

**Feasibility Study for
Alternative Yukon Fibre Optic Link**

Summary Report

February, 2014



Contents

- 1 Executive Summary.....3**
- 2 Project Background.....3**
- 3 Situation.....4**
 - 3.1 Telecommunications Market.....4
 - 3.1 Service Providers5
 - 3.2 Services.....5
 - 3.3 Infrastructure6
 - 3.4 Telecommunications Regulation6
 - 3.5 Summary of Needs7
- 4 Network Requirements and Options.....7**
 - 4.1 Capacity.....7
 - 4.2 Infrastructure and Technology Options.....7
 - 4.3 Route Options.....8
- 5 Recommended Infrastructure.....10**
 - 5.1 New Fibre Link10
 - 5.2 Performance Requirements.....12
 - 5.3 Whitehorse Point-of-Presence Building and Equipment12
 - 5.4 Customer Access Facilities.....12
 - 5.5 Carcross Point-of-Presence.....13
- 6 Business Structure13**
 - 6.1 Recommended Structure.....13
 - 6.2 U.S. Partner14
 - 6.3 Market opportunity.....14
 - 6.4 Subsidy funding15
- 7 Recommended Solution – Summary15**

1 Executive Summary

Almost all telecommunications in and out of Yukon is carried over a single fibre optic transmission system owned and operated by Northwestel. This report summarizes the methodology and results of a feasibility study covering the proposed establishment of a second, diverse fibre link into Yukon. The rationale for this proposal is based on improving reliability of telecommunications services and promoting competition and lower service prices in the Yukon market. Based on assessment of opportunities to date, this market is presently too small to support such a large project without public funding. Planetworks Consulting was engaged to develop cost and revenue estimates and to determine the size of the public subsidy required. The study is intended to provide sufficient depth and credibility to enable private sector investors, Yukon government and other agencies to make funding decisions and to initiate the project.

Based on the findings of the study it is recommended that a privately owned company be established to implement a Whitehorse–Juneau fibre optic link with connections to Seattle as well as offer wholesale data and internet services in Whitehorse. The company will require a one-time grant of at least \$12.8 Million to cover half of the startup costs and enable a viable business plan. The business plan assumes funding from both public and private sources, capacity sharing agreements with Northwestel, and a 10 year commitment from the Government of Yukon to purchase connection capacity from the new company.

After evaluating business structure options, it is recommended that the new company build, own and operate the fibre system to the U.S. border, and engage a U.S. partner to construct, own and operate all facilities on the U.S. side of the border. This option requires a lower public subsidy and would avoid higher costs and involve risks associated with operating facilities in a foreign country.

2 Project Background

The Information and Communications Technology (ICT) sector is a key component of Yukon economy in providing high paying stable jobs as well as supporting industries that rely on ICT services. The telecommunications sector also provides Yukoners with access to the internet and the wealth of information and possibilities that it provides.

A major inhibitor to realizing the potential of the ICT sector has been identified as the single fibre optic link that connects Yukon to southern Canada. Also, Yukon prices for enterprise data and internet services are higher than in southern Canada while innovation and the introduction of new services lags behind. The situation is well described in the recent ICT Sector Strategic Plan and Yukon Telecommunications Development Report¹. The realization of an alternative fibre link by an independent service provider would improve the reliability of communications services and enable

¹ Yukon Telecommunications Development Final Report, Lemay-Yates Associates for the Government of Yukon, December 14, 2012.

competition and innovation in the telecommunications sector thus reducing prices and improving service levels.

Studies conducted by the Government of Yukon suggest that an alternate fibre link will result in:

(a) the emergence of competitive services which will

- Lower prices
- Increase innovation
- Provide additional employment, and

(b) improved reliability of services which will

- Reduce lost productivity due to data and internet outages
- Reduce lost revenue due to point-of-sale outages
- Enable new businesses that provide application level services to emerge
- Improve the ability of businesses and organizations to utilize cloud based services.

3 Situation

3.1 Telecommunications Market

Numerous studies have described the telecommunications market in Yukon and the City of Whitehorse in particular since it represents about 70% of Yukon population and is therefore of most interest to service providers. A recent analysis by BDC Consulting² examined retail and wholesale revenues for data services in Whitehorse. Revenue estimates were segmented into consumer, small/medium business, enterprises and institutional categories covering television, cell phone and internet/data services. Wireline telephone, long distance voice and business private line services were not included since they are not growing and cannot be easily transferred to next generation Internet Protocol (IP) based networks. In fact these legacy services still represent a large portion of total telecommunications revenue. As current subscribers migrate their voice and data requirements to internet-based services there is projected to be a gradual decline in total net revenue.

It is useful to examine the telecommunications market in terms of volumes (e.g., number of users, Megabytes per month, etc.) rather than revenues since the latter are dependent on current service prices that tend to be more volatile. As an example, in early 2013 the CRTC ordered a roughly 60% reduction (later revised to about 50%³) in Northwestel's wholesale data service rates. This will likely result in a corresponding reduction of retail prices due to new competitive providers entering the market. Prices for mobile data are also volatile with frequent increases in volume limits without corresponding price increases.

² Fiber One Market Assessment, BDC Consulting for Total North Communications, January 2010

³ Telecom Regulatory Policy CRTC 2013-711 : Northwestel Inc. – Regulatory Framework, Modernization Plan and related matters , 18 December 2013 <http://www.crtc.gc.ca/eng/archive/2013/2013-711.htm>

Monthly internet traffic volume in Yukon is currently increasing at about 25% per user per year for wired services and about 40% per year for mobile users. At the same time voice long distance minutes are decreasing at about 6% per year.

The most recent CRTC Communications Monitoring Report⁴ shows that the average traffic downloaded per month by residential internet subscribers in Canada rose from 17.9 GB in 2011 to 28.4 GB in 2012; an increase of over 50%. This is heavily weighted by metropolitan areas where, unlike Yukon, there are minimal bandwidth restrictions.

BDC's 2010 study² estimated that the total retail revenues associated with the data services market in Whitehorse exceeds \$18 Million per year.

3.1 Service Providers

As of 2012 Northwestel was the only telecommunications and cable television provider in Yukon with the exception of Bell Mobility in Whitehorse and the community-owned cable TV provider in Dawson City. Both Northwestel and Bell Mobility are part of the Bell Canada Enterprises (BCE) group. Satellite TV services are provided by both Bell and Shaw.

Recently Bell Mobility announced acquisition of Northwestel's Latitude Wireless business throughout Yukon and Ice Wireless began offering service in Whitehorse. Also, Mid Arctic Technology Services has announced plans to provide internet service to high volume customers (e.g., hotels) in Whitehorse. Additional competing ISPs are emerging to take advantage of Northwestel's CRTC-mandated Wholesale Connect rates.

3.2 Services

Considering its small and remote population the availability of modern telecommunications services in Yukon is quite extensive and comparable to most areas of southern Canada. Unfortunately the pricing, capacity and reliability of these services fall well outside an acceptable range due to the cost and vulnerability of infrastructure and lack of competition. There are simply not enough customers and revenues available to support required investments and operating costs.

The Lemay-Yates study notes that services in Yukon are not keeping up with the rest of Canada. This is confirmed by detailed analysis as well as stakeholder interviews. In comparing Yukon to Canadian averages the report describes several areas of concern including:

- 33% lower internet download speeds (average);
- higher prices for the same speeds for consumer, business and mobile internet services; and
- lower reliability caused primarily by outages on Northwestel's non-redundant network links.

⁴ <http://www.crtc.gc.ca/eng/publications/reports/policyMonitoring/2013/cmr.htm>

These telecommunications shortfalls have a significant negative impact on the Yukon economy and its ability to be competitive in the future.

3.3 Infrastructure

Almost all publicly available telecommunications infrastructure in Yukon is owned and operated by Northwestel. This includes the fibre and microwave radio backbone network which connects Whitehorse with other communities and the outside world as well as all telephone, DSL and cable TV customer access facilities within the City.

In addition to Northwestel's facilities there are numerous low capacity wireless links and systems in place for private use. Satellite TV and internet services are also available.

Due to Yukon's geography and transportation corridors, and the resulting design of Northwestel's backbone network, there are many network segments that cannot be restored on diverse routes in the event of failure (e.g., fibre cable damage, power outages). This means that service outages are frequently extensive and last many hours. Since higher layer functions in the network (e.g. switching and routing) tend to be in a star configuration with Whitehorse at the center, one outage may impact all of Yukon as well as Northwestel services in other territories.

3.4 Telecommunications Regulation

The recent Lemay-Yates report provides an extensive description of historical and current CRTC regulations affecting telecommunications in Yukon. The relevant and key regulatory factors to date can be summarized as follows:

- The CRTC has acknowledged the need for ongoing subsidies to sustain Northwestel's operation and ensure that all Yukon communities continue to have at least basic telephone services. Northwestel currently receives \$20.8 Million in annual subsidy from the National Contribution Fund (NCF);
- Given that Northwestel is the only provider of local telephone service in the region the CRTC regulates the rates, terms, and conditions under which it may offer this service. This regulatory regime is known as the price cap framework;
- In 2011 the CRTC expressed concern that Northwestel's shareholders have benefited from the price cap regulatory framework to a far greater extent than its customers and denied Northwestel's proposed \$2 increase to residential and business local service rates. It also denied an additional NCF subsidy to fund two service improvement plans and reduce the Carrier Access Tariff (CAT), a per-minute rate paid by competitive long-distance providers to originate and terminate traffic in Northwestel's territory;
- The Yukon telecommunications market is open to competition for most services. However, established competitors have not materialized due to small markets, high costs and/or acquisitions by Northwestel;

- In Decision 2013-771 the CRTC found that Northwestel has market dominance in retail internet services and decided to re-regulate, by requiring Northwestel to file tariffs for all retail internet services;
- Northwestel was recently ordered by the CRTC to reduce its data wholesale rates³ significantly to encourage competitors to enter the market;
- A CRTC public review of Northwestel's revised network modernization plan has been completed; and
- The CRTC has established target minimum broadband internet speeds of 5 Megabits per second (Mbps) downstream and 1 Mbps upstream for all Canadians by 2015.

3.5 Summary of Needs

There is a clear consensus amongst public sector entities, businesses and the general public in Yukon that major improvements in the reliability, speeds and pricing of internet and other data services are required. It is not possible to provide acceptable service reliability with a single fibre route connecting Yukon to the rest of the world, and highly unlikely that internet speeds and pricing will improve as long as there is only one service provider that must maximize benefits to its shareholders. It is also recognized that the small telecommunications market in Yukon cannot provide sufficient revenues to support the cost of a second fibre route and that a large public subsidy will be required.

4 Network Requirements and Options

4.1 Capacity

The current active fibre system capacity on Northwestel's route crossing Yukon - BC border is 10 Gigabits per second (Gbps) according to the Lemay – Yates report. The total capacity requirement for cross-border telecommunications services is estimated to be in the range of 15 to 20 Gbps by 2017 and 30 to 40 Gbps by 2022. This includes all legacy voice and data as well as internet-based services. A diverse route will need to provide at least equivalent capacity in order to maintain operation of all services in the event of failure of the existing Northwestel Whitehorse to Fort Nelson fibre route. In normal conditions both routes will carry a share of working traffic. The new fibre route must be easily expandable in 10 Gbps increments without major investments in equipment.

4.2 Infrastructure and Technology Options

The only communications technology that can provide the required capacity and scalability is a fibre optic transmission system consisting of fibre optic cable and electronic terminal equipment. Each fibre cable consists of multiple fibre strands encased by a protective sheath and appropriate armor for buried or undersea installation. Transmission of information is normally carried on two fibre strands, one for each direction. A second pair of strands is often assigned for back-up. Electronic equipment at each end

of the fibre cable converts information (e.g., voice, video, data) into light pulses at a particular wavelength and can transmit information at speeds up to 40 Gigabits per second or higher. 80 or more wavelengths can be used simultaneously on the same pair of strands. Typically 24 or 48 strand cable is used resulting in a total cable capacity of at least 38 Terabits per second. Most fibre cables are capable of providing even greater capacity using more sophisticated terminal equipment.

4.3 Route Options

In order to provide a route that is fully diverse from the existing Northwestel fibre route a high capacity connection needs to be constructed between Whitehorse and a major North American gateway location where there is access to both the internet backbone and to fibre networks operated by other major carriers. Potential gateway locations that are relevant to Yukon include Juneau, Anchorage, Seattle, Portland, Vancouver and Edmonton. See Figure 1 for an overview of existing and proposed fibre routes in the region.

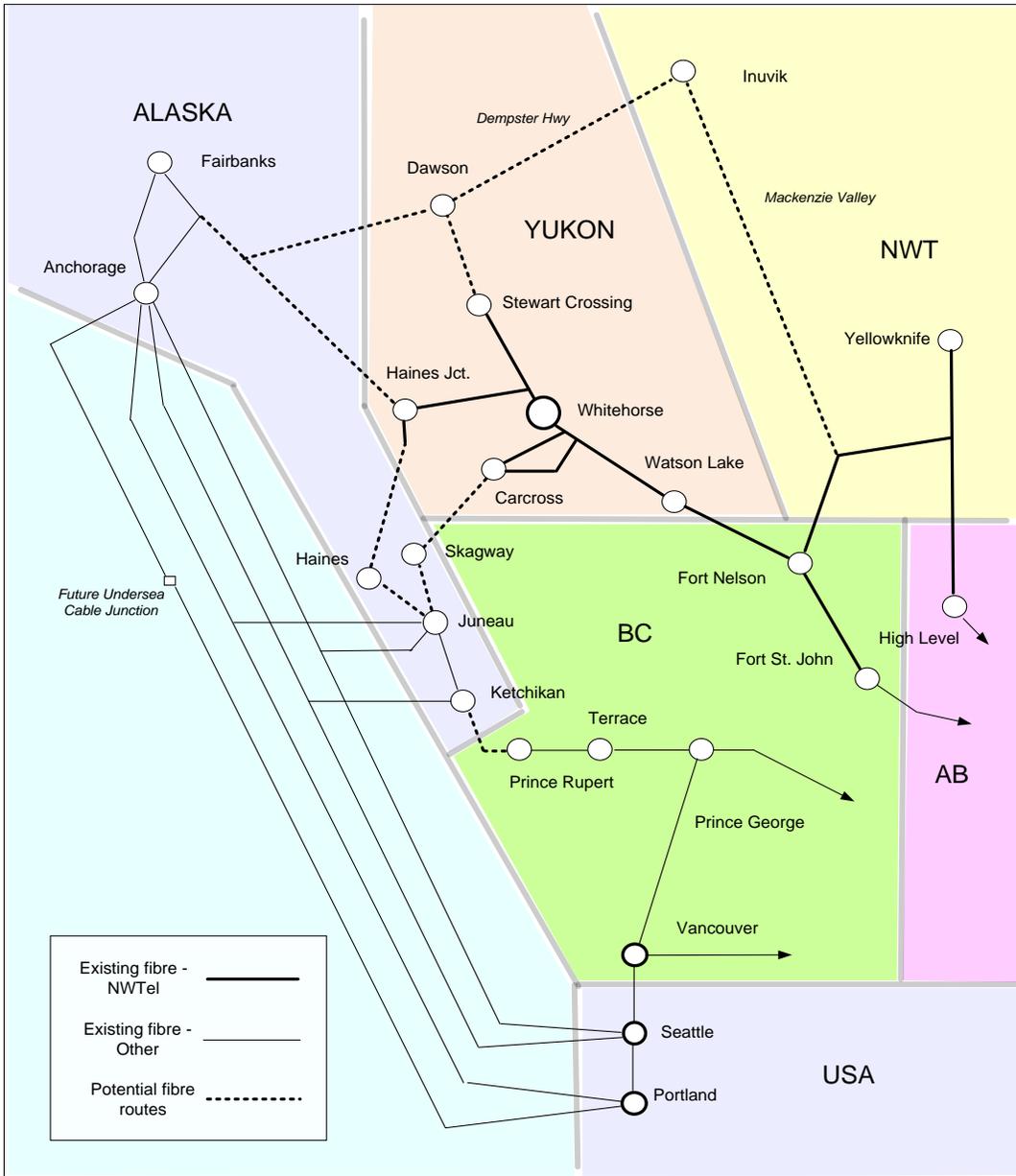


Figure 1 Fibre Routes

Following is a list of the various diverse route options considered in the study. The capital cost estimates cover fibre cables, fibre terminal equipment and IRUs⁵ on existing cable. All options will also require point-of-presence equipment such as routers and customer access links Whitehorse.

Table 1 Fibre Route Options	
Option	Approximate Initial Cost (\$ Millions CDN)
a) Whitehorse – Carcross - Skagway - Juneau - Seattle or Portland	23 to 28
b) Whitehorse – Skagway - Juneau - Prince Rupert - Vancouver	32 to 36
c) Whitehorse - Edmonton via the Dempster Highway and proposed Mackenzie Valley fibre	50

As shown in Table 1 above the fibre route option which meets the requirement for connection to a major internet gateway with the lowest initial cost is Whitehorse via Carcross and Skagway and Juneau to an internet gateway Seattle or Portland. Therefore route option (a) is recommended.

5 Recommended Infrastructure

5.1 New Fibre Link

Based on the analysis described in the previous section, a fibre optic link between Whitehorse and Juneau consisting of the following route sections is recommended:

- An IRU on existing Northwestel fibre between Whitehorse and Carcross (or other cable sharing option negotiated with Northwestel);
- A new 48-strand buried fibre cable between Carcross and Skagway; and
- A new 24-strand undersea fibre cable between Skagway and Juneau.

The fibre cable used will meet or exceed single mode fibre transmission standards with sheath and armour appropriate for direct burial and undersea requirements. The larger strand counts for the buried highway sections are recommended since adding cables in the future would be problematic. In the unlikely event that a future additional cable will be required in the undersea section it could be added without difficulty. As explained in Section 5.2 a 24-strand cable with Wavelength Division Multiplexing (WDM) has an ultimate capacity of at least 38 Terabits per second or about 4000 times the current traffic requirement. WDM equipment will be required at Whitehorse, Carcross, Skagway and

⁵ An Indefeasible Right of Use (IRU) is a contractual agreement between the operators of a communications cable and a client giving the client exclusive, unrestricted, and indefeasible right to use specified capacity in the cable for any legal purpose. An IRU is effectively a long term lease (temporary ownership) of capacity that is paid up front and treated as a capital investment.

Juneau or a nearby cable landing as shown in Figure 2 below. Equipment on the Alaska side will likely be housed in the U.S. partner's facilities.

Agreements will be required for use of Northwestel's of existing fibre between Whitehorse and Carcross. Alternatively, a new buried fibre cable along the opposite (west) side of the highway from the existing cable could be placed.

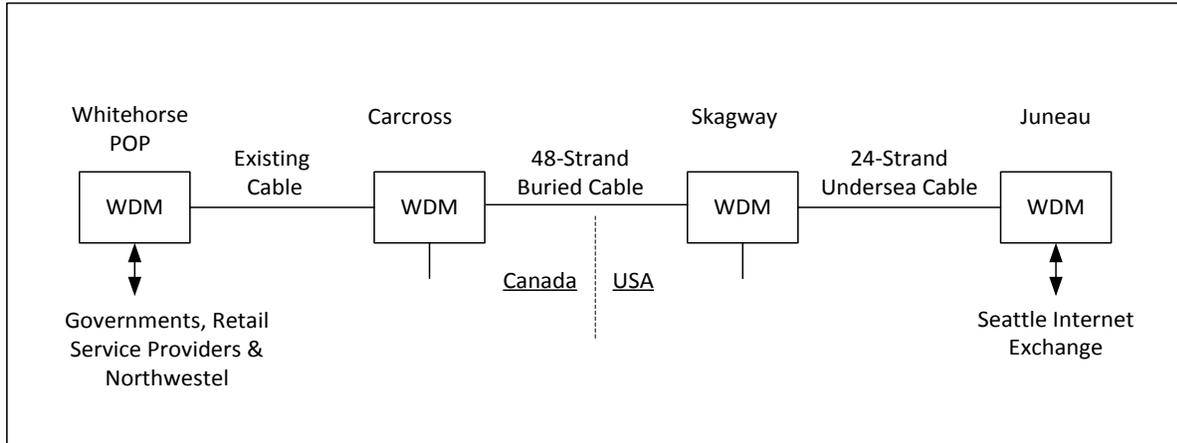


Figure 2 High Level System Design

5.2 Performance Requirements

The required performance⁶ of the fibre system is shown in Table 2. Required end-to-end performance between the Whitehorse POP and internet gateway is described in the study.

Table 2 Whitehorse – Juneau Fibre System Performance		
Performance Parameter	Requirement	Notes
Availability	99.9% or better	During outages all traffic will be restored on the diverse Northwestel route via Fort St. John.
Average Annual Outage	Less than 9 hours	
Packet Loss	Less than 0.2%	Measured between 10 Gbps WDM Ethernet interfaces at Whitehorse and Juneau.
1-Way Latency	Less than 10 ms	
Jitter	Less than 5 ms	

5.3 Whitehorse Point-of-Presence Building and Equipment

A point-of-presence (POP) facility in Whitehorse will be required to house electronic equipment to terminate and utilize the new fibre optic route to Juneau, to interconnect with Northwestel and retail service providers, and to monitor and manage the fibre network and wholesale service portfolio. This facility will be secure and temperature controlled and will include back-up power generation. At least one high-end router equipped with optical transceivers as well as several servers will be required.

From a technical viewpoint a good location for the Whitehorse POP would be within available co-location space in a Northwestel building with existing fibre connections to Northwestel's Yukon network and to southern Canada. Northwestel charges CRTC-approved tariffs⁷ for this equipment space and associated services including power.

5.4 Customer Access Facilities

Broadband access connections between the Whitehorse POP and local retail service providers (wholesale customers) can utilize a number of technologies including:

⁶ These are based on industry standards and are required to ensure that service quality is at least equivalent to Northwestel's as specified in its Wholesale Connect tariff.

⁷ See Item 746 of the Northwestel special services tariff at http://www.nwtel.ca/media/tariffs2009/crtc_3010.pdf

- Point to point wireless links⁸;
- Leased or purchased copper, coax or fibre capacity from Northwestel; and
- Placement of fibre cable using existing poles or conduit routes.

The total cost of access connections will depend on the POP location, the number and locations of wholesale customers, bandwidths required, and the technologies utilized.

5.5 Carcross Point-of-Presence

Access to the proposed fibre system will be available at Carcross to provide for government requirements and possibly other customers. It is assumed that the required WDM and other equipment will be housed in the Northwestel equipment building. This will also be the interconnection point between the new and existing fibre cables.

6 Business Structure

6.1 Recommended Structure

The study examined three potential business structures that could be used to establish and operate the fibre optic link. These were based on ownership by a public sector entity, a public/private consortium or a private sector entity. It is recommended that a shareholder-owned corporation be established to own and operate the fibre optic link and associated facilities and services as shown in the diagram below. The proposed entity is referred to herein as Newco.

⁸ For an example of the use of wireless access links see <http://onegigabit.ca/servicearea.shtml> . Typical products are at <http://www.meridianmicrowave.com/> and http://dl.ubnt.com/datasheets/airfiber/airFiber_DS.pdf

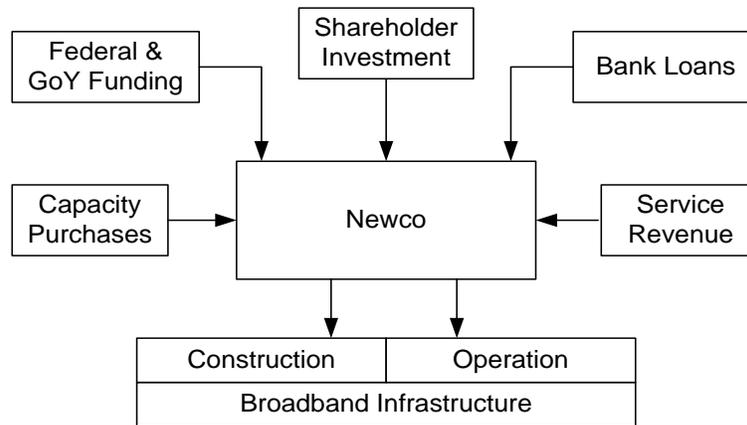


Figure 3 Business structure

6.2 U.S. Partner

A partner company in Alaska is required for successful operation of the Whitehorse – Juneau fibre optic system as well as linkage to an internet gateway. Based on discussion with potential U.S. partners, this arrangement would have the following characteristics. Newco owns all infrastructure on the Canadian side of the border and the U.S. partner owns all facilities on the U.S. side. A physical fibre cable interface and connection point is established at the border. The U.S. partner provides internet transit and wavelength capacity connections to other carriers at Juneau and/or Seattle. Operation of the fibre optic system would need to be tightly coordinated with well-defined responsibilities of the two parties. This is especially critical for the identification, location, restoration and repair of fibre cable failures, as well as operation of Wavelength Division Multiplex (WDM) channels end-to-end.

6.3 Market opportunity

Newco's potential customers include retail internet service providers serving residential, mobile and business markets as well as several government and other large public sector entities. Based on demographic and usage data from published sources, it is clear that demand growth will continue to increase. Further, experience from other markets suggests that introducing more capacity and more choices into the market will have a stimulative effect on demand. As the provider of an alternative high speed link to a major internet gateway, Newco will offer a value proposition to any provider in the Whitehorse market, and beyond, that would benefit from improved reliability and service continuity. This would include Northwestel, which could provide its own customers with route diversity through leasing capacity on Newco's fibre system.

6.4 Subsidy funding

The capital costs for investments like this are significant, and out of proportion to the market opportunities that would justify the investments, at least in the short term. Smaller service providers (such as prospective retail internet companies in Yukon) could not establish in the short term a business case on their own to invest in the fibre link. In fact, Northwestel has been unable to justify several fibre transport projects on its own, despite its relative economies of scale and scope as by far the largest service provider in the North. Therefore it is unlikely that this fibre link could be justified without subsidy funding.

The alternative fibre link represents a key element of telecommunications infrastructure in Yukon, and will be available to benefit all telecommunications users through whichever retail service provider they choose. In addition, the alternative fibre link will effectively operate as a catalyst in Yukon market by making available additional capacity and reliability.

7 Recommended Solution – Summary

Based on the findings of the study it is recommended that a privately financed company be established to implement a Whitehorse - Juneau fibre optic link with connections to Seattle as well as offer wholesale data and internet services in Whitehorse. The new company will require a one-time grant of \$12.8 Million to cover half the capital cost and make the business viable. Based on overall financial and risk assessments the recommended option is based on a U.S. partner constructing, owning and operating all facilities on the U.S. side of the border.

In order to proceed, public and private funding sources must be secured along with a commitment from Northwestel to swap diverse capacity across the existing and proposed fibre links. To reduce financial risk, a commitment is required from the Government of Yukon to purchase significant internet connection capacity from the new company for a 10 year period.