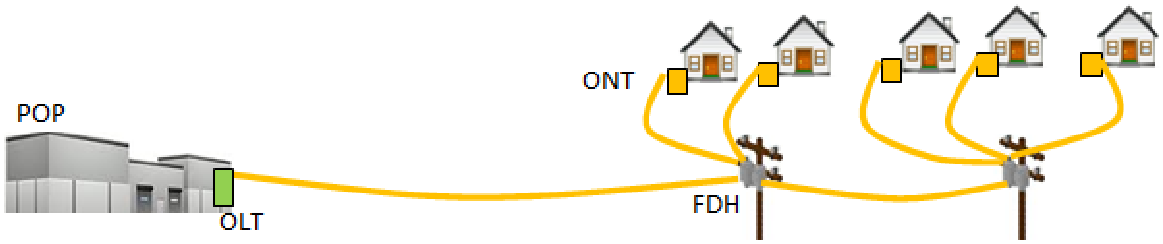

Figure 4-1. FTTH Schematic Diagram

In the above figure, the OLT is located in the POP and connected to the core network through switches and routers.

The FDH is where the fibre from the POP is distributed to the homes. It contains several passive optical splitters, usually in a combination of 1x4, 1x8, or 1x32 splitters. FDH comes in various configurations, including FDH-144, FDH-216, and FDH-288.

The ONT is the CPE endpoint of the FTTH network. The ONT is an optical-to-electrical device that can deliver triple-play services. GPON is completely passive, and therefore at this endpoint there must be a power connection to perform the optical-to-electrical conversions for the services.

In rural areas where household density is low, the splitting is done in several steps. For example, instead of using a 1x32 splitter, 1x4 and 1x8 splitters can be used along the fibre path to minimize total fibre length. The total length of fibre from the POP to the ONT should be less than 20 km.

4.2.2 HFC Technology

There are several different architectures for HFC (Hybrid Fibre Coax) systems, such as tree and branch, star, ring, and cascading hubs. A simple HFC structure is shown below to highlight the main elements of the HFC system.

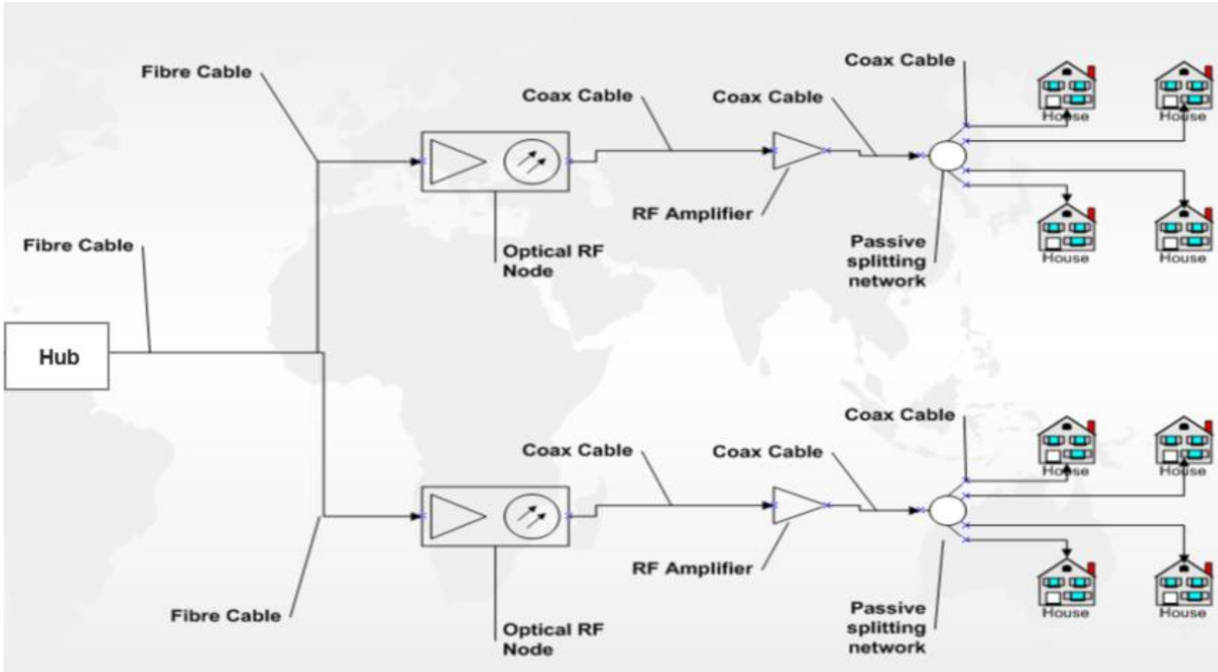

Figure 4-2. HFC Schematic Diagram

The node, or optical fibre node, is a broadband optical receiver that converts the download optical signals coming from the hub to RF signals going to the homes through coaxial cables. A node can typically serve about 250 houses, and in special cases up to 2,000 homes, although this is not recommended. Nodes can be connected to one another by fibre. The typical distance between the nodes is 5 to 40 km. For long distances, an amplifier can be used between nodes to maintain adequate signal strength.

Optical fibre nodes fed using home-run fibre from a master headend are used to convert the optical signals to electrical in the downstream and, conversely, convert electrical to optical signals in the upstream. A cable modem device using DOCIS 3.0 is used in the customer's premise to convert the RF (electrical) based signals to Ethernet, which then can be processed by the customer's computer or home network.

4.2.3 Fixed Wireless Technology

In fixed wireless systems, Internet service is delivered wirelessly from a tower site to a transceiver at the customer location. The tower site can be connected by fibre or by wireless microwave link to the POP. Towers can be interconnected using a variety of topologies, including tree and branch, ring, or star. The figure below shows a tree and branch topology, in which three wireless towers are connected to one another via microwave links.

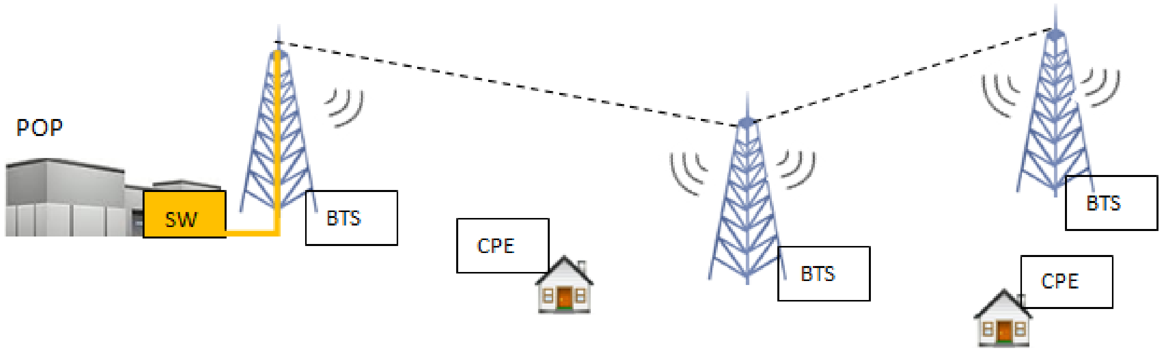

Figure 4-3. Fixed Wireless Schematic Diagram

In the above diagram, the CPE is the equipment located at the customer's location. It typically consists of an outdoor antenna and transceiver equipment.

The BTS is the equipment located at the tower site. Together with tower-mounted antenna equipment, the BTS provides wireless communications between the CPE and the network.

At the POP, there is switching equipment that aggregates the traffic from many customers serviced by the tower sites, and that sends the traffic to the core of the network through the middle mile fibre network.

4.3 Engineering Process Overview

At a high level, the process for scoping the enhancement of the middle mile network in Nova Scotia involves mapping the demand for Internet, mapping the existing middle mile infrastructure in the province, and then determining the areas where the Internet demand exceeds the capacity of the existing infrastructure to deliver the required service. A budgetary design is then conducted to address the service gaps—for example, by adding new or expanded infrastructure to service unserved or underserved areas.

This process is shown graphically below.

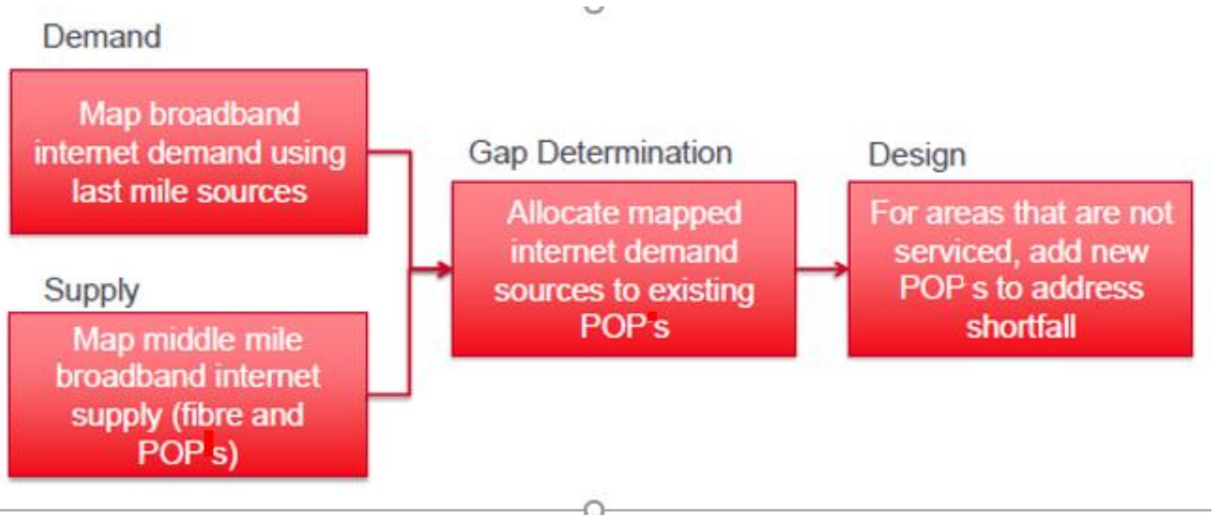

Figure 4-4. Engineering Process Flow Diagram

4.4 Demand Mapping

4.4.1 Demand Mapping Process

It is critical that the middle mile network is able to meet the peak network demand requirements throughout the province. To determine the peak Internet demand, it was necessary to map the Internet demand sources and calculate the peak demand from these demand sources.

The approach followed to map the peak demand was as follows:

Step 1. Identify the potential sources of fixed Internet demand.
Step 2. Model the traffic from each source of fixed Internet demand.
Step 3. Calculate the demand from each fixed Internet source by time of day.
Step 4. Adjust the peak demand to account for mobile Internet traffic.
Step 5. Adjust the peak demand to account for Internet traffic growth.
Step 6. Aggregate the peak demand into 1 km^2 grids for presentation and analysis purposes.

Step 1. Identify the potential sources of fixed Internet demand.
The traffic load on the middle mile network is ultimately derived from last mile sources of Internet demand, such as computing equipment or smart devices in residences, or networking equipment in businesses, government buildings, or education facilities. To support mapping of the last mile traffic in the province, the Brightstar team used property data received from Property Valuation Services Corporation (PVSC). The data set used was current as of November 2016 and included planned property listing changes for 2017.

The PVSC data resolution was to the lot level, and each property was categorized by type and included building size and location information. The Brightstar team met with the PVSC team to ensure the data could be filtered to exclude any property that should not be treated as a potential source for Internet demand. Of the 637,651 properties in the original database, 370,771 were identified as demand sources for mapping purposes.

Step 2. Model the traffic from each source of fixed Internet demand.

Of the properties identified as demand sources, the Brightstar team assigned usage profiles and usage quantities based on the property category. Usage profiles fell into one of four categories, as listed below.

- HH (residential): this traffic profile is typical of a household, characterized by high traffic in the evenings, when people are home from work, and lower traffic levels in the day.
- Biz (business): this traffic profile is typical of a business, characterized by higher daytime traffic and lower levels in the night time and early morning.
- HH-flat: this traffic profile has usage volumes similar to a household, but traffic is spread relatively consistently across daytime and evening periods.
- Biz-flat: this traffic profile has usage volumes similar to a business, but traffic is spread relatively consistently across daytime and evening periods.

These profiles were derived in part using feedback received during the service provider consultation sessions.

Usage volumes were applied to each property based primarily on the property category (e.g., apartment unit, residential, school) and in some cases also based on the building size.

Step 3. Calculate the demand from each fixed Internet source by time of day.

The peak demand may occur for different times of day, depending on the relative density of the Internet demand sources. For example, areas with a high residential concentration will tend to have peak demands at night-time, whereas commercial and business regions will have peak demands during the day.

To calculate the peak demand for each demand source, the team made use of average monthly data usage information from the Cisco VNI Report, 2015–2020, in combination with the usage profile and quantity information as described in Step 2.

Monthly usage data was available in the Cisco VNI Report for Canada for both residences and businesses. The average monthly residential usage in Canada is 120 GB, compared with 325 GB for businesses.[4] Feedback on the accuracy of these metrics as part of stakeholder engagement consultations with the service providers was varied (too low, too high, and about right).

The Cisco data is seen as extremely useful for this study, because it reflects actual usage whose average is weighted toward a larger proportion of urban users who are likely to have the option of purchasing Internet speeds of up to 50 Mbps (last mile target speeds for this strategy). The middle mile network that is being proposed should be capable of supporting the expected peak traffic when high quality last mile Internet service options are available. Usage when lower quality last mile options are available will naturally tend to be lower, thereby reducing the demand experienced by the middle mile network.

[4] Cisco VNI Report, 2015–2020

The Cisco numbers also intrinsically factor in the uptake rate of a wide range of plans (some lower, some higher than 50 Mbps), considering a range of variables, such as economics and need. This is important, for just because a 50 Mbps service plan is available does not mean that everyone will subscribe to it. In some cases, the customer may not see a need for higher service plans or is not willing to pay more for one.

Step 4. Adjust the peak demand to account for mobile Internet traffic.
The middle mile infrastructure will also need to support mobile data traffic. Property location was used as a proxy for the distribution of mobile users throughout the province.

Monthly mobile data usage (non-Wi-Fi) per mobile device averaged 2 GB/month in Canada, representing about 3 per cent of all Internet traffic in Canada.[5] Using this adjustment factor, the monthly usage and corresponding peak downstream data rates were adjusted.

Step 5. Adjust the peak demand to account for Internet traffic growth.
Since the cost of the middle mile is significant, it is important to ensure that it will be sufficient for many years to come, considering Internet traffic growth.

The Cisco VNI Report has projected a compound annual growth rate in Internet usage of 18 per cent per residence and 17 per cent per business.[5] Penetration of broadband Internet in Canada is flattening out, with a compound annual growth rate of 1.3 per cent over the last 5 years.

In terms of mobility, the Cisco VNI Report has projected that the percentage of mobile Internet traffic relative to total Internet traffic will increase significantly over the next 5 years, from 3 per cent to 8 per cent. If this compound annual growth rate persists for mobile data, in 10 years mobile data traffic will comprise 21 per cent of total Internet traffic.

Using these metrics, 5- and 10-year demand projections per residence and business were calculated.

Based on 5-year demand projections for residential properties, a peak download data rate of 2.74 Mbps per residence will occur at night-time, whereas for business properties a peak download data rate of 8.58 Mbps will occur in the daytime. Residences and businesses with flat usage profiles will have sustained download data rates of 1.27 Mbps and 4.50 Mbps, respectively.

Step 6. Aggregate the peak demand into 1 km^2 grids for presentation and analysis purpose.
In the last step of demand mapping, the download peak demand rates for day and night scenarios were applied to each property in accordance with the usage volume and profile as classified in Step 2 for present-day, 5-year, and 10-year time frames.

Property demands were allocated within 1 km x 1 km square grids, based on lot location, to facilitate analysis. Because residential areas have a higher night-time peak usage and business areas have higher peak usage in the daytime, the demand map used for the study considered the maximum peak

[5] Cisco VNI Report, 2015–2020

demand (day versus night) within each 1 km x 1 km grid. This "worst case" demand map was then compared with the middle mile supply map, whose derivation is described in the next section, to derive what areas would benefit from expanded middle mile infrastructure.

4.4.2 Demand Mapping Results

The demand map below shows the distribution of demand data throughout the province.

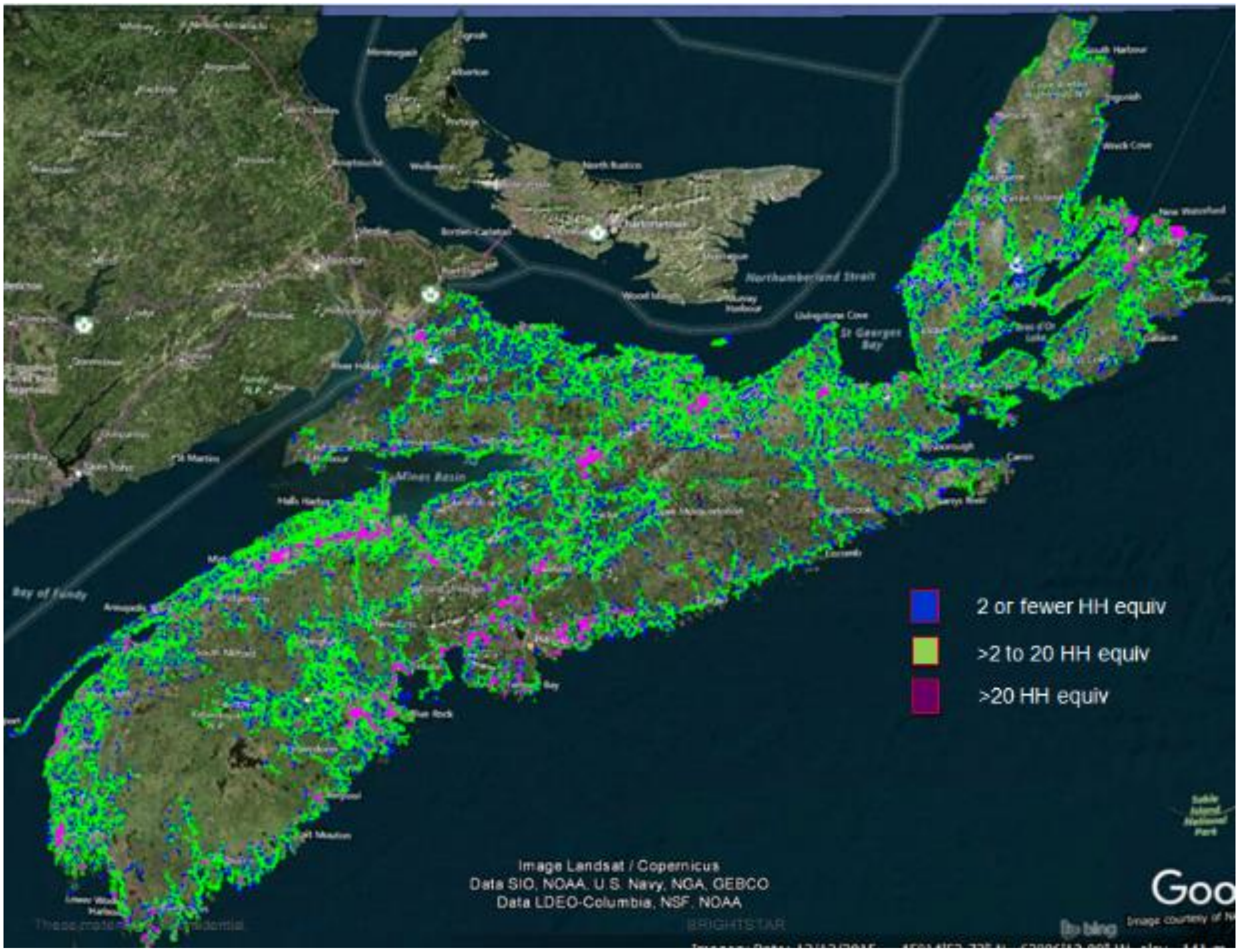

Figure 4-5. Demand Map in Units of HH-equiv

In the above map, a household equivalent (HH equiv) equals 1.06 Mbps today, 2.74 Mbps in 5 years, and 7.81 Mbps in 10 years. For conducting the budgetary design, 5- and 10-year demand maps were used.

4.5 Supply Mapping Process and Results

The middle mile infrastructure includes a network of optical nodes or points of presence (POPs) interconnected by fibre. The mapping of the infrastructure required input from the middle mile service providers, since the locations of the infrastructure is proprietary information.

Ideally, the supply map would include not only the locations of the POPs and optical nodes, but also their capacities and how they are interconnected with one another through fibre. The Brightstar team requested this information through the stakeholder engagement process from the companies with middle mile assets. The response varied by company. Some supplied complete POP information, others partial information, and some no information.

There are a few limitations to the study that are a consequence of incomplete infrastructure information from the ISPs:

1. Because POP/optical node capacity information was in general not made available, it was not possible to assess if a given POP/optical node was sufficiently sized to address the demand when performing the gap analysis. It was only possible to identify areas that could benefit from a new POP.
2. Because it was generally not known how the optical nodes/POPs were interconnected, the effects on the capacity of upstream POPs due to newly added downstream POPs were unknown.
3. Some providers' optical node/POP locations were not precisely known, and, it was not possible to know which households were serviced by which POP/optical node. Strategies have been put in place to estimate which households are serviced by which POP, as described in below.

Based on the optical node/POP location information received, a serving radius of 5 km was selected for analysis purposes. The serving radius was seen as sufficient to enable last mile service levels of 50 Mbps downstream for cable and fibre services and 10 Mbps downstream for fixed wireless services, which are the speed targets for the infrastructure. All properties within the serving radius would then be considered as adequately serviced by the existing middle mile infrastructure. Properties that remain outside the serving radii of the POPs and optical nodes collectively would need to be serviced through last mile services enabled through expanded middle mile infrastructure. This approach is shown graphically in the figures below.

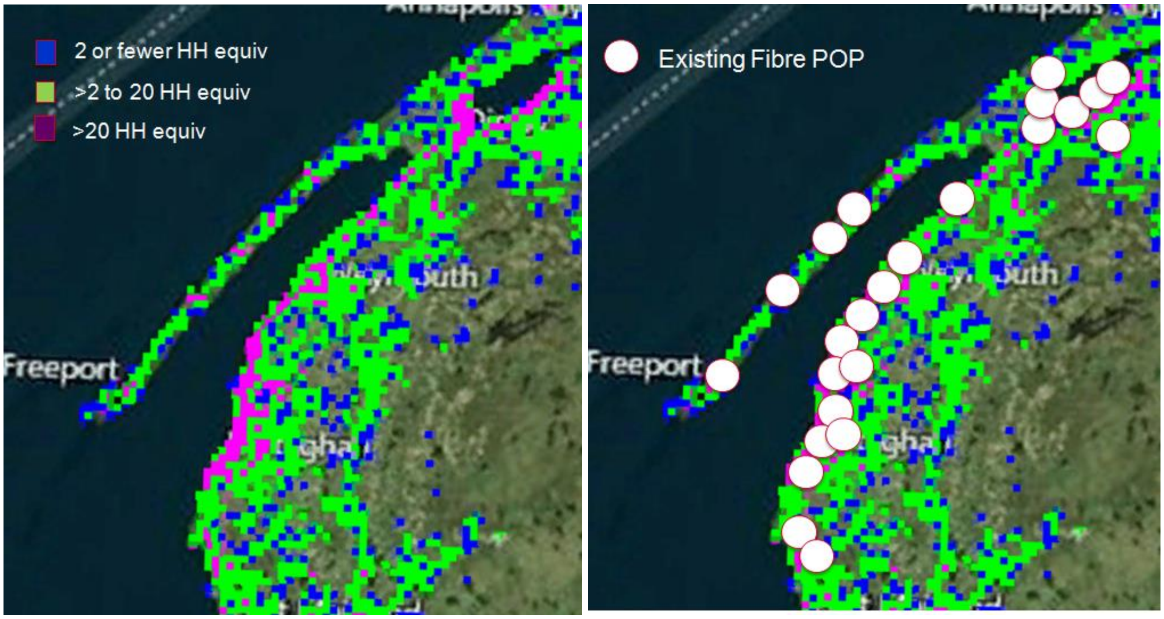

Figure 4-6. Demand Map showing Traffic Demand in 1 km² Grids in units of equivalent households with and without Existing POP/Optical Node Serving Radii (Supply Map for illustrative purpose only—does not present actual POP locations)

The image on the left shows the demand map with the demand density grids overlaid on Google Earth. The image on the right shows POP/node locations as white circles (for illustrative purposes). Each white circle has a radius of 5 km and grids below the white circle are considered serviced. Uncovered grids are considered unserved and would require additional middle mile infrastructure to enable service.

Note that only POP locations that were capable of delivering last mile services within the infrastructure performance targets were considered. Because DSL POPs are only able to support data rates of up to 7 Mbps, these were excluded from the supply maps.

4.6 Gap Analysis and Middle Mile Budgetary Design

4.6.1 Design Process

Once the supply map was overlaid on the demand map, Brightstar conducted a high-level reference design to address the service gaps, focusing on the demand density grids not already covered by existing infrastructure. The process followed to achieve this is described below.

To add middle mile infrastructure to enable last mile services for unserved areas, communities with a higher forecasted demand were identified as POP/optical node locations. Communities already identified as locations that would benefit from middle mile infrastructure through the Connect to Innovate program were selected as preferred candidates. A serving radius of 5 km was used for all new locations. This is illustrated graphically in the figure below.

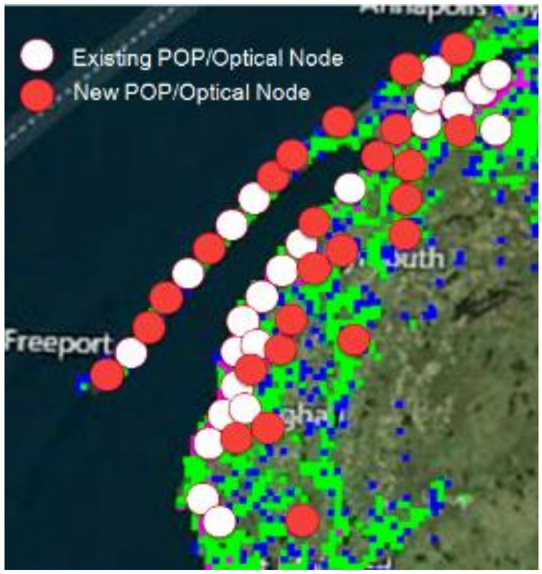

Figure 4-7. Map showing New POPs added to address Unserved Demand (Existing POPs shown are for illustrative purpose only—map does not present actual POP locations)

When reviewing this method with the ISPs, feedback was provided that new POPs in clusters of two or three could be combined into a single POP while still meeting speed targets. The map below illustrates this design modification. The red open circles represent the "service extension areas" of a new POP.

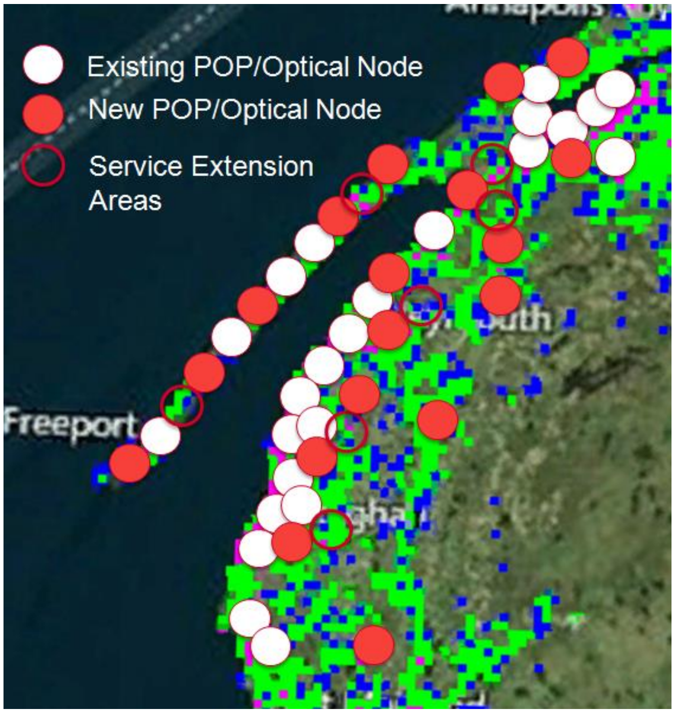

Figure 4-8. Map showing New POPs added to address Unserved Demand with Service Extension Areas (Existing POPs shown are for illustrative purpose only—map does not present actual POP locations)

To address the remaining demand, potential last mile wireless tower sites could be added. The towers could be backhauled by microwave links to POP/optical node sites. Industry practice for wireless network design is to avoid chaining multiple wireless towers together. This is because as last mile service plans increase, chaining sites can lead to wireless backhaul congestion. With this in mind, POP/optical node sites were added to ensure wireless tower sites do not need to hop through another tower site to reach the middle mile network.

Note that wireless tower sites are not considered to be part of the middle mile infrastructure. In all cases, location selection for POPs/optical nodes and tower sites has been determined from a budgetary perspective to facilitate infrastructure costing and to identify areas that could benefit from additional middle mile infrastructure. Actual site locations would be left to the private sector and would require consideration of a number of additional factors, including access to power, terrain quality, and space availability and affordability.

New POPs, in the vast majority of cases, need to be connected by fibre. In Nova Scotia, fibre is typically not buried. Rather, it is carried aerially on utility poles managed by Nova Scotia Power. To estimate the fibre length to connect the new POPs/optical nodes to the existing network, the following methodology was used:

1. The nearest POP/optical node location to the new POP/optical node added was identified.
2. The route between the POPs was examined for suitability (e.g., no river crossings, roads linking both POPs exist).

3. The straight-line distance between the POPs was measured and then multiplied by the square-root of 2. This multiplication factor is conservative and is reflective of the distance for a zigzag route between the POPs.

In cases where new POPs cannot be connected by fibre, a high capacity microwave link is assumed. This link would require that a tower site be constructed at each POP location. For example, this may occur for island regions where connection by fibre is not practical. The Brightstar team considers that in such a case the microwave equipment and tower sites would be part of the middle mile infrastructure.

4.6.2 Reference Engineering Design and Gaps Results

The process for Internet gap analysis is described in detail in Section 4.6.1. To perform the gap analysis, assumptions had to be made about which properties were serviced by existing middle mile infrastructure. A 5 km serving radius was assumed, since Internet speeds exceeding 50 Mbps download are possible for both HFC and FTTH technologies. The radius is also sufficient in most cases for meeting the fixed wireless service infrastructure speed targets of 10 Mbps download. Note that because it is not possible to know which properties are in reality allocated to which POPs, errors will be inherent in the gap map. Some locations within 5 km of a POP in certain cases may not be serviced by the POP, and there may be locations beyond 5 km from the POP that are serviced. The 5 km radius selected was seen as a reasonable serving radius capable of meeting last mile speed targets for practical purposes.

The process for conducting the middle mile budgetary design using the Internet gap analysis is described in detail in Section 4.6.1. As part of this process, new POPs were identified in areas with relatively high household densities within a 5 km serving radius. Preference to locations also identified in the ISED middle mile infrastructure funding project (the Connect to Innovate program) was given when identifying new POP locations. As described in Section 4.6.1, potential last mile wireless tower locations were also identified in areas of lower density, where a wired last mile service may be less practical. These wireless towers are included in the study but do not comprise the middle mile infrastructure. They were included so that the demand they cover can be included and its backhauled traffic can be allocated to a POP within the middle mile infrastructure.

Note, as well, that the location selection for POPs/optical nodes and tower sites as part of the design has been done from a budgetary perspective to facilitate infrastructure costing and to identify areas that could benefit from additional middle mile infrastructure. Actual site location determination would be left to the private sector and would require consideration of a number of additional factors, including access to power, as well as terrain and space availability and affordability.

4.6.2.1 5-Year Reference Design

To address the 5-year demand projections, Brightstar prepared a reference design for the unserved and underserved areas.The reference design includes 174 new or upgraded POPs and 1,079 km of additional fibre. Of the 174 POPs, 42 are new POPs located in communities that could qualify for Connect to Innovate funding.

Based on this design, 64.7 per cent of household-equivalents are already serviced by existing middle infrastructure. The new or upgraded POPs would enable service to an additional 28.7 per cent of household-equivalents, and 6.4 per cent would be within 15 km of a new or existing POP (i.e., within one wireless tower site to the POP). Only 0.2 per cent of the remaining household equivalents are more than 15 km from a POP. This middle mile coverage distribution is tabulated below.

Table 4-1. 5-Year Design—HH Coverage

Projected HH-eq Coverage Breakdown	HH-eq	%HH
Within existing footprint	203403	64.7%
Within new POP footprint	90216	28.7%
Within 1 wireless hop to new POP footprint	20212	6.4%
Within >1 wireless hop to new POP footprint	714	0.2%

It is also worth noting that the capacity upgrades of existing POPs due to higher local demand or due to new downstream POPs cannot be assessed. This is because existing POP capacity information was not made available by the service providers, nor was information relating to how the POPs/optical nodes were interconnected.

4.6.2.2 10-Year Reference Design

The reference design based on 10-year demand projections is mapped and shown in Appendix D. In this design, several wireless towers identified in the 5-year design have been converted to fibre POPs due to increased demand forecasts within 10 years. Whereas the 5-year design assumed a forecasted peak demand of 2.74 Mbps per household-equivalent, in 10 years, this is expected to increase to 7.81 Mbps. Once the local serviced demand for the wireless tower reaches 1 Gbps, it is assumed that the tower should be backhauled by fibre instead of wirelessly.

The design proposed is an evolution of the 5-year design. In this design, 37 new POPs would be added at the budgetary wireless tower locations. These POPs are connected using an additional 561 km of fibre compared to the level of the 5-year design. The design also considers that the wireless towers are converted to POPs or optical nodes so that a wireline service capable of 50 Mbps downstream speeds would be enabled.

Based on this design, the number of household-equivalents that would be serviceable by a wireline service within the new POP footprint would grow from 28.7 per cent to 30.2 per cent, and the number of household-equivalents that would be within a wireless hop of a POP would drop from 6.4 per cent to 4.9 per cent. This middle mile coverage distribution is tabulated below.

Table 4-2. 10-Year Design—HH Coverage

Projected HH-eq Coverage Breakdown	HH-eq	%HH
Within existing footprint	203403	64.7%
Within new POP footprint	95080	30.2%
Within 1 wireless hop to new POP footprint	15348	4.9%
Within >1 wireless hop to new POP footprint	714	0.2%

4.7 Alignment with Other Projects

The recommendations from this middle mile strategy, if implemented, will result in a significant deployment of new electronic networking equipment across Nova Scotia. The construction associated with the installation of this equipment will potentially see hundreds of kilometres of new fibre optic cable run, as well as the creation of many new points of presence (POPs) and optical nodes.

It is recommended that existing buildings and locations are utilized for the housing of this new equipment wherever feasible. In addition, if there are any existing federal, provincial, or municipal projects occurring in areas where new middle mile infrastructure is to be installed, these projects should be evaluated to determine if there is any way in which they may be of benefit to the implementation of the middle mile strategy.

The following paragraphs will describe the basic physical requirements of suitable POP locations and what types of projects may be of benefit to the implementation of middle mile technologies. The last paragraphs of this section will suggest various stakeholders (governmental departments, agencies, and groups) who should be contacted to determine what project work is being done in the areas where middle mile technologies are being implemented.

A POP is a break-out point where the main fibre optic network cables are tapped into and electronics are connected to allow individual households or businesses to be connected to the Internet. For a rural area, a single POP often consists of several electronic components mounted on a rack. The physical equipment of the POP can be contained in a weather-proof cabinet or enclosure or in a closet-like room within an existing building. It can be more cost effective to house these electronics inside existing physical structures, rather than build specialized, weather-proof structures. For this reason, all public buildings, in particular during any renovation projects, should be considered during the implementation of middle mile infrastructure to see if a POP can be co-located in them. The buildings in question include government offices, hospitals, schools, warehouses, post offices, and police and fire stations, to name a few.

When considering whether an existing structure can be used as a POP, the following conditions would have to be met: sufficient space, adequate physical security, access to an appropriate power source, proximity to the main fibre optic backhaul cable, adequate control of the environment (including temperature, humidity, and dust), and, finally, accessibility for technical staff needed to maintain the equipment (access to the equipment should be unlimited, for if you can't get on a school roof on a Saturday, then it is not really an option). The list of requirements for a POP is essentially the same as what is required for the building of a communications or server room for a medium-size organization. As the physical requirements for a POP are not that onerous, many existing public buildings in the province would provide ideal locations for this new equipment.

In conjunction with the establishment of the POP, hundreds of kilometres of fibre optic cable will need to be run across the province. Most of the existing fibre in Nova Scotia is "aerial," which means it is mounted above-ground on utility poles. Additional fibre to be run can be mounted on utility poles, but it may also be buried if there is a financial advantage to doing so. If there is a local project involving paving or curb, gutter, water or sewer work in an area where new fibre optic cable is to be installed, it may be advantageous to install the fibre at the same time as the other project is being conducted, to save the cost of trenching and excavating.

Likewise, any other government-funded projects that involve data or electrical wiring should be investigated for the possibility of the co-location of a POP. These projects may include typical technology-related work, such as renovations to server rooms and data centres, or the building of communication towers. Other projects that may not immediately be considered, but may be of benefit, include the building of road signage, digital signage, street lights, and traffic cameras. Many of these projects could contribute to cost savings by reducing the need for additional power or by providing a location for the mounting of electronic equipment.

The list of stakeholders to survey for information concerning potentially beneficial projects essentially includes all governmental departments; however, below is a list of key groups that should be contacted at the time of implementation of the middle mile strategy. The list is not exhaustive and is meant to be a guide to the variety of groups that may have projects whose coincidental implementation with the strategy could contribute to cost savings:

- Municipal Affairs
    - Municipalities
    - UNSM
    - Real estate developments
- Transportation and Infrastructure Renewal
    - NS Highway
    - Public Works
- Internal Services Department
- Department of Energy
- Department of Natural Resources
- Office if Aboriginal Affairs
- Department of Health and Wellness
    - Hospitals/clinics
- Department of Education and Early Childhood Development
    - Schools
- First Nations
- Service Nova Scotia
    - Access NS
- Department of Labour Advanced Education
    - Colleges/Universities
- Communities Culture and Heritage
- Regional Economic Networks
- Federal Departments/Organizations
    - ISED
    - ACOA
    - Department of Fisheries and Oceans
    - Canadian Armed Forces
    - RCMP

    - Coast Guard
    - Canada Post
- NS Power
    - NS Power is a key stakeholder, considering it owns most utility poles on which most fibre optic cable is mounted in the province.
- Other community buildings or locations, including
    - Fire departments
    - Police departments
    - Community services offices
    - Department of Energy offices
    - Wind farms
    - Port Authorities/wharves
    - Natural Resources offices
    - Emergency Measures offices

5 Financial Analysis

The objective of the financial analysis is to estimate the cost to build and operate the additional middle mile infrastructure and to determine the public subsidy that would be needed to ensure it remains viable and sustainable. The process followed was to estimate the capital (CapEx) and operating (OpEx) expenses and revenue that would result from implementing the middle mile infrastructure reference engineering designs. The financial analysis of the CapEx and resulting middle mile net operating return or loss was then used to determine if a market failure condition exists.

The CapEx and OpEx used for the budgetary engineering designs were determined based in part on ISP feedback. Middle mile infrastructure CapEx that was considered included the costs for POP and fibre equipment and their installation. OpEx that was considered included the ongoing costs to operate and maintain the middle mile infrastructure equipment, including rent, pole access costs for fibre, cost of power, maintenance, and warranty.

The revenue generated for the incremental middle mile infrastructure was based on revenue estimates validated through ISP feedback for the middle mile only. Middle mile revenue is derived from middle mile access fees and capacity sold to ISPs, private enterprise, and public institutions. No last mile revenue is considered in the middle mile infrastructure financial analysis.

Net present cash flow analysis was completed using third-party sourced rates of return for the industry and the cost and revenue resulting from the engineering design.

The 5-year and 10-year demand designs are based on middle mile infrastructure asset locations (POPs) provided from middle mile service providers capable of enabling last mile speed targets. These designs are described in Sections 4.6.2.1 and 4.6.2.2.

In the 5-year design, 174 new or upgraded POPs are required, which will serve 110,428 household-equivalents, as tabulated below. After 10 years, the total number of POPs will increase to 211.

Table 5-1. Middle Mile Infrastructure for 5-Year and 10-Year Design

New POPS	5-Year Quantity	10-Year Quantity
TOTAL POPs	174	211
km Fibre	1,079 km	1,640 km

The CapEx of the expanded middle mile infrastructure for the 5-year design is estimated at $75–85 million for 174 POPs, with an on-going annual OpEx of $6–$8 million. An incremental CapEx of $25–$30 million would be needed to meet the projected 10-year demand. The 10-year design CapEx total is estimated at $100–$115 million for 211 POPs.

It is worth noting that for the 5-year design only 43 of the 174 POPs generate a positive operating return. For the 10-year design 116 of the 211 POPs generate a positive operating return.

Middle mile revenue is derived from middle mile access fees and capacity sold to ISPs, private enterprise, and public institutions. The middle mile also serves to provide last mile services, which are not considered in this analysis. Feedback from the ISPs provided varying views regarding the amount of revenue that could be earned from their middle mile customers, and hence a range of middle mile sales penetration rates were evaluated for the 5-year and 10-year designs based on their feedback.

When conducting net present value analyses across a range of the sales penetration rates, ranging from the most pessimistic to the most optimistic, the NPV operating return for the full range of 5-year demand middle mile sales penetration rates was negative. For the 10-year analysis, in only the most optimistic scenario was a positive NPV observed.

For this reason, Brightstar has concluded that a middle-mile-only implementation would most likely not be considered by a market participant, and the last mile market would need to be taken into consideration when determining whether a middle mile investment is economically viable.

5.1 Last Mile Considerations

In a large number of cases, the owner of the middle mile infrastructure is also the last mile provider. When the middle mile infrastructure owner is also the last mile provider, there would be opportunities to significantly increase last mile services and revenue to support the cost of building middle mile infrastructure.

The enhancement of middle mile infrastructure provides an opportunity to invest in last mile infrastructure to deliver more capacity and faster Internet speeds, thereby allowing the sale of higher revenue generating packages to consumers for Internet, TV, and home services. ISPs can convert their customers from voice-only services to voice and Internet services, or potentially convert to a triple-play offering (voice, Internet, TV) to generate increased average revenue per user (ARPU).

Because of this, when assessing the middle mile and last mile together, there is very likely an opportunity to generate positive operating returns. This could lead to the necessity of the middle mile provider also being the last mile provider, in most cases, to earn a positive operating return.

There is an opportunity to support operating the middle mile infrastructure build if the last mile revenue is taken into consideration. An engineering design of the last mile and a more in-depth analysis of the last mile operating return, including ISP feedback, is needed to determine the financial contribution of the last mile to the middle mile.

5.2 Funding Middle Mile Infrastructure – Market Failure

Notwithstanding all of the evidence and analysis that has been summarized to support the adoption of universal service objectives of the Province of Nova Scotia, there is still a wide range of opinion on who should fund the expansion of broadband Internet infrastructure to meet these objectives—and, if the funding comes from both private and public sectors, on how much each contribute. Many people observe that private sector telecom companies make substantial profits and wonder why governments would provide any funding to companies that are already profitable. The answer to this question forms the basis for a very important policy recommendation for the middle mile broadband strategy:

The government of Nova Scotia should provide funding and organizational support for the deployment of middle mile broadband Internet only in circumstances in which there is clearly identified market failure or a compelling public policy imperative.

Economics Online explains these terms:

> A significant market failure is the failure to produce some goods and services, despite being needed or wanted. Markets can only form under certain conditions, and when these conditions are absent markets may struggle to exist. The most extreme case of a *missing market* is the case of pure public goods.
>
> Pure public goods clearly provide a benefit to the consumer, but, for several reasons, are unlikely to exist in a market economy. Examples of pure public goods include national defence, the police service, and street lighting. Because markets for these goods are not likely to form they are called missing markets and are considered a special case where demand exists, but supply is absent.[6]

The rapid evolution of the Internet and the resulting growth of a digital economy are creating a shift in the perception of public versus private goods. Historically, broadband Internet services have evolved out of private sector innovation and investment, but now all citizens require access to the Internet in order to participate in the digital economy. Under a purely market-driven model, rural citizens would either get no or insufficient access to broadband Internet, or they would have to pay exorbitant fees. In this case, broadband Internet has become an essential public good, like street lighting or police services.

The following process was used to identify whether there is indeed market failure in the supply of middle mile broadband Internet in the province of Nova Scotia:

- Analysis of the current and future supply of middle mile infrastructure in Nova Scotia (See Section 4.5)
- Mapping of existing known middle mile broadband Internet assets (See Section 4.5)
- Consultation with ISPs on future development plans (See Section 3.2)
- Determination of the current and future demand for broadband Internet in Nova Scotia, using industry analyst projections and modeling (See Section 4.4)
- Determination of whether there is a gap between supply and demand (See Section 4.6)
- Analysis of what it would cost to close the gap between supply and demand, using industry average infrastructure costs (See Section 5)
- Determination of whether the private sector would invest enough money to close the gap between supply and demand, using industry average economic analysis of internal rates of return (IRR):

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[6] Economics Online. http://www.economicsonline.co.uk/Market_failures/Missing_markets.html

• If YES, on what timeline would they close the gap? If the private sector is likely to close the gap with its own investment on a reasonable timeline, then there is no need for government investment.
• If NO, then there is market failure and the government should intervene.

If there is a market failure condition, the following process should be considered:

- Use a competitive procurement process to identify the most cost effective (i.e., requiring the least amount of government subsidy to achieve universal service objectives) way to close the gaps between supply and demand.
- Negotiate service-level agreements that require private sector broadband Internet providers to continue ongoing infrastructure investments in the future.

6 Recommendations

After consulting with public sector stakeholders and Internet service providers in the province, the team has arrived at the following recommendations concerning Internet speed, coverage, and timeline.

1. Speed: The middle mile infrastructure that is developed should **enable last mile Internet service speeds of up to 50 Mbps download for wired last mile services and up to 10 Mbps download for wireless last mile services**. The 50 Mbps target is consistent with recent CRTC goals for connectivity in Canada.[7] The middle mile speed targets are tabulated below.

Service Type	Minimum Download Speed (Mbps)
Wired (e.g., Fibre and Hybrid Fibre-Coax)	50 Mbps
Fixed Wireless Service	10 Mbps

2. Coverage: The **middle mile infrastructure should enable coverage for the vast majority of rural residents, in excess of 95 per cent of populated rural property locations**. Although coverage is a last mile goal, the middle mile infrastructure should be sufficient to make these last mile targets achievable. Most of the remaining populated rural property locations could then be serviced through satellite technologies, which do not rely on middle mile infrastructure. Satellite speeds of up to 25 Mbps downstream will be possible later in 2018 with the launch of the new satellite service.
3. Timeline: Due to the expense of the middle mile infrastructure, the timeline for its usefulness must extend out several years. For the middle mile infrastructure, the team is recommending a time horizon of **10 years for middle mile electronics**. Deployed fibre must have a much longer time horizon due to deployment expense and the expected longevity of the technology. To save cost yet allow for scalability, the initial electronics deployment should be sufficient to meet 5-year demand projections and be scalable up to its ultimate capacity over 10 years. The team concludes that **the expanded middle mile infrastructure could potentially be implemented within 2–4 years of signed contracts**.

After developing reference designs for the expanded middle mile infrastructure that can meet the infrastructure performance goals, Brightstar performed a financial analysis of the expanded infrastructure and confirmed that a condition of market failure exists. This demonstrates a need for public sector support to build the expanded middle mile; the conditions are not sufficient for the infrastructure to be built by the private sector alone. Furthermore, the Brightstar team has determined that, under most scenarios studied, middle mile broadband Internet wholesale revenues are insufficient to offset operating costs for the expanded infrastructure, making the infrastructure non-viable regardless of any government subsidy. However, when last mile revenue is also considered, Brightstar has determined that a business case exists with government subsidization. To estimate the subsidy requirement, last mile costs will also need to be considered. These last mile costs will need to

[7] Telecom Regulatory Policy CRTC 2016-496

be determined as part of the last mile strategy, which is beyond the scope of this strategy. This analysis has led Brightstar to make the following recommendations:

- commence implementation of the middle mile strategy
- complete the development of the last mile strategy and then implement

Appendix A – Stakeholder Engagement Consultations

As part of the development of a middle mile strategy for the Province of Nova Scotia, the engagement of a variety of key stakeholders was deemed essential. This section provides the meeting outline and questions asked to the stakeholders.

1.1 Public Sector Consultations Meeting Outline and Questions

1.1.1 Opening Remarks

The Department of Business introduced the Brightstar team members and provided the background to the day's session, explaining that

- the province recognizes the importance of dependable, affordable high-speed Internet services to municipalities, residents, businesses, and the education and health sectors
- ensuring sufficient bandwidth for today and for future demand is a key priority of the minister and the government
- significant parts of Nova Scotia are either unserved or underserved
- improving high-speed services, especially in these areas, will help grow the local and provincial economies
- the objective of this strategy is to develop a *middle mile strategy* that will support high-speed Internet infrastructure across the province

1.1.2 Why is the Middle Mile Important?

Why the middle mile is important was explained to the participants at each session. The question served as an opportunity to explain what the middle mile is and how it fits with the overall approach to improving broadband Internet availability.

The middle mile is essentially the "backhaul" network that carries information traffic to and from the Internet. It must be scalable to manage the ever-increasing demand for bandwidth, and it must have "on and off ramps" strategically located so that Internet service providers can connect to it and serve their customers in their homes, businesses, or institutions.

1.1.3 Objectives of the Session

In each session, the Brightstar team set out the general objectives and outlined what importance the provincial government has placed on consulting with key stakeholders. The participants were advised that this was Phase 1 and that we would be seeking their feedback on the following matters:

- technical issues
- the importance of high-speed services to their operations currently and into the future

- what they felt were their required service levels today and would be in the future
- feedback on possible models for the delivery of the middle mile and the governance thereof
- identifying any local or regional municipal infrastructure projects that might support the building of the middle mile

During the planned Phase 2 of the stakeholder engagement process, the team will
- share the observations and suggestions offered during Phase 1
- share draft recommendations
- gather further recommendations and suggestions for consideration

1.2 Service Provider Meeting Outline and Questions

1.2.1 Opening Remarks

The Department of Business introduced the Brightstar team members and provided the background to the meeting, explaining that
- the province recognizes the importance of dependable, affordable high-speed Internet services to municipalities, residents, businesses, and the education and health sectors
- ensuring sufficient bandwidth for today and for future demand is a key priority of the minister and the government
- significant parts of Nova Scotia are either unserved or underserved
- improving high-speed services, especially in these areas, will help grow the local and provincial economies
- the objective of this strategy is to develop a *middle mile* strategy that will support high-speed Internet infrastructure across the province

1.2.2 Last Mile Service Provider Questions

The Brightstar team posed the following questions to the last mile service providers to better understand how they are connecting to middle mile infrastructure:

a. Do you believe the middle mile infrastructure is sufficient to meet the needs of your customers today and in the future?
b. What are your plans for growing your last mile network? (e.g., higher speed offerings, more customers, new territories)
c. What barriers presently exist that keep you from offering higher speed Internet services to your customers or adding new customers to your last mile network?
d. What rates are you paying for middle mile access? What rates would keep you from connecting to the middle mile infrastructure? Could you supply your rate charts for service?
e. What type of last mile access do you currently offer (e.g., fibre, DSL, cable, fixed wireless)?
f. What speeds are you capable of offering your customers?
g. Would your customers be willing to pay more for higher speed or better Internet service if it were available?

1.2.3 Engineering Questions

The Brightstar team presented the technical approach for determining the middle mile infrastructure gap, as well as the costs of addressing the gap. Relating to the presented methodology, the following questions were posed:

1. Middle mile demand sources: Other than last mile sources of demand, such as residences, businesses, cellular telephone customers, government facilities, and health and public safety services, are there other sources of demand we should consider in the government's rural middle mile strategy?
2. Middle mile demand estimates by user base. Can you provide feedback on the following monthly demand targets by user base?
    a. Residences: 120 GB/mo (CAGR of 18%): source Cisco VNI report 2015–2020
    b. Businesses: 325 GB/mo (CAGR of 17%): source Cisco VNI report 2015–2020
    c. Mobile data: 2 GB/mo (CAGR of 42%): source Cisco VNI report 2015–2020
3. What average monthly usage per residential Internet connection are you seeing in urban areas?
4. For residential users, what times of day (e.g., 10:00–2:00) have the highest sustained usage? What is the peak usage you are observing?
5. What average monthly usage per business Internet connection are you seeing in urban areas?
6. For business users, what times of day (e.g., 10:00–2:00) have the highest sustained usage? What is the peak usage you are observing?
7. To help us map the current middle mile infrastructure capability, can you provide the following engineering inputs?
    a. map showing POP/CO locations (jump-off points to last mile) and capacity at each location
    b. the last mile technology in existence at each POP/CO location
    c. the serving radius from a POP/CO by last mile technology (e.g., fibre, DSL, fixed wireless) for different targeted data rates (e.g., 5 Mbps/10 Mbps/25 Mbps/100 Mbps)
    d. last mile technology choice based on household density (For example, at what household density or community size would you deploy fibre versus DSL versus fixed wireless?)
    e. map showing middle mile fibre: lit fibre capacity and dark fibre capacity
    f. overbooking ratios/rules applied for middle mile when designing the middle mile network
    g. your method for converting between GB/mo and Mbps for demand mapping (percentage of traffic during busy hour, busy hour duration, etc.)
    h. typical middle mile traffic utilization thresholds applied before upgrading POP/CO locations

1.2.4 Financial Questions

The Brightstar team posed several financial questions to help inform the strategy about the business case that needs to be developed to address the middle mile infrastructure gap.

1. What are the sources of middle mile revenue? “Wholesale” last mile revenue (e.g., $ per Mbps/month)? Other sources of revenue?
2. Would you participate in the middle mile project if there were no guarantee of a last mile government subsidy?
3. What community sizes would you foresee as requiring some degree of middle mile subsidization?
4. In such communities, what would your expected uptake rate be and what revenue would you expect to get within the community (e.g., in units of $ per household or $ per Mbps)?
5. CapEx cost elements. Could you provide budgetary guidance on the following CapEx cost elements for middle mile infrastructure?
    - POP/CO upgrade costs (e.g., $/Gbps)
    - POP/CO build costs (e.g., $/Gbps)
    - fibre-build costs (e.g., $/km)
6. OpEx cost elements: Could you provide budgetary guidance on the following OpEx cost elements for middle mile infrastructure?
    - power, rent, maintenance, equipment warranty, etc.
    - other OpEx elements
7. Return on investment threshold targets: What ROI requirements or targets would you need to achieve before you would extend your middle mile infrastructure into a community?

Appendix B – Property Selection Rules and Demand Data

1.1 Property Selection Rules

The property data provided by PVSC included over 600,000 listings, not all of which could be considered potential sources of Internet demand. After discussions with PVSC, properties with limited-use codes (LUCs) as follows were excluded from our study as sources of Internet demand:

- 0408 — sports field/parks
- 0504 — conservation properties
- 0507 — blank — for future use
- 0805 — incubator malls
- 1003 — highway commercial
- 1004 — waterfront development land
- 2001 — natural gas processing facility
- 2002 to 2005 — pipelines
- 2006 — related natural gas sites
- 2007 — distribution lines
- 3002 — fibre optics
- 3100 to 3150 — power generation
- 3210 to 3211 — substations
- 3250 — towers, lines, poles
- 5555 — condo parking spaces
- 6666 — $0 value land
- 7777 — $0 value condo parking space
- 8888 — possible commercial sale
- 9999 — income valued in another account

Additional rules regarding inclusion and exclusion are listed below.

- Apartments — INCLUDE this group.
- Commercial Sale — EXCLUDE this group.
- Commercial Vacant Land — INCLUDE this group if Building Size >1000.
- Condominiums — INCLUDE this group.
- Default LUC — INCLUDE this group if Building Size >1000.
- Industrial – INCLUDE this group if Building Size >1000.
- Lodgings — INCLUDE this group if Building Size >1000.
- Mobiles — INCLUDE this group.
- Office — INCLUDE this group.
- Pipeline — EXCLUDE this group.
- Professional Services — INCLUDE this group if Building Size >0.
- Public Buildings — INCLUDE this group if Building Size >1000, regardless of VACANT/IMPROVED.
- Restaurants/Recreational — INCLUDE this group if Building Size >1000.
- Retail — INCLUDE this group if Building Size >1000.

- Services — INCLUDE this group if Building Size >1000.
- Special Purpose/Heavy Industrial — INCLUDE this group if Building Size >1000.

1.2 **Property Demand Data**

After the property data was filtered to include only potential Internet demand sources, each property was assigned a usage quantity and profile in accordance with the property category, as tabulated below. For some categories, more than one usage profile was applied.

Category	Description	Usage	Profile	Usage	Profile
Apartment Units	each apartment in building	1	HH		
Commercial	general commercial	1	Biz		
Condo Units	each apartment in building	1	HH		
Res Units	house	1	HH		
Industrial Units	warehouse, distribution facility, light manufacturing	0.4	Biz		
Hotels	Hotels - hotel with multiple rooms	10	HH	1	Biz
Motels	Motels - motel with multiple rooms	3	HH		
Campgrounds	Campground	2	HH		
Country Inn	Country Inn - inn with multiple rooms	2	HH		
Residential	house	1	HH		
Daycare	Daycare	0.5	Biz		
Senior Home	Senior Home	1	HH-Flat	1	Biz-Flat
Retirement Home	Retirement Home	1	HH-Flat	1	Biz-Flat
Resorts	Resorts	5	HH		
Cottage	Cottage	1	HH-Flat		
Nursing Home	Nursing Home	1	HH-Flat	1	Biz-Flat
B&B	B&B	1	HH		
Mobiles	Trailers in a trailer park - one per trailer	1	HH		
Office < 3000	Office < 3000 sq-ft	1	Biz		
Office < 30000	Office < 30000 sq-ft	5	Biz		
Office > 30000	Office > 30000 sq-ft	10	Biz		
Professional Services Units	Includes banks and medical buildings	1	Biz		
Church	Church	0.1	Biz		
Education	Schools - this data has already been provided by Gvt	10	Biz		
Courts	Courts	2	Biz		
Fire Stn	Fire Stn	1	Biz-Flat		
Police Stn	Police Stn	2	Biz-Flat		
Post Office	Post Office	0.2	Biz		
Museum	Museum	0.5	Biz		
Halls	Assembly halls	1	Biz-Flat		
Fast Foods	Fast Foods	1	Biz-Flat		
Dining	Restaurant	0.5	Biz-Flat		
Bar	Bar	1	Biz		
Sports Facility	Sports Facility	2	HH		
Racetrack	Racetrack	1	Biz-Flat		
Bowling	Bowling	1	HH		
Arena	Arena	2	HH		
Theatre	Theatre	1	HH		
Marina	Marina	1	Biz		
Retail	Malls, plazas, grocery stores, dept stores, shops, big box stores	1	Biz-Flat		
Services	Car dealerships, garages, gas stations, transport companies	1	Biz		
Special Purpose	Refineries, gypsum plants, ship building, pulp mills	1	Biz		