A Matter of Survival

Arctic Communications Infrastructure in the 21st Century

Arctic Communications Infrastructure Assessment Report

Prepared for the Northern Communications & Information Systems Working Group

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Foreword

The Project Steering Committee of the Northern Communications and Information Systems Working Group (NCIS-WG) is pleased to present the Arctic Communications Infrastructure Assessment (ACIA), produced by Imaituk Inc.

Every government department serving the Arctic struggles to communicate effectively with people scattered over huge distances with finite budgets and increasing expectations. Arctic communication service providers struggle to keep pace with expanding Southern services, serving a small population located in a region that is arguably the most expensive to reach on the continent.

The ACIA was initiated to provide information on the current state of communications infrastructure, identify future requirements, and provide insight into areas where federal and territorial departments could work collaboratively to solving communication challenges.

The Assessment also encouraged communications service providers to give their perspective and current capabilities for wide distribution to federal agencies and territorial governments.

An analysis of how other countries have initiated the building of networks in high cost regions was examined, to learn how these initiatives might apply to the Arctic.

The visioning workshops in Yellowknife, Whitehorse, Iqaluit and Ottawa, provided an excellent opportunity for different levels of government to learn from each other, and think about ways to work together to solve some immediate communication challenges, while working toward longer term solutions.

We hope this Assessment has provided useful recommendations for both NCIS-WG members, and government stakeholders to consider as they make investment decisions that can help ensure service providers can develop services that not only meet the needs of government, but also benefit the Northern economy, and Arctic residents in all communities in the long term.

We invite people to read this report, consider its recommendations, and be part of the search for solutions.

While the challenges are significant, the spirit of collaboration is genuine and the willingness to move forward and improve was evident throughout the production of this Assessment.

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Co-Chair, NCIS-WG

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- Micheal Corbett, Canadian Northern Economic Agency (CanNor)
- Dilprit Shergill, Public Safety Canada
- Al McIntosh, Government of the NWT, Municipal and Community Affairs
- Linda Maljan, Government of the NWT, Finance

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- Telesat team led by Paul Bush

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1 Executive Summary

1.1 Communications: A Matter of Survival

The Arctic must have reliable communication networks to establish and maintain Canada's sovereignty, and to meet international obligations for ensuring safe passage for road, sea and air traffic.

Emergency responders must have excellent communications ability to rapidly respond to both natural disasters such as earthquakes, and man-made tragedies that will surely occur as air and ship traffic increases with global warming.

Canadians are becoming more reliant on communication services in every aspect of their lives, and the Arctic is no exception. Arctic residents must have reliable, affordable communications infrastructure to engage in 21st century opportunities -- many communities' long term survival will depend on it.

Canada needs a healthy, educated, prosperous population of Canadians living in the Arctic to properly manage the vast land that contains so much of Canada's natural resources that benefit the entire country. The 100,000 residents living in 75 communities spread over 1/3 of Canada's land mass need affordable communications to improve the distribution of health care, engage in education, participate in the economic opportunities in their region, and continue to ensure the Canadian Arctic is part of a sovereign Canada.

Communications for maintaining sovereignty and emergency response is a fundamental requirement. So too, is the requirement for modern communication services to Arctic communities -- it is a matter of survival.

1.2 Assessment Background

This Arctic Communications Infrastructure Assessment (ACIA) was initiated by the Northern Communications and Information Systems Working Group (NCIS-WG). After a serious breakdown in communications infrastructure during a 2009 exercise, the NCIS-WG was tasked by the Arctic Security Working Group to look into the communication issues evident in the North, and look at ways to help solve the problems. The NCIS-WG decided to cast a wide net - requesting that the Assessment gather input from not only emergency response, security and military organizations, but also government departments across the Arctic that struggle with providing adequate communications services.

There are about 13,000 territorial government employees, and 2000 federal government employees working in the Arctic. Many more federal employees based in the South have direct service responsibilities in the North. Seventy-five government managers from a

wide range of departments in Whitehorse, Yellowknife, Iqaluit and Ottawa participated in this Assessment's workshops, and another 100 responded to detailed surveys.

Participants provided details on their current use of communication technologies, their issues and concerns, and their future plans for improving program delivery that depends on robust communication networks.

The two main service providers providing direct services in the Arctic, NWTel and SSi Micro, provided details of their current capacity. Telesat has also provided details on the satellite space segment capacity available in the Arctic. The Assessment documents the availability of local services such as cell phone and Internet in every community, and the backbone capacity, detailing how much bandwidth is available for purchase into and out of every community in the Arctic. Civilian HF radio details are also provided.

1.3 Arctic Communication Issues and Recommendations

Yukon, Northwest Territories, and Nunavut have vastly different geography, history, demographics, economies and road infrastructure. But these Arctic territories all have serious challenges in accessing affordable, reliable communications services.

There are three realities that have led to the state of the Arctic communications infrastructure:

1. The geographic facts make the entire Arctic region challenging from an economic perspective for building, maintaining and evolving communication services that meet users' needs at an affordable price, without significant public investment;
2. The existing network investment models in the North are not meeting the rapid pace of increasing change and convergence of communication services available in the South.
3. There is currently no comprehensive strategy for connecting all Arctic communities to the level of service required within communities or between communities.

This Assessment further identified specific issues common among all three territories. With each issue identified, the Assessment provides recommendations, summarized below.

No service parity

There is a growing gap between the level of service available in the North versus the South, causing serious challenges to both residents and visitors, even in the capital cities of Yellowknife and Whitehorse. Communities outside of Yellowknife and Whitehorse have even poorer service, threatening the viability of many communities as it becomes increasingly difficult to engage in opportunities that rely on 21st century connectivity.

> Recommendation 1: Commit to service parity among Arctic communities, and set minimum connectivity standards for all Arctic communities that assure service parity to southern urban centres.

Bandwidth shortage and high cost to end user.

There is a severe shortage of affordable bandwidth, both in terrestrial (microwave and fiber) and satellite served communities. While there may be more capacity available for purchase, very few can afford to purchase what they need. Satellite-served communities face additional challenges on older networks that exacerbate the effects of satellite latency, so that many applications on these networks simply won't work.

As the largest single purchaser in the Arctic, government has tried to play the role of using its purchasing power to meet its own needs, and at the same time, hope to stimulate the creation and maintenance of a private communications sector that will meet the needs of the public. Government has also made one-off investments in isolated initiatives that have not yet resulted in stable, affordable access in the long term in any of the three territories.

> Recommendation 2: Develop an Arctic-specific strategy with clearly defined rules, that articulates a sustained, multi-year funding commitment for communications network development to meet connectivity standards set by policy makers.

Reliability and quality of service gap

All territories suffer from frequent network outages. In Whitehorse, where services are arguably the fastest (with 10,000 Mb/s fibre connection to the South), repeated cuts to the only fiber connection connecting it to the Internet ground the modern city to a halt, drastically affecting their local economy, and causing outages and slow downs to all the communities feeding into Whitehorse. Challenges with continuity of service, and a lack of redundant networks across the North leaves communities vulnerable.

> Recommendation 3: Ensure there is a redundant connection into every Arctic community to avoid gaps in the provision of essential communication services.

Geographic coverage inadequate

HF radio services are not ubiquitous across the Arctic. There is no cell phone coverage along the vast majority of roads in NWT and Yukon. There are dead spots in satellite phone reception. It is very difficult to send photos or large amounts of data from the field during an emergency, and challenging to keep workers safe if communications fail. There are, however, many isolated initiatives being conducted by different departments across the Arctic to try to solve connectivity issues on the land.

> Recommendation 4: Create an inventory of Arctic communications technology projects and services that aim to connect people from remote locations outside of communities in order to share experiences, best practices, and lessons learned.

Emergency Response Challenges

Information is key for emergency responders to be prepared - whether the response is local, regional, territorial, or national. Connectivity is the life line for emergency response and recovery, but during an emergency, the local telecommunications system is often

overwhelmed. Military generally deploy their own communications systems when acting in an emergency response role, arriving after civilian responders. All responders need to be able to interconnect and must have reliable systems to connect with people quickly and efficiently using reliable, robust communication networks from wherever they are.

> Recommendation 5: Identify communication services that will be required in a variety of emergency settings, developing protocols with service providers for surge capacity requests and prioritization of public communications networks for emergency responders within communities. Maintain an inventory of what is commercially available in communities.

Cannot Keep Pace with Technological Change

Converging voice, video and data technologies are forcing rapid change, stress and opportunity for communication service providers. Changing consumer expectations, and the government's need to take advantage of potential cost-savings and better ways to reach the public have resulted in calls for policy makers and regulators to change the current regulatory framework and investment strategies to ensure Arctic residents can benefit from new technologies just as other Canadians do.

> Recommendation 6: Investment strategies for Arctic communication networks must include provisions for the increasing rate of change of technology, and the continuous introduction of new consumer services and devices.

Lack of Choice

Accepted economic principles argue competition is necessary for innovation, but in the Arctic, there is limited competition. Few opportunities for innovation, and risk-averse government buyers and service providers will lead to a lack of choice in any market. Procurement practices that define the technical solution rather than define the business outcomes ultimately lead to lack of choice.

> Recommendation 7: Investment models should allow for, and encourage competing services in as many market segments as possible, thereby promoting consumer and government choice, and innovation and improved services.

> Recommendation 8: Government procurement officers should encourage innovation through RFPs that focus on business outcomes requirements and technology neutral RFPs to stimulate innovative solutions from service providers.

Human Resource Gap

Arctic communities outside of Yellowknife and Whitehorse have a dearth of IT professionals to run complex networks and applications. Also, governments are using network connectivity to link people with the necessary expertise to provide better levels of service through videoconferencing and data transfers, increasingly relying on communication networks to help solve shortages in human resources. Many departments

are looking for ways to deliver training to all levels of government staff more efficiently, and are turning to information and communication technologies (ICT) to help.

> Recommendation 9: Recognize the reality of community capacity, and design applications and networks that will allow for effective remote service delivery.
>
> Recommendation 10: Take advantage of robust networks to deliver training to government workers using new communication tools.

1.4 Global Economic Insights

The three territories represent a difficult environment in which to operate. They are characterized by a small consumer base located across a vast geographic range. Nevertheless, suppliers of broadband do operate on somewhat of a competitive basis, but the majority of that competition is for government subsidies. It is ironic, then, that Arctic innovation in IT will not be about how to get the services to people, as much as it will be about finding innovative ways to pay for those networks.

Countries around the world are implementing plans to connect citizens in remote regions, using various economic models that work within their value system. The Assessment provides a series of items to consider, highlighting important steps taken in other countries as they developed their innovative system for bringing communications infrastructure to difficult regions.

Step 1: Understand the Market

Step 2: Recognize the importance of competition

Step 3: Establish minimum standards

Step 4: Develop communication infrastructure strategy that will achieve minimum standards

Step 5: Stop relying on cross-subsidization models

Step 6: End market disruption caused by government's muddled approach to the marketplace as owners, regulators, and purchasers of Internet services.

1.5 Strategy Forward

Ensuring appropriate communication services may be one of the few truly affordable infrastructure efforts that address some of the challenges facing northern residents, and the sustainability of communities in the long run.

This Assessment provides baseline information from which initiatives can be developed. There are many ways NCIS-WG members may be involved, from identifying which policy makers should be spearheading the development of an "Arctic Communications Strategy" to creating a new communication protocol to handle surge capacity in emergencies.

NCIS-WG members can play a key role in assisting many other players within government and the private sector to move the agenda forward, working to solve the communication issues they helped to identify in the Canadian Arctic.

2 Introduction

2.1 Purpose

Canada's Arctic region has rarely received as much attention as it does today with sovereignty discussions, military exercises, increasing air and sea traffic, and rising commodity prices of resources found in abundance in the Canadian Arctic.

Canadians see the Arctic region as an important part of Canada to be secured for the benefit of the entire country - a key part of our sovereign nation.

This Arctic Communications Infrastructure Assessment (ACIA) was originally inspired by emergency management and security organizations tasked with the security of the Arctic and its people. These organizations identified robust communications infrastructure as a critical foundation for establishing and maintaining the security of the Arctic.

Without the ability to communicate effectively, any response to an emergency or threat of any kind would be compromised.

> *"People's sense of security is attached to their connectivity. Losing communication services can trigger a sense of distress… This will only increase as society becomes more dependant on communication services in the future."* Jennifer Trapnell, Executive Council Office, Government of Yukon

Good communications can be a matter of survival for those involved - whether the emergency is personal, local, regional, or national.

However, in an effort to look for inclusive solutions for some of the communications challenges facing the Arctic, this Assessment examines more than just emergency response and security organizations' issues. It also considers the communications challenges raised by a wide range of territorial and federal government departments operating in the Arctic. It also documents the existing infrastructure and highlights some of the concerns raised by communications service providers.

As people all over Canada become more and more reliant on communication services, the Arctic must keep pace in order to be able to respond not just to emergencies, but to engage in all opportunities that new communications technologies bring. A reliable, affordable communication infrastructure is a fundamental requirement for all aspects of life in the Arctic today.

Internationally, it is recognized that a good communication infrastructure can support improved health care delivery, can help people take advantage of educational opportunities, support the development of thriving businesses, and improve the overall quality of life for people.

The economic benefit of having a good communication infrastructure in Arctic communities is examined from a global perspective in Chapter 8. This chapter also

examines the economic challenge of providing broadband in an extremely high-cost region of Canada, and looks at examples from other countries in solving these challenges.

The economic chapter of this report looks carefully at the role of communications infrastructure in the very survival of many of the communities in the Arctic.

The 100,000 Canadians living in the 75 communities across the Arctic play an important role for all of Canada. They help to maintain Canada's sovereignty over the Arctic, they provide a base and labour for resource exploration and extraction, knowledge on climate change, and are inextricably involved in emergency response, security and reconnaissance. These 75 communities provide a much-needed base for many of the activities that occur in the Arctic today. After all, when an emergency occurs in the Arctic, the people who live there are probably impacted by the emergency and are expected to be part of the solution.

The sovereign north needs a healthy, educated, connected population of Canadians living in the Arctic to be part of the solution for the rapidly changing Arctic environment for the good of the entire country -- and connectivity is a key part of the solution.

Good communications in an emergency is a fundamental requirement. So too, is the requirement for routine modern communication services to Arctic communities -- it is a matter of survival.

2.2 Why an Assessment?

In 2009, 'Exercise Operation Nanook' was conducted in the Canadian Arctic. This exercise was designed to test multi-jurisdictional response frameworks and identify opportunities for improving regional mitigation and response planning.

The influx of out-of-territory personnel arriving in one community overloaded the local cell phone and Internet network, and severely hampered the communication capabilities of the emergency responders conducting the operation.

One of the main issues identified by participating agencies in Exercise Operation Nanook was the vulnerability of communications networks in the Arctic.

This exercise brought together the right combination of local and external emergency management and national security stakeholders to start examining ways to improve the communications infrastructure through a concerted federal-territorial effort.

> *"Reliable communications is our Achilles heel when responding to a disaster in the Arctic."*
> Yellowknife visioning workshop participant, NWT

This Assessment is one of the results of this group's efforts to begin meeting the challenges of the Arctic's communications infrastructure.

2.3 Who is Behind the Assessment?

Operation Nanook's profound communication failure kick-started the process of addressing the fragile infrastructure with the creation of the Northern Communications and Information Systems Working Group (NCIS-WG), created by the Arctic Security Working Group (ASWG).

The ASWG was established to enhance the security and sovereignty of Canada's North through information sharing and cooperation among federal and territorial government departments, Aboriginal governments and organizations, NGOs, and other stakeholders operating in the North. It provides:

- A forum for information sharing and intelligence;
- A venue for the coordination of activities;
- A venue for planning activities and for testing response capabilities.

The purpose of the NCIS-WG is to develop an understanding of communication capabilities in the North, assets that are available, identification of communications deficiencies and redundancies, and development of a timeline to address concerns/issues. It provides a forum for mutual discussion and development in the field of communications in the Arctic.

Members of the NCIS-WG recognize the fragility of the Arctic communications infrastructure affects more than military and emergency response capabilities.

A fragile communications infrastructure also affects the ability of governments to properly provide healthcare and education services, build the economy, protect the environment, and provide good governance. Any successful solution to solving the communications infrastructure challenge involves many players.

In January of 2010, the NCIS-WG members determined that a full Assessment should be undertaken to work towards addressing identified issues and concerns. A steering committee issued an RFP in November 2010, seeking proposals to conduct an Assessment, subsequently contracting the winning bidder, Imaituk Inc., to carry out the Assessment from January to April, 2011.

The NCIS-WG commissioned this Arctic Communications Infrastructure Assessment, with the hope that this report can be a stepping stone on the path to a more robust, stable, responsive Arctic communications system that can benefit both the local population and emergency responders in the future.

2.4 Objectives of this Assessment

The purpose of the Assessment as defined by the RFP was to identify existing resources and infrastructure, future requirements and the gaps between them, so that departments

working in the Yukon, NWT, and Nunavut can begin to work together to address stated areas of concern.

The contractor, Imaituk Inc., was tasked with the following activities:

A. Identify and Map Current Infrastructure:

Research and identify communications infrastructure, technologies and capacity in the NWT, Yukon and Nunavut. This objective addresses the NCIS-WG need for a snapshot of "what is", the technologies, network facilities and capacity that currently exist or are available.

B. Identify Future Requirements:

Identify future requirements (3-5 years ahead) for communications infrastructure, technologies and/or capacity that major federal and territorial departments require.

C. Conduct a Fit/Gap Analysis:

Conduct a fit/gap analysis of communications infrastructure, technologies and capacity required to get from the current state to the Departments' desired future state, based on their identified future requirements (B above.)

D. Assess Community Development Implications:

Review relevant literature to identify the communications infrastructure, technology and capacity requirements needed for effective community and economic development. It further includes an assessment of the gaps that exist between the elements (from literature) and the current state in the North, with suggestions for addressing the gaps.

All territorial and federal government departments operating in Yukon, Northwest Territories, and Nunavut were invited to participate in the assessment.

Existing communications service providers of the current Arctic communications infrastructure were also invited to provide their input into this Assessment.

2.5 The Report Contents

In carrying out the objectives as stated in the original RFP, the Assessment has been grouped into four areas, corresponding with the original tasks, in a slightly different order, with some additions to provide a complete picture of the issues, current state, future state, economic issues and path forward. This report is divided into four sections, with relevant chapters listed below.

A. Current State:

To document the current state of the communications infrastructure as it stands today, this Assessment looked at the current state of not only the communications infrastructure, but also examined the current state of government needs, and identified the resulting issues in detail, documented in the report as follows:

Chapter 3: Government Needs Today

Chapter 4: Technical State Today

Chapter 5: Issues Today

B. Future State:

To document the future needs, the Assessment has produced two sections, identifying both government needs for the future, and an estimate of the future capacity that will be required to meet those needs:

Chapter 6: Government Future Needs

Chapter 7: Future Technical Capacity

C. Community and Economic Development Implications:

To assess community development implications and the gap between other jurisdictions and the Canadian Arctic, the Assessment focused on how other countries are meeting the challenge of ensuring citizens have access to broadband services, addressing the economic, regulatory and subsidy regimes in building robust communication networks that serve all citizens. The Assessment presents this information as background to the final chapter.

Chapter 8: Insight into the Economics of 'Broadband'

D. Fit/Gap Analysis and Strategy Forward:

Issues raised in Chapter 5, the need for increasing technical capacity as defined in Chapter 7, and overall economic issues raised in Chapter 8 provide the framework for possible recommendations. Strategies for moving forward are the compilation of input from the many people involved in this Assessment.

Chapter 9: Addressing the Issues: Recommendations

Chapter 10: Strategy for Moving Forward

2.6 Arctic Territories - Brief Background

Canada's Arctic Territories include Yukon, Northwest Territories and Nunavut, making up more than 1/3 of Canada's landmass.

More than 100,000 Canadians live in the Arctic, spread out into 75 distinct communities.

The three Arctic territories have a different legal and political status in Canada compared to the 10 provinces. This difference, summarized below for the purposes of this report, results in a unique relationship between Canada and the territories compared to Canada's relationship with provinces.

This different relationship means that Canada has a broader responsibility for communications issues (and more financial resources) than would be the case if similar issues were reviewed from a provincial perspective:

- The most senior representative of government in each territory is the Commissioner (in a province this position is Lieutenant Governor);
- The Commissioner of a territory receives instructions from the Cabinet of Canada via the Minister of Indian of Northern Affairs and under conditions not applicable to provinces, the Parliament of Canada may override legislation passed by territorial legislatures;
- Subject to all the complexities of land claim and other historic issues, the ownership of resources under the ground are generally believed to be held by Canada not the territorial governments (thus Canada's higher financial resources when dealing with Arctic issues compared to the same issues in a province);
- The complex issues related to resource ownership (and the financial benefit of these resources) are the subject of various devolution discussions and agreements that are in various stages across the Arctic and do not at this time apply equally to all territories.

Yukon

Yukon has 17 communities, with the majority of its 34,000 population living in the capital of Whitehorse, with more than 20,000 residents.

Roads link all but Old Crow (pop 253), the most northerly community in Yukon. According to the 2006 census, 85% of the population reported English as their mother tongue. English and French are the official languages.

Robert Service road leading out of Whitehorse, Yukon. Photo: C. Small

The landscape features some of the country's largest mountain ranges, and boreal forest that covers much of the Yukon territory.

Mining and tourism are mainstays of the Yukon economy. As a territory, the Government of Yukon still depends on approximately 65% of its operating budget to come from the federal government. Over the years, through devolution negotiations, more powers have been transferred from the Government of Canada to the Government of Yukon, which has increased responsibilities for public lands, water, forestry and mineral resources.

Northwest Territories

The Northwest Territories has the largest number of communities of the three territories, with 33 official communities. Only 77% of the population identify English as their mother tongue. NWT has 11 official languages, nine of which are aboriginal.

Ten of the 33 communities are fly-in only, with no access to roads at any time of the year. A further 9 communities only have winter roads. Of the 43,000 residents, Yellowknife, the capital, has about 20,000 residents, and is the largest community in the NWT.

The Mackenzie Valley is a defining feature of the territory, with rolling hills and boreal forest covering much of the land. NWT also has tundra in the north, where many of the most isolated communities are located.

Fort Providence, NWT. Photo: Legislative Assembly of the NWT

Mining and potential oil and gas are key economic drivers in the NWT. Currently federal transfer payments make up 67% of the NWT government's operating budget each year. The Government of the NWT is currently in talks with the federal government on devolution.

Nunavut

Nunavut has a vastly different geography from Yukon and NWT. There are no roads serving any of its 25 communities, and the territory is all above the tree line, with rolling tundra in the west and central parts, and mountains covering much of Baffin Island in the east.

The capital Iqaluit, has 7,000 people out of a total population of 33,000, with other communities ranging in size from Grise Fiord (Pop 150) to Rankin Inlet (Pop 2,700). Inuit make up 90% of the population. Only 27% of the population identified English as their mother tongue in the 2006 census. Nunavut has four official languages, including English, French, Inuktitut and Inuinaqtun, with a majority of the population speaking Inuktitut.

Pond Inlet, Nunavut. Photo: L. Thomas

Nunavut became its own Territory in 1999, splitting with the NWT. It also operates as a decentralized government, with various departments operating out of one of 11 communities in an attempt to ensure more jobs are available throughout the various regions of Nunavut, instead of being concentrated in the capital. Nunavut's government depends on the federal government for over 90% of its operating budget.

As the youngest of the three territories, the Government of Nunavut has very little taxation power, and does not share in the resource revenues of the exploding mining sector. The majority of the Northwest Passage is located within the Nunavut jurisdiction of Canada.

Objective A: Current State

3 Government Needs Today

3.1 Introduction

Federal and Territorial governments require reliable, affordable communication services within all communities and between communities to carry out their various mandates.

This section of the report provides an overview of federal and territorial governments' need for communication services today, including examples of various programs highlighted by departments that participated formally in the Assessment.

3.2 Gathering Input

Government agencies were invited to participate in one of six facilitated 'visioning workshops' held in Yellowknife, Whitehorse, Iqaluit and Ottawa. Every session had a mix of federal and territorial representatives. Each workshop had between 11 to 18 participants with over 75 government representatives attended. (See Appendix A for the list of participants).

Participants detailed their department's key responsibilities, communication services they use now and plan to use in the future, issues they face, and ideas to ensure communications services can meet their needs in the future.

In addition, an online survey gathered additional details from almost 100 respondents from a wide range of departments across the three territories and federal government. Data from the questionnaire was also supplemented by documents provided by government departments, with most information on Nunavut coming from data already collected by the Department of Community Government Services. The full survey can be found in Appendix B.

3.3 Federal Departments Serving Territories

Overview

There are approximately 2,000 federal employees working in the Arctic, with approximately 400 in Nunavut, 1,150 in the NWT and 550 in Yukon. The vast majority of Federal employees are located in the three regional capitals, with a handful of federal employees working in smaller communities, (such as Parks Canada staff.)

The RCMP are an exception, with members stationed in almost every Arctic community, with significant numbers of staff (both members and Federal/Divisional units) in each of the three capitals.

Department Name	Staff in Arctic?	Visioning Workshop	Survey Response
Agriculture and Agri-Food Canada	*	No	Yes
Canada Border Services Agency (CBSA)	*	Yes	Yes
Canada Revenue Agency (CRA)	0	Yes	No
Canadian Heritage	*	No	No
Canadian Northern Economic Development Agency (CanNor)	***	Yes	Yes
Citizenship and Immigration	*	Yes	No
Canada Mortgage & Housing Corp. (CMHC)	*	No	No
Correctional Service of Canada (CSC)	*	Yes	Yes
Department of Fisheries and Oceans (DFO), including Coast Guard	***	Yes	Yes
Department of National Defence (DND)	****	Yes	Yes
Environment Canada (EC)	***	Yes	Yes
Health Canada	0	Yes	No
Human Resources and Skills Development Canada (including Service Canada) (HRSDC)	***	Yes	Yes
Indian and Northern Affairs Canada (INAC)	****	Yes	Yes
Industry Canada	*	Yes	Yes
Justice	**	No	Yes
Natural Resources Canada (NRCan)	**	No	No
NavCan (not-for-profit agency)	*	Yes	Yes
Nunavut Federal Council	*	No	No
Nunavut Geoscience	*	No	No
NWT Federal Council	*	No	No
Parks Canada	***	No	No
Public Health Agency of Canada (PHAC)	0	Yes	Yes
Public Safety (PS)	*	Yes	Yes
Public Prosecution Services of Canada	***	No	No
Public Works and Government Services Canada (PWGSC)	**	Yes	Yes
RCMP	****	Yes	Yes
Rural Secretariat	*	No	No

*10 or less ** 11-50 personnel ***51-100 personnel ****101 or more

Data was compiled using 2009 data provided by the Nunavut Federal Council, NWT Federal Council and Yukon Government Executive Council Office , with input from some individual departments. Due to variations in reporting from each territory, this report provides approximate numbers of staff with the purpose of providing relative sizes of departmental staffing. This data reflect full time positions, and do not include visiting military personnel, or Coast Guard vessel positions.

The three largest federal departments (measured by full time employees) operating in the Arctic are Indian and Northern Affairs Canada with approximately 450 personnel split between the three territories, followed by the RCMP located in all communities, and the Department of National Defence with 245 full time employees mostly in Yellowknife.

There are eight 'mid-sized' federal departments with between 50 and 100 personnel spread between the three territories, including CanNor, DFO, Environment Canada, HRSDC (Service Canada), Parks Canada, and Public Prosecution Services.

Remaining federal departments with responsibilities in the Arctic have somewhere between no staff and 50, with the majority having less than 10 people spread out across all three territories.

Because of the vast differences between federal departments' presence in the Arctic, their activities, and mandate, it is challenging to provide an overview that encapsulates the breadth and depth of federal communication needs. This proposal has divided the needs into two categories:

- Federal departments requiring services in communities
- Federal departments requiring communication services 'in the field'

Each section will illustrate these needs using examples raised by various departments in their efforts to meet their national objectives in the provision of federal services.

Federal departments requiring services in communities

Federal employees working in communities to deliver services need to be able to purchase affordable, robust communication services that allow them to communicate reliably with:

- Other government agencies and the public within their community in person and via communication networks;
- Federal offices in the south, interfacing with people, systems and software to carry out their mandate;
- Public located in communities within their Territory via public communication networks.

Federal employees who travel into communities to work (whether they are based in one of the capitals in the North, or are based in the South) need to be able to hook into local networks with their BlackBerries and laptops in order to maintain connectivity with their head offices. Federal employees look to local commercial networks to connect to stay in touch with their head offices.

Departments such as Indian and Northern Affairs Canada and CanNor have significant numbers of personnel in each of the three capitals. INAC carries out both a "northern

mandate" and an "Aboriginal mandate", working extensively with other governments (Aboriginal, Territorial and other federal departments) and the public. Services include economic development initiatives, land management, and administering funding programs to name a few. Due to its large federal presence in the Arctic, INAC is one of the few federal departments that have staff who are responsible for connecting its employees to adequate communication resources. These IT professionals also support connectivity to some smaller federal departments.

Service Canada (under HRSDC) has a large presence in the Arctic, with staff in each of the three capitals. They have a huge need to be able to connect with the public locally, and in communities. They deliver direct federal services such as supporting Canadians in retraining, family support programs, employment programs, retirement programs such as Canada Pension, supporting Service Canada activities etc. Service Canada also runs an outreach program whereby employees go into community for a short period of time with a laptop and information to offer services to the public.

Both INAC and Service Canada maintain storefront operations, conduct outreach into communities, and rely on databases and systems located in the south in order to do their work.

Departments with a smaller physical presence such as Justice, PWGSC, Industry Canada, the Correctional Service of Canada (CSC), Citizenship and Immigration, Agriculture and Agri-Food, CMHC and Canadian Heritage are in constant communication with their southern counterparts in carrying out their work, from policy development and service delivery to solving trouble tickets when their communications are down.

Departments such as Health Canada and CRA have no staff in the Arctic, but rely on good communication networks in order to work with Territorial governments and the public in the delivery of information and services to the public.

The RCMP is a unique federal agency from a communications perspective. They are the only department with permanent staff in all Arctic communities. All officers require 99.9% reliable communications capability into and out of every Arctic community no matter how small, in order for the RCMP to provide appropriate support to front line police officers.

Another unique federal agency is the Canada Border Services Agency, which supports border agents along the Yukon-Alaska border in carrying out their duties. They require constant connectivity from remote border locations in order to conduct critical queries on travelers entering Canada, requiring robust networks that can communicate with southern servers. These sites are not typically located within existing communities, so CBSA cannot take advantage of any existing community-based commercial communication services.

Today, all federal employees working in Arctic communities require robust, reliable communication networks in their place of work (at their office or when visiting communities) that properly support voice and data connections in order to do their jobs.

Most of these federal departments rely on the existence of commercial services that can be purchased to meet their needs. In most cases, these connections are organized by southern IT specialists, who are responsible for providing services in many jurisdictions across the country, including the north.

Federal agencies requiring communication services 'in the field'

Many federal departments must support seasonal researchers, emergency responders, and military personnel who travel in and out of communities and do work 'on the land' for extended periods of time. These staff are required to have communication services back to head office while 'in the field'.

Examples of these types of activities include:

- collecting environmental data;
- responding to emergencies wherever they occur;
- tracking wildlife;
- ensuring Arctic sovereignty.

Additional communication networks are required for the collection and timely distribution of data so that people, ships and aircraft can travel more safely through the Arctic, such as:

- providing navigational aid to ships and aircraft;
- monitoring weather.

These federal agencies need to be able to purchase communication services that work in all corners of the Arctic - both within communities and between communities.

Examples of departments who engage in this 'in the field' communications work include Public Safety, Department of Fisheries and Oceans (including Coast Guard), Environment Canada (including Canadian Wildlife Services), NRCan, Parks Canada, Department of National Defence and NavCan.[1]

Public Safety regional office needs to be able to connect with their northern/southern counterparts no matter what location they happen to be in at the time of an event. The Public Safety mandate is that of a coordination function, in which the regional office is the primary link for federal and territorial emergency management. Therefore this is why

[1] NavCan is now a not-for-profit private agency, but they work closely with Environment Canada to collect and distribute environmental information critical to the safe operations of aircraft in the Arctic. They participated in the assessment because of their public role in providing air traffic control services for flights over 27,000 feet traversing arctic air space. They collect and manage critical data from over 50 sites across the North, and work with every Arctic airport.

Public Safety concerns itself with ensuring emergency response organizations located throughout the territories are properly connected, and that systems used can interoperate with each other in the field in the event of an emergency. In the event of a large scale event such as a Major Air Disaster (MAJAID) or an earthquake, there are many levels of responders that would need to be coordinated and connected to ensure an efficient and timely response.

Department of National Defense (DND) has over 200 staff stationed in Yellowknife as part of Joint Task Force North (JTFN). JTFN requires robust connectivity to DND headquarters in the south, similar to any other federal government office located in the north.

DND has many initiatives and responsibilities that require advanced communication services in locations outside of communities. DND connects various remote Arctic military sites to DND headquarters, participates in search and rescue, and are responsible for sovereignty up to the North Pole. DND maintains its own HF Radio system for communications, and uses a variety of satellite connections to link to headquarters.

The Coast Guard also has a wide range of responsibilities in the Arctic reliant on communication services. For example Coast Guard is required to provide internationally compliant communications system so that every vessel can report their information prior to entering and exiting Canada's northern waters. They must implement the Global Maritime Distress and Safety System in the Arctic, and provide vessel traffic services via VHF.

Environment Canada runs many programs that require connectivity between communities. The science-based department conducts field work, operates non-manned research stations, and provides advice to those responding to an environmental emergency. The Canadian Wildlife Service performs extensive field surveys across the Arctic on wildlife and wildlife habitat, and manages 18 Bird Sanctuaries and National Wildlife Areas across the NWT and Nunavut. The Meteorological Service of Canada (MSC) relies on communication infrastructure to receive data from remote high arctic weather / upper air stations and marine buoys to send weather data to their main data centre in Montreal.

In Resolute Bay, Polar Continental Shelf researchers (under NRCan) use the local QINIQ service to link their researchers while in their base camp in Resolute. But due to the nature of their work, scientists returning from the field need to move many GB of data every day - reaching the bandwidth caps set by the publicly available network extremely quickly. They also need to be able to reach researchers just outside the community, outside of the local network's range. In order to solve the researchers' GB and coverage challenge, IT professionals from the Communications Research Centre (CRC) installed a custom-built network linked to a larger specialized KA band satellite dish that linked researchers to the Internet backbone over satellite. This local network was built entirely separately from the local system in order to solve the researchers' GB challenge. It is

maintained by CRC staff in Resolute. The researchers also continue to maintain their local QINIQ accounts too.

In summary, Federal agencies are directly responsible for activities in the Arctic that rely on both commercially-available connectivity within communities, and on communication networks outside of communities that must be developed specifically to meet Federal needs.

3.4 Yukon

Yukon has the most established communications infrastructure of the three Territories.

Yukon is also the most road-connected Territory, with only one fly-in community. Their large network of roads also requires that they have communication services between communities to support traveling government employees, and to serve and protect the traveling public.

Yukon has approximately 4,800 government employees, with about 3,800 of them in Whitehorse and the remaining 1,000 working throughout Yukon.

The chart below shows population, number of government employees and students. Whitehorse, with a population of 26,761, is by far the largest community with 14 times more people than the next largest town of Dawson City with a population of 1,881. Of the remaining communities, only Watson Lake and Haines Junction has more than 500 people.

While Whitehorse dominates the territory from a population standpoint, the Yukon Government works to ensure all people in the territory have equal access to all programs offered by the government, no matter where people live.

	Population	Yukon Government employees	Students
Beaver Creek	104	31	7
Burwash Landing	104	6	**
Carcross	431	68	46
Carmacks	485	70	104
Dawson City	1881	234	188
Destruction Bay	47	20	9
Faro	390	50	39
Haines Junction	809	130	131
Mayo	439	78	61
Old Crow*	233	27	32
Pelly Crossing	320	31	47
Ross River	352	55	61
Tagish	245	1	**
Teslin	463	54	58

	Population	Yukon Government employees	Students
Watson Lake	1525	176	203
Whitehorse***	26761	3846	4089
Other****	78	65	
TOTAL YUKON:	**34667**	**4877**	**5075**

Data for this chart was obtained from http://www.eco.gov.yk.ca/stats/pdf/population_dec_2010.pdf and from the Yukon Government Department of Education, with explanatory notes from Department of Economic Development.

*Satellite served community
**Students in Burwash Landing attend school in Destruction Bay. Tagish has no school.
*** Includes population of Marsh Bay, 457.
****"Other" population refers to very small communities such as Champagne, Elsa, Johnson's Crossing, Keno City, Stewart Crossing, and Swift River totaling 78 people. "Other" Yukon Government staff totaling 58 refers to workers at Transportation Maintenance Camps in Blanchard, Drury Creek, Eagle, Fraser, Ogilvie, Swift River and Tuchitua. This also includes Hershcel Island - a Parks Yukon site with seasonal workers.

Yukon departments have implemented advanced digital government services that rely on a robust communications infrastructure. All departments are making use of their communications infrastructure to manage and deliver many programs and services.

For example, Health and Social Services is implementing a digital x-ray program that relies on the movement of large digital files into and out of communities and to the south for analysis. Their acute care facilities in communities are linked more and more to the hospital in Whitehorse to extend services to communities, through new communication tools. They have well-established home care services in all communities, and public health programs such as immunization programs that utilize communication tools to operate effectively, efficiently and safely.

Education connects 2,900 students and teachers in the 30 schools throughout Yukon. They have a long list of applications used within schools to extend the delivery of education via distance education, and improve efficiency in the management of education in the Territory. They are even working on an advanced bus scheduling system with GPS tracking to help ensure the safety of students on busses.

Justice, Health and Education all make extensive use of videoconferencing in the delivery of their programs, requiring significant bandwidth and low latency to operate.

Emergency Measures and Protective Services have many initiatives that rely on robust communications, as they work to respond to, and prepare for emergencies in all locations in Yukon. This department has a vital need to connect responders between communities.

The recent launch of the Mobile Radio System (MRS) is a key communication tool that supports EMO and other first responders all over Yukon.

Many key departments participated in the Assessment. Representatives from Highways and Public Works ICT branch represented other departments in identifying specific communication needs in the visioning workshops.

Yukon Government departments include:

Department	**Url**	Partici-pated in Workshop	Partici-pated in Survey
Community Services (EMO, Protective Services & Public Libraries)	http://www.community.gov.yk.ca/	Yes	Yes
Economic Development (Finance and Info Serv)	http://www.economicdevelopment.gov.yk.ca/	Yes	Yes
Education	http://www.education.gov.yk.ca/	No	Yes
Energy, Mines and Resources	http://www.emr.gov.yk.ca/	No	Yes
Environment	http://www.environmentyukon.gov.yk.ca/	No	No
Executive Council Office	http://www.eco.gov.yk.ca/	Yes	Yes
Finance	http://www.finance.gov.yk.ca/	No	No
French Language Services Directorate	http://www.flsd.gov.yk.ca/	No	No
Health and Social Services	http://www.hss.gov.yk.ca/	No	Yes
Highways and Public Works (ICT branch)	http://www.hpw.gov.yk.ca/	Yes	Yes
Justice	http://www.hpw.gov.yk.ca/	No	Yes
Public Service Commission	http://www.psc.gov.yk.ca/	No	No
Tourism and Culture	http://www.tc.gov.yk.ca/	No	No
Women's Directorate	http://www.womensdirectorate.gov.yk.ca	No	No

Please see Appendix C for a specific listing of some of the applications identified by the various departments as part of this assessment.

3.5 Northwest Territories

The Northwest Territories is the most populous territory, with the most significant difference in communication services within its borders. At one end of the scale, Yellowknife has the best communication access, while the 10 communities relying on satellite currently have the poorest government communication services.

Yellowknife is the largest city at almost 20,000 people - almost half of the population. It is only 6 times larger than the next largest community of Hay River, which has 3,700 people. Other medium sized communities include Inuvik, Fort Smith, and Behchoko all with over 2,000 people. Fort Simpson has 1,200, and 10 other communities have between 500 and 1,000 people, some of which are served by satellite. This population distribution means that communication networks must support a good deal of traffic between communities within the NWT, as networks are required to support services to half of the population located outside of the capital.

	Population	NWT Government Employees	Students
Aklavik	658	57	146
Behchoko	2080	169	604
Colville Lake	158	9	41
Deline*	567	40	134
Detah	260	0	53
Enterprise	98	14	n/a
Fort Good Hope*	592	40	117
Fort Liard	587	41	122
Fort McPherson	795	54	195
Fort Providence	767	64	196
Fort Resolution	494	42	102
Fort Simpson	1270	211	251
Fort Smith	2483	494	601
Gamèti*	301	14	82
Hay River	3726	283	745
Hay River Reserve	328	22	71
Inuvik	3552	495	667
Jean Marie River	71	2	9
Kakisa	55	2	8
Lutselk'e*	297	23	81
Nahanni Butte*	120	6	21
Norman Wells*	816	117	140
Paulatuk*	336	22	83
Sachs Harbour*	134	9	21
Trout Lake*	100	12	16
Tsiigehtchic	123	8	38

	Population	NWT Government Employees	Students
Tuktoyaktuk	916	42	199
Tulita*	564	36	138
Ulukhaktok	472	31	97
Wekw eèti	141	7	30
Wha Ti*	497	27	144
Wrigley	113	13	21
Yellowknife	19927	2209	3406
Other**	361		
Total NWT	**43759**	**4615**	**8579**

Data for this chart came from: NWT Statistics, 2010
http://www.stats.gov.nt.ca/population/population-estimates/commtotal.html
NWT Public Service Annual report, 2009, NWT Dept of Education, Grade Distribution of Enrollment, 2010
*Satellite served communities
**Unorganized areas, population of less than 50

There are 4,600 NWT government employees working in all 33 communities in NWT. Of these, almost half work in Yellowknife. The remaining 2,400 government employees work in communities all over NWT.

The wide range of quality of communications services within the territory means that government's efforts to launch new digital services must always consider which communities can be served and which can not be served effectively in any new digital initiative.

Many departments are working on creative new services, that rely on robust communication networks. They would like infrastructure solutions to bring up the level of service in under-served communities, so that new services can be implemented everywhere equally.

The Technology Service Centre (TSC) supports over 4,000 government employees with workplace support, enterprise-wide services, such as e-mail and other communication and network services and tools, and host many department applications and websites. They provide advice to departments when selecting and implementing technology solutions. The TSC recently built a large data centre in Yellowknife to meet the growing data storage needs of the GNWT.

According to the Technology Service Centre, Health and Education account for about 80% of all traffic on government networks.

For example, Education connects over 8,000 students, teachers and parents in a Student Information System. They provide remote education for children aimed at increasing access to specialized teachers from the south through e-learning.

Health and Social Services have many initiatives that rely on good connectivity, and need to "bend the trend" of rising costs by looking at ways to deliver better services to everyone, at a lower cost. They are actively implementing new technology that aims to improve service delivery to patients throughout NWT at lower costs. Efforts include increased telehealth for specialist connections, better electronic record management through PACS (Picture Archiving and Communication System), increased computing radiography rolled out in 18 communities, plus Telespeech projects in schools that link students by videoconferencing with speech therapy services in other communities.

Environment and Natural Resources require connectivity between communities to carry out their mandate. They collect and shares data on species, publish wildlife management information, administer a remote research station, and download satellite data from collared animals. They also by collect and report on the state of forest resources, integrating geomatics, information management, fire prevention, community protection, environmental monitoring, disturbance mapping, and collaboration with national and global fire management agencies.

The participation rate in the survey from the NWT departments was extremely high. Representation of many departments for the visioning workshop was provided by the Technology Service Centre (TSC) within Public Works and Services. Please see Appendix C for a list of applications identified by participating departments.

Department	**Url**	Participated in Workshop	Participated in Survey
Aboriginal Affairs & Intergov'l Rel's	http://www.daair.gov.nt.ca/	No	No
Aurora College	http://www.auroracollege.nt.ca/	No	Yes
Education, Culture & Employment	http://www.ece.gov.nt.ca/	No	Yes
Environment & Natural Resources	http://www.enr.gov.nt.ca/	Yes	Yes
Executive	http://www.executive.gov.nt.ca/	No	Yes
Finance	http://www.fin.gov.nt.ca/	No	No
Health & Social Services	http://www.hlthss.gov.nt.ca/	No	Yes
Human Resources	http://www.hr.gov.nt.ca/	No	Yes
Industry, Tourism & Investment	http://www.iti.gov.nt.ca/	Yes	Yes
Justice	http://www.justice.gov.nt.ca/	No	Yes
Legislative Assembly	http://www.assembly.gov.nt.ca/	No	No
Municipal & Community Affairs	http://www.maca.gov.nt.ca/	Yes	Yes
Public Works & Services	http://www.pws.gov.nt.ca/	Yes	Yes
Transportation	http://www.dot.gov.nt.ca/	No	Yes

3.6 Nunavut

More than any other territorial jurisdiction, Nunavut's government relies on a robust communication infrastructure in order to operate efficiently.

Nunavut took a decentralized approach when setting up its government in 1999, to share government employment opportunities with as many communities as reasonably possible. So while the capital of Iqaluit has the most government employees, many departments' headquarters and regional offices are located in the ten 'decentralized' communities.

Nunavut has an entirely different dynamic in terms of the relationship of the capital to other communities, simply because of the way the population is distributed. Iqaluit represents only 21% of the total population of Nunavut, with 7,000 people out of 33,000. The next largest community, Rankin Inlet, is just under half the size of Iqaluit, with 2,730 people. In contrast, Whitehorse has more than 75% of the population of Yukon, and has 14 times more people than the next largest community. Yellowknife accounts for almost half the population of the NWT, and has 6 times more people than the 2nd largest community.

Community*	Population	Government of Nunavut employees	Students
Arctic Bay	746	55	222
Arviat**	2339	194	848
Baker Lake**	1963	113	592
Cambridge Bay**	1626	222	399
Cape Dorset**	1407	117	367
Chesterfield Inlet	383	29	99
Clyde River	922	58	306
Coral Harbour	870	54	285
Gjoa Haven**	1138	101	331
Grise Fiord	154	16	36
Hall Beach	718	35	177
Igloolik**	1686	146	498
Iqaluit	7010	1514	1340
Kimmirut	455	32	133
Kugaaruk	738	48	250
Kugluktuk**	1427	136	292
Pangnirtung**	1476	129	378
Pond Inlet**	1465	152	419
Qikiqtarjuaq	534	43	109
Rankin Inlet**	2730	423	746
Repulse Bay	875	44	311
Resolute Bay	255	20	55

Community*	Population	Government of Nunavut employees	Students
Sanikiluaq	810	52	264
Taloyoak	891	40	255
Whale Cove	400	31	143
Unorganized (total)	30		
TOTAL NUNAVUT:	**33048**	**3804**	**8855**

Data for this chart came from http://www.eia.gov.nu.ca/stats 2011 estimates, Department of Human Resources and Dept of Education Enrollment headcount and FTE Verification 2010-2011
*All communities are satellite served.
**'decentralized' communities: communities with GN offices

Of the 24 communities in Nunavut (not including Iqaluit), 2 communities have over 2,000 people, 8 communities have over 1,000 people, 8 have between 500 and 1,000 people, and only 5 communities have under 500 people.

Of the 3,800 government employees, 1,500 work in Iqaluit. The 10 decentralized communities - those with government offices - all have at least 100 government positions, with Rankin Inlet having over 400.

Clearly, connectivity to meet government's ability to operate effectively is a top priority to carry out the internal work of government, due to the decentralized nature of the government offices.

The need is great for communication services in Nunavut to support government delivery of services to the public as well -- whether they live in a 'decentralized' community or not.

Educators need distance education tools. Human resources requires intelligent systems for managing human resources. Every department wants to make use of videoconferencing to reduce costs and improve access to services. But currently most of these initiatives are not yet implemented.

The good news is, that all 25 communities face essentially the same basic infrastructure challenges, since all are served by satellite. This means that when planning service delivery, Nunavut can choose systems that if they work in Arviat, they can be made to work in Grise Fiord.

The bad news is, that due to their infrastructure challenges and overall youth of their government, they have not yet been able to take advantage of many of the digital services being developed in the NWT and Yukon yet.

Nunavut also has the added challenge that the majority of people speak Inuktitut as their first language, with a significant portion of the population unilingual Inuktitut speakers. All public services must be available in Inuktitut and English, and are also often offered in Inuinaqtun and French which are also official languages in Nunavut. In addition, Inuktitut in the Kivalliq and Baffin region use a syllabic font, (not roman orthographic that is universally recognized by computers) requiring all software to recognize unicode in order for Inuktitut to be sorted and displayed properly over digital communication tools. The need for using a syllabic writing system adds another level of complexity when managing databases in Inuktitut and communicating over the Internet.

Government Departments include:

Department	**Url**	Partici-pated in Workshop	Partici-pated in Survey
Community and Government Services	http://cgs.gov.nu.ca/en/	Yes	Yes
Culture, Language, Elders and Youth	http://www.cley.gov.nu.ca/en/	Yes	No
Economic Development and Transportation	http://www.edt.gov.nu.ca/apps/authoring/dspPage.aspx?page=home	Yes	No
Education	http://www.edu.gov.nu.ca/apps/authoring/dspPage.aspx?page=home	Yes	Yes
Environment	http://env.gov.nu.ca/	No	No
Executive and Intergovernmental Affairs	http://www.eia.gov.nu.ca/en/about.aspx	No	No
Finance	http://www.finance.gov.nu.ca/apps/authoring/dspPage.aspx?page=home	No	No
Health and Social Services	http://www.hss.gov.nu.ca/en/Home.aspx	No	No
Human Resources	http://www.gov.nu.ca/hr/site/index.htm	Yes	Yes
Justice	http://www.justice.gov.nu.ca/apps/authoring/dspPage.aspx?page=home	No	No

There was an excellent turn out of GN departmental representatives at the visioning workshops in Iqaluit. Those departments that were unable to attend were represented by Community and Government Services, which is responsible for connecting government

employees across Nunavut. Much of the feedback from these representatives is captured in the "issues" section, which best reflects the communication situation in Nunavut today.

The Government of Nunavut provided a single comprehensive list of the current applications being run by various departments, since they had just completed an internal assessment with some of the same questions in this assessment. Those specific applications are included in Appendix C. To avoid duplication of effort, very few individual departments filled in this assessment's survey.

4 Technical State Today

4.1 Introduction

This chapter of the Assessment reports on the current state of the Arctic communications infrastructure, to clearly establish a baseline of existing services.

This chapter includes:

- The scope of the current state data gathered;
- An overview of how the data was gathered;
- An overview of the service providers currently operating in the Arctic;
- A listing of consumer Internet and cell phone services by community;
- A listing of backbone capacity by community in raw and architectural terms;
- A listing of civilian VHF radio infrastructure by region.

The scope of this current state description does not include communications infrastructure that only operates within a community, typically referred to as Municipal Area Networks (MAN). Instead, the focus is on backbone services, those services that connect communities to each other or to the Internet, and local services, those services that connect individuals or residents to the backbone services.

This chapter of the Assessment presents a snap shot of the current infrastructure at a given point in time based upon the current state of the technical infrastructure as reported by service providers in February, 2011. While recognizing that services are continually evolving and will fall out of date, this baseline snapshot is intended to provide data for comparing the gap between what is available today, and what will be needed in the future for planning purposes.

It is important to note that during the workshops and individual interviews, Northern participants expressed concern with the ability of the existing infrastructure to support their current needs. With each passing year, more services are delivered to citizens digitally, and it will be increasingly difficult for infrastructure to keep pace.

4.2 Scope

The focus of this section of the Assessment is on the backbone services that link Arctic communities together and to the Internet backbone. In gathering the existing backbone data, only service providers currently in operation were consulted. This part of the Assessment includes only providers that responded, and which currently and directly serve communities in the Arctic.

The Assessment also documents the current availability of local Internet and cell phone services available to purchase, itemized by community. There was no attempt to document at the technical details how these public Municipal Area Network (MAN) services are delivered within a community, only that they are or are not available.

4.3 Approach

In order to ensure that data was captured in a meaningful and comparable way, a series of grids were developed in consultation with the key service providers. These grids were then provided to each of the key service providers with instructions on how to complete them. Once completed, the service providers were then provided an opportunity to meet with the project team to discuss their data to ensure accuracy.

In addition to the backbone grid, service providers were asked to complete a local services availability grid for each territory. Once completed, the grids were reviewed, summarized and logical and physical network diagrams were developed based upon the provided data. These diagrams were then provided to the service providers for comment and any required changes incorporated.

In order to ensure comparable data and to present a realistic view of what is currently available today, service providers were instructed to only describe their infrastructure in terms of what is currently available without further investment. This would not preclude reconfiguration of existing infrastructure or purchase of additional satellite transponder space but would exclude replacement or augmentation of existing physical infrastructure.

Service providers were asked to provide information about current utilization and capacity. One service provider chose to withhold current utilization data, considering it business confidential. As a result, all backbone data presented in the backbone section represents capacity only. Any current utilization data provided by other providers has been excluded.

When providing capacity data, service providers were asked to describe their network and its services as they exist today, without any planned or potential upgrades or modifications.

This guideline was implemented to ensure that the data provided accurately reflects the capacity of the infrastructure in its current state and not a potential future state.

In addition to the grids described above, service providers were asked to comment on a series of additional questions by backbone infrastructure type, namely:

- Satellite;
- Fiber (land);
- Microwave.

A sample of the questions for satellite is included below:

1. Can logical networks be allocated remotely or do they require a site visit?
   - If done remotely please describe how this is accomplished.
2. Can CIR and/or logical network bandwidth be allocated or adjusted remotely or does it require a site visit?
   - If done remotely please describe how this is accomplished.
3. Can any available bandwidth be dynamically (real time) allocated across logical networks?
   - If "yes" please describe how this is accomplished.
4. Can the network broadcast to multiple points in a single transmission?
5. Can data within a logical network be segregated by source/type/destination?
   - If "yes" please describe how this is accomplished.
6. Is the satellite network fully meshed?
   - If "yes" please describe how this is accomplished.
7. Does the network support routing for local community bound traffic to avoid WAN traffic?
   - If "yes" please describe how this is accomplished.
8. Can the network be cross-connected with other vendors or private networks within a community?
   - If "yes" please describe how this is accomplished.
   - If "no" please describe the barriers to supporting this feature.
9. Does the network support both voice and data?
10. Does the network support any other services (TV, cellular)?

Finally, service providers were given space to reply with additional notes they wished to have included with their grids.

4.4 Service Provider Overview

There are a relatively small number of primary service providers in the Arctic. Nunavut and the Northwest Territories have two major service providers, and Yukon has one. Both of these providers are served by one satellite company.

A brief description of each provider is included below. Each of these descriptions has been reviewed and approved by the service provider.

Northwestel

Headquartered in Whitehorse, Northwestel delivers a broad range of telecommunications solutions & television services to a population of 120,000 northern Canadians in 96 communities scattered throughout the Yukon, the Northwest Territories, Nunavut, northern British Columbia and Alberta.

Northwestel's operations include local telephone services; long distance communications by microwave radio, fiber optic cable and satellite; cable television, and advanced data communications, including High Speed Internet in many parts of its operating area.

Northwestel also provides wireless services for northern customers through cellular, broadband wireless, wireless Local Area Networks, wireless Metropolitan Area Networks and trunked radio services.

Website: http://www.nwtel.ca/

SSi Micro

SSi is a recognized leader in the field of remote and rural connectivity. They specialize in deploying turnkey networks to support the needs of communities that do not have access to terrestrial connectivity. SSi's networks deliver broadband Internet via an advanced satellite delivery platform, and provide local distribution services using licensed and unlicensed wireless technologies.

Headquartered in Yellowknife, SSi is the largest ISP in Northern Canada, serving more than 60 Northern communities within Nunavut and the Northwest Territories. These two territories account for 1/3 of Canada¹s land mass, covering 1,327,919 square miles.

SSI's accomplishments include the deployment of satellite/wireless networks throughout Nunavut, the Northwest Territories and Nunavik, as well as various communications projects in developing nations. SSi is a unique Northern company recognized for their ability to integrate advanced technologies in order to deliver complete solutions that address the needs of their clients. SSi has a reputation for delivering high quality solutions to complex problems and are renowned for being on the leading edge of the latest developments in satellite, wireless and Internet technologies.

Website: http://www.ssimicro.com/

Telesat

Headquartered in Ottawa, Telesat is a leading global fixed satellite services operator providing satellite-delivered communications solutions worldwide to broadcast, telecom, corporate and government customers. The company operates a fleet of 12 satellites with three more under construction, and manages the operations of additional satellites for third parties. Privately held, Telesat's principal shareholders are Canada's Public Sector Pension Investment Board and Loral Space & Communications Inc.

Website: http://www.telesat.com/

4.5 Technical Definitions Appearing in Data Summaries

Various terms are used in the remainder of this chapter. Technical definitions of words relating to bandwidth, local services, and backbone services have been provided here.

Bandwidth definitions

This report describes bandwidth numbers in terms of Kilobits, Megabits or Gigabits per second. A definition of each has been provided below to ensure a common understanding.

Kilobit per second

A kilobit per second (kbit/s, kb/s, or kbps) is a unit of data transfer rate equal to:

- 1024 bits per second or
- 125 bytes per second.

Megabit per second

A megabit per second (Mbit/s, Mb/s, or Mbps; not to be confused with mbit/s which means, literally, millibit per second) is a unit of data transfer rate equal to:

- 1,048,576 bits per second or
- 1,024 kilobits per second or
- 131,072 bytes per second.

Gigabit per second

A gigabit per second (Gbit/s, Gb/s, or Gbps) is a unit of data transfer rate equal to:

- 1,024 megabits per second or
- 1,048,576 kilobits per second or
- 134,217,728 bytes per second

Local service definitions

In order to ensure a base level of understanding about the various local services available across the three territories more detailed descriptions have been provided below. These terms will be used in Section 4.6, Local Services Data Summary.

CDMA 1x

CDMA2000 1x is a wireless standard that brought data capabilities to cellular communication products. It supports both voice and 153 Kbps of data using the same bandwidth configuration as legacy IS-95A1 CDMA networks (i.e. 1.25 MHz channel bandwidth, thus the "1x" designation, also known as 1xRTT: 1 times Radio Transmission Technology). Real world data transmissions average 60–100 kbps in most commercial applications.

HSPA

High Speed Packet Access (HSPA) is a cellular-based wireless technology that supports increased peak data rates of up to 14 Mbit/s in the downlink and 5.8 Mbit/s in the uplink.

It also reduces latency and provides up to five times more system capacity in the downlink and up to twice as much system capacity in the uplink, reducing the production cost per bit compared to original WCDMA protocols.

Evolved HSPA (also known as HSPA+), released late in 2008 with subsequent adoption worldwide beginning in 2010, provides data rates up to 84 Mbit/s in the downlink and 22 Mbit/s in the uplink (per 5 MHz carrier) with multiple input, multiple output (MIMO) technologies and higher order modulation.

DSL / ADSL

Digital Subscriber Line (DSL) is a family of technologies that provides digital data transmission over the wires of a local telephone network. By utilizing frequencies that are not used by a voice telephone call, a splitter, or DSL filter, allows a single telephone connection to be used for both ADSL service and voice calls at the same time. DSL can generally only be distributed over short distances from the central office, typically up to 5 kilometres.

DSL comes in a variety of 'flavors', varying in configurations, data rates, and ranges. The most common is ADSL (Asymmetric Digital Subscriber Line), where the download data rate is greater than the upload data rate. VDSL (Very High Speed Digital Subscriber Line) offers high enough data rates to allow "triple play" services (up to 52 Mbps downstream and 16 Mbps upstream), but range is limited to under one kilometer. VDSL2 increases download speeds to 100 Mbps, but cuts range to 300 metres. Future versions, such as GDSL (Gigabit Digital Subscriber Line) promise to push limits even further.

Cable

Cable Internet access is a form of broadband Internet access that uses the DOCSIS standard for transmitting data over cable television infrastructure without interfering with the television service itself. Downstream data rates can be as high as 400Mbps (although 50-100Mbps is a more typical maximum) with upstream rates of up to 20Mbps. The range of cable Internet is much greater than DSL – up to 160 kilometres.

Fixed wireless

Unlike DSL and Cable Internet technologies that use generally existing copper infrastructures to enter subscribers' homes, fixed wireless broadband networks send data wirelessly from an Access Point (AP) to radios at subscribers' homes. Subscribers may have an external antenna mounted on their home, or may simply use a desktop modem with a built-in antenna. Wireless networks can use licensed or unlicensed spectrum, and may or may not require line of sight (LOS) to the AP, typically mounted on a tower or local high spot (such as a silo or water tower). Data rates can reach 10 Mbps, and APs can have a range of up to 30 kilometres, depending mostly on their antenna height and obstructions (such as terrain or foliage.) A common protocol being used today is WiMax (IEEE 802.16).

Fibre to the home/node/curb

Fibre to the Home/Node/Curb (FTTH/FTTN/FTTC or generalized as FTTx) are broadband network architectures that uses optical fiber to carry data to either subscribers' homes or a common point close to several homes. In the case of the latter, copper (or less commonly wireless) is used carry the signals from the common point into the subscribers' homes, making them hybrid networks. Fibre optic networks enable much higher speeds and ranges than copper or wireless, but typically require much more physical construction than technologies that make use of existing telephone or TV networks, or use no wired network at all.

Backbone services definitions

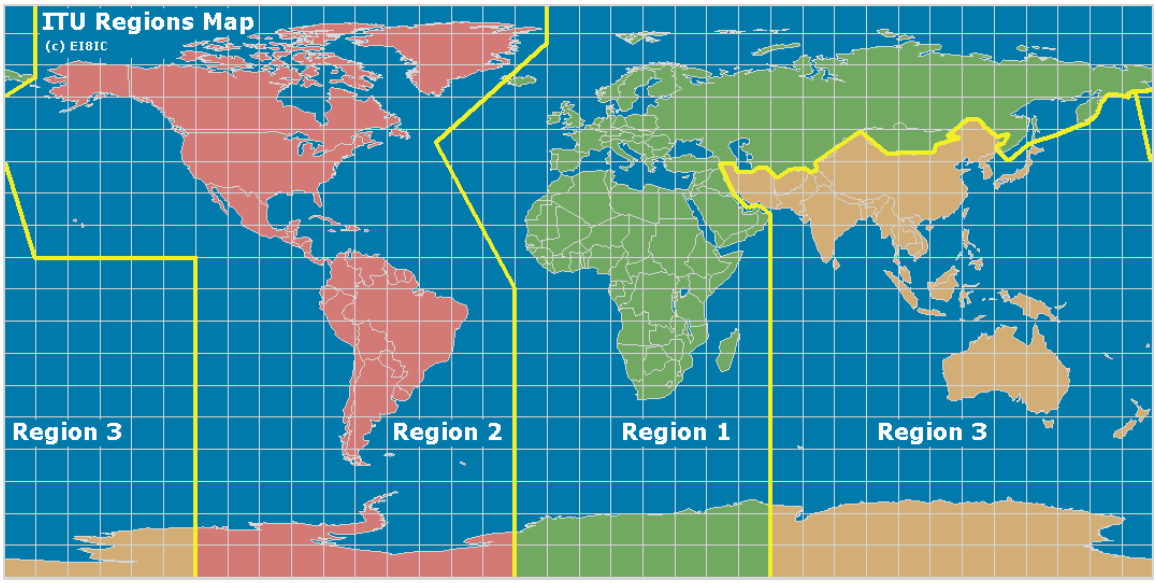
A brief overview describing the backbone services utilized across the three territories is included for the sake of clarity. These terms will be used in Section 4.7: Backbone Services Data Summary.

Microwave

The microwave spectrum is usually defined as electromagnetic energy ranging from approximately 1 GHz to 100 GHz in frequency, but older usage includes lower frequencies. Most common applications are within the 1 to 40 GHz range. Microwave frequency bands, as defined by the Radio Society of Great Britain (RSGB), are shown in the table below:

L band	1 to 2 GHz	Q band	30 to 50 GHz
S band	2 to 4 GHz	U band	40 to 60 GHz
C band	4 to 8 GHz	V band	50 to 75 GHz
X band	8 to 12 GHz	E band	60 to 90 GHz
K_u band	12 to 18 GHz	W band	75 to 110 GHz
K band	18 to 26.5 GHz	F band	90 to 140 GHz
K_a band	26.5 to 40 GHz	D band	110 to 170 GHz

The International Telecommunication Union (ITU) has divided the world into three regions for the purposes of managing the global radio spectrum with each region having its own set of frequencies. A map of the three ITU regions is below.



Region 1 – covers Europe, Africa, the Middle East west of the Persian Gulf including Iraq, the former Soviet Union and Mongolia.

Region 2 – covers the Americas, Greenland and some of the eastern Pacific Islands

Region 3 – covers most of non-former-Soviet-Union Asia east of and including Iran and most of Oceania.

Satellite communications

There are three types of satellite services discussed in this report, Ku, Ka and C band. All three bands represent a portion of the electromagnetic spectrum in the microwave range of frequencies. A brief description of each is provided below.

All satellite backbone services are aggregate and do not account for different satellites. In the case of C-Band services it is important to note that the transponder counts provided are aggregate and do not account for different satellites or polarizations. Currently, the two major service providers are utilizing the same pole on the same satellite. Migrating a service provider to a different pole and/or satellite would require significant investment in ground station infrastructure.

The satellite operator and network vendors using satellite services were asked to identify the coverage they provide in the North and we have documented those claims. Readers should be aware that all satellites providing commercial service to the North are situated at the equator and therefore some services are more difficult to receive in the higher latitudes. Sites further north may require larger antennas that point near or even below the horizon, require more transmit and receive power and more antenna vulnerability to wind damage due to the increased size of the antenna.

C Band

The C band contains frequency ranges that are used for many satellite communications transmissions, some Wi-Fi devices, some cordless telephones, and some weather radar systems. For satellite communications, the microwave frequencies of the C-band perform better under adverse weather conditions in comparison with Ku and Ka bands.

The communications C-band was the first frequency band that was allocated for commercial telecommunications via satellites using the same frequencies already in use for terrestrial microwave radio relay chains. As a result, C-band satellite systems are restricted in power to avoid interference with terrestrial microwave systems. Nearly all C-band communication satellites use the band of frequencies from 3.7 to 4.2 GHz for their downlinks, and the band of frequencies from 5.925 GHz to 6.425 GHz for their uplinks. By using the band from 3.7 to 4.0 GHz, C-band overlaps somewhat into the IEEE S-band for radars.

The C-band communication satellites typically have 24 radio transponders spaced 20 MHz apart, but with the adjacent transponders on opposite polarizations. Hence, the transponders on the same polarization are always 40 MHz apart. Of this 40 MHz, each transponder utilizes about 36 MHz. The unused 8.0 MHz between the pairs of transponders acts as "guard bands" in case of imperfections in the microwave electronics.

The satellite communications portion of the C-band is associated with what is commonly called "big dish" systems, since small receiving antennas are not optimal for C-band systems. Typical antenna sizes on C-band capable systems ranges from 7.5 to 12 feet (2.5 to 3.5 meters) on consumer satellite dishes, although larger ones also can be used.

The C-band frequencies of 5.4 GHz is used for IEEE 802.11a Wi-Fi and cordless telephone applications, leading to occasional interference with some weather radars that are also allocated to the C-band.

Ku band

The Ku band (Kurz-under) is primarily used for satellite communications, particularly for editing and broadcasting satellite television and utilizes frequencies ranging from 11.7 to 12.7 GHz (downlink) and 14 to 14.5 GHz (uplink). The first commercial television network to extensively utilize the Ku Band for most of its affiliate feeds was NBC, back in 1983. When frequencies higher than 10 GHz are used in a heavy rainfall area, a noticeable degradation occurs commonly known as known as "rain fade". The higher frequency spectrum of the Ku band is

particularly susceptible to signal degradation, much more so than C band satellite frequency spectrum, though the Ku band is less vulnerable to rain fade than the Ka band frequency spectrum. A similar phenomena, called "snow fade" occurs when snow accumulation significantly alters the focal point of your dish. The Ku band satellites typically require considerably more power to transmit than the C band satellites. However, both Ku and Ka band satellite dishes tend to be smaller, varying in size from 2' to 5' in diameter.

Ka band

The Ka band (Kurz above) uses frequencies between 27.5GHz and 31Ghz (uplink) and between 18.3 and 18.8Ghz and between 19.7 and 20.2Ghz (downlink). Ka band dishes can be much smaller than C band dishes varying from 2' to 5' in diameter. The higher frequencies of Ka band are significantly more vulnerable to signal quality problems caused by rainfall and snow.

Unlike C-band, the Ka and Ku bands are not restricted in power to avoid interference with terrestrial based communications allowing for the power of their uplinks and downlinks to be increased. This higher power also translates into smaller receiving dishes and highlights a general correlation between a satellite's transmission power and a dish's size. As the power increases, the dish's size can decrease. This is because the purpose of the dish element of the antenna is to collect the incident waves over an area and focus them all onto the antenna's actual receiving element, mounted in front of the dish (and pointed back towards its face); if the waves are more intense, less of them need to be collected to achieve the same intensity at the receiving element.

Fiber optic cabling

An optical fiber is a thin, flexible, transparent fiber that acts as a waveguide to transmit light between the two ends of the fiber. Optical fibers are widely used in fiber-optic communications, which permits transmission over longer distances and at higher bandwidths than other forms of communication. Fibers are used instead of metal wires because signals travel along them with less loss and are also immune to electromagnetic interference. Optical fiber typically consists of a transparent core surrounded by a transparent cladding material with a lower index of refraction. Light is kept in the core by total internal reflection causing the fiber to act as a waveguide. Fibers that support many propagation paths or transverse modes are called multi-mode fibers (MMF), while those that only support a single mode are called single-mode fibers (SMF). Multi-mode

fibers generally have a larger core diameter, and are used for short-distance communication links and for applications where high power must be transmitted. Single-mode fibers are used for most communication links longer than 1,050 meters (3,440 ft).

Optical fiber can be used as a medium for telecommunication and networking because it is flexible and can be bundled as cables. It is especially advantageous for long-distance communications, because light propagates through the fiber with little attenuation compared to electrical cables. This allows long distances to be spanned with few repeaters. Additionally, the per-channel light signals propagating in the fiber have been modulated at rates as high as 111 gigabits per second by NTT (Nippon Telegraph and Telephone Corp) although 10 or 40 Gb/s is typical in deployed systems. Each fiber can carry many independent channels, each using a different wavelength of light called wavelength-division multiplexing (WDM).

4.6 Local Services Data Summary

This section describes the type of local Internet and cellular services available in the communities across all three territories. Where there are two providers (NWT and Nunavut) the data presented is aggregated between the two service providers.

Where a particular Internet service is available it is clearly indicated. For cellular service, the type of service available within a community is indicated. Empty squares indicate that no service is available.

Local Nunavut services

Community	Cellular	Local Internet Access			
		Dialup	ADSL	Wireless	Cable
Arctic Bay		Yes		Yes	
Arviat		Yes		Yes	
Baker Lake	CDMA-1X	Yes		Yes	
Bathurst Inlet		Yes		Yes	
Cambridge Bay	CDMA-1X	Yes		Yes	
Cape Dorset		Yes		Yes	
Chesterfield Inlet		Yes		Yes	
Clyde River		Yes		Yes	
Coral Harbour		Yes		Yes	
Gjoa Haven		Yes		Yes	
Grise Fiord		Yes		Yes	
Hall Beach		Yes		Yes	
Igloolik		Yes		Yes	
Iqaluit	CDMA-1X	Yes	Yes	Yes	
Kimmirut		Yes		Yes	
Kugaaruk		Yes		Yes	
Kugluktuk	CDMA-1X	Yes		Yes	
Pangnirtung		Yes		Yes	
Pond Inlet	CDMA-1X	Yes		Yes	
Qikqtarjuaq		Yes		Yes	
Rankin Inlet	CDMA-1X	Yes		Yes	
Repulse Bay		Yes		Yes	
Resolute		Yes		Yes	
Sanikiluaq		Yes		Yes	
Taloyoak		Yes		Yes	
Whale Cove		Yes		Yes	

Local Northwest Territories services

Community	Cellular	Local Internet Access			
		Dialup	ADSL	Wireless	Cable
Aklavik			Yes	Yes	
Behchoko			Yes	Yes	
Colville Lake				Yes	
Deline				Yes	
Dettah			Yes	Yes	
Enterprise			Yes	Yes	
Fort Good Hope			Yes	Yes	
Fort Liard			Yes	Yes	
Fort McPherson			Yes	Yes	
Fort Providence			Yes	Yes	
Fort Resolution			Yes	Yes	
Fort Simpson	CDMA-1X		Yes	Yes	
Fort Smith	CDMA-1X, HSPA		Yes	Yes	
Gameti		Yes		Yes	
Hay River Res.	CDMA-1X, HSPA		Yes	Yes	
Hay River	CDMA-1X, HSPA		Yes	Yes	
Inuvik	CDMA-1X		Yes		
Jean Marie River		Yes		Yes	
Kakisa		Yes		Yes	
Lutselk'e				Yes	
Nahanni Butte		Yes		Yes	
Norman Wells	CDMA-1X				Yes
Paulatuk		Yes		Yes	
Sachs Harbour		Yes		Yes	
Trout Lake		Yes		Yes	
Tsiigehtchic			Yes	Yes	
Tuktoyaktuk	CDMA-1X		Yes	Yes	
Tulita			Yes	Yes	
Ulukhaktok		Yes		Yes	
Wekweeti		Yes		Yes	
Whati			Yes	Yes	
Wrigley		Yes		Yes	
Yellowknife	CDMA-1X, HSPA		Yes	Yes	Yes

Local Yukon services

Community	Cellular	Local Internet Access			
		Dialup	ADSL	Wireless	Cable
Beaver Creek	CDMA-1X		Yes		
Burwash Landing	CDMA-1X		Yes		
Carcross	CDMA-1X		Yes		
Carmacks	CDMA-1X		Yes		
Dawson City	CDMA-1X		Yes		
Destruction Bay	CDMA-1X		Yes		
Faro	CDMA-1X		Yes		
Haines Junction	CDMA-1X		Yes		
Keno			Yes		
Marsh Lake	CDMA-1X, HSPA		Yes		
Mayo	CDMA-1X		Yes		
Old Crow	CDMA-1X		Yes		
Pelly Crossing	CDMA-1X		Yes		
Ross River	CDMA-1X		Yes		
Tagish	CDMA-1X		Yes		
Teslin	CDMA-1X		Yes		
Watson Lake	CDMA-1X		Yes		
Whitehorse	CDMA-1X, HSPA		Yes	Yes	Yes

As can be seen from the charts above, cellular and ADSL access in the Yukon is much more widely available than in NWT and Nunavut. It is important to note that cellular service is not readily available on the land between any communities, including along roads that link communities.

Comparison to southern local services, costs, speeds and caps

Costs to purchase Internet access in communities is generally much higher than in the south. Speeds are also slower, and service providers set monthly GB caps on Internet accounts to persuade heavy data users to manage their bandwidth usage carefully.

Section B.3.3 of the Government of Northwest Territories Final Argument submitted to the CRTC concerning Telecom Notice of Consultation CRTC 2010-43 dated 12 November, 2010 included recent data on pricing in Arctic communities compared to Southern jurisdictions. These tables have been reproduced here for reference.

Monthly pricing for access is substantially higher in the North. Speed constraints, and GB caps are imposed on users by all service providers jn order to manage bandwidth usage

by customers. This results in consumers being charged far higher rates for far slower services than in the South.

*Table 1: Northwestel High Speed Residential Internet Rates**

	Download Speed	Allowed Monthly Usage	Monthly Rate	Installation Fees
DSL Lite	0.384 Mbps	5 GB	$41.95	$29.95 to $99.95
DSL Classic	2.5 Mbps	15 GB	$62.95	$29.95 to $99.95
DSL Ultra	5 Mbps	30 GB	$83.95	$29.95 to $99.95
High Speed Lite Cable**	0.384Mbps	5 GB	$41.95	$49.95
High Speed Cable**	5 Mbps	20 GB	$62.95	$49.95
High Speed Performance	16 Mbps	60 GB	$83.95	$49.95
DSL Lite Iqaluit	0.512 Mbps	2 GB	$72.95	$29.95 to $99.95
DSL Classic Iqaluit	0.768 Mbps	5 GB	$84.95	$29.95 to $99.95
DSL Ultra Iqaluit	1.5 Mbps	10 GB	$119.95	$29.95 to $99.95

* Does not include rates for satellite based access, i.e. Internet access where the service subscriber must purchase or rent a satellite dish. All services are not available in all areas.

**Cable services are only available in Yellowknife, Norman Wells, Whitehorse, Fort Nelson and High Level.

Table 2: Bell Canada High Speed Residential Internet Rates

	Download Speed	Allowed Monthly Usage	Monthly Rate**	Installation Fees
Essential Plus	2 Mbps	2 GB	$25.90	*
Fibe6	6 Mbps	25 GB	$35.90	*
Fibe12	12 Mbps	50 GB	$40.90	*
Fibe16	16 Mbps	75 GB	$50.90	*
Fib25	25 Mbps	75 GB	$56.90	*

** The monthly rate includes $3.95 a month added as a modem charge. Actual rates may differ depending on what service bundle is subscribed to.

Table 3: SSi Micro Internet Rates (Business and Residential)

	Download Speed	Allowed Monthly Usage	Monthly Rate	Installation Fees*
NWT Gold	0.256 Mbps	2 GB	$60.00	$50.00
NWT Platinum	0.384 Mbps	5 GB	$120.00	$50.00
NWT Diamond	0.768 Mbps	20 GB	$400.00	$250.00

Nunavut QANNIQ	0.386 Mbps	3 GB	$60.00.	$50.00
Nunavut MASAK	0.512 Mbps	5 GB	$120.00	$50.00
Nunavut PIQSIQ	0.768 Mbps	20 GB	$400.00	$250.00
Yellowknife SoHo	Not Available	8 GB	$150.00	$50.00
Yellowknife High Velocity	0.768 Mbps	15 GB	$299.00	$99.00
Yellowknife Prestige DSL	1.5 Mbps	20 GB	$399	$99.00

*Installation fees do not include refundable deposit fee for wireless modem..

Table 4: Rates For Ka-Band Satellite Based Internet Access

	Download Speed	Allowed Monthly Usage	Monthly Rate	Installation Fees*
NWTEL SERVICES				
-Netkaster Web Surfer	0.512 Mbps	No Cap	$69.95	$299.00
-Netkaster Web Surfer Ultra	1.0 Mbps	No Cap	$99.95	$299.00
-Netkaster Business 1.5	1.5 Mbps	No Cap	$149.95	$299.00
-Netkaster Business 2.0	2.0 Mbps	No Cap	$249.95	$299.00
BARRET XPLORENET SERVICES				
-Telesat Kazam	0.512 Mbps	No Cap	$49.99	$498.00
-Telesat Kazoom	1.0 Mbps	No Cap	$79.99	$498.00
-Telesat KaBang	1.5 Mbps	No Cap	$119.99	$498.00
-Telesat Kaboom	2.0 Mbps	No Cap	$169.99	$498.00
-Hughes Basic Lite	0.512 Mbps	No Cap	$49.99	$498.00
-Hughes Basic	1.0 Mbps	No Cap	$59.99	$498.00
-Hughes Pro Plus	1.6 Mbps	No Cap	$119.99	$498.00
-Hughes Elite	2.0 Mbps	No Cap	$149.99	$498.00
-Hughes Elite Plus	3.0 Mbps	No Cap	$199.99	$498.00
-Hughes Elite Premium	5.0 Mbps	No Cap	$299.99	$498.00

* Installation fees include equipment fees plus activation charges.

4.7 Backbone Services Data Summary

In the east, Nunavut is completely reliant upon satellite services for all of its communities. Just to the west, Northwest Territories is a mixture of land-based services and satellite served communities. And in Yukon, all but one of the communities are served by land-based services. Not surprisingly, the existence of land-based backbone services coincides with the existence of roads linking communities together.

The following tables summarize the current aggregate capacity of the two primary service providers operating in the Arctic. As mentioned previously, current utilization numbers were withheld by one of the service providers for reasons of business confidentiality. Therefore the current utilization numbers for the other service provider have been excluded from this Assessment. The backbone services have been broken out by territory and are presented on the following pages.

All capacity numbers presented are in Megabits Per Second (Mbps) except for the C-band, Ku-band and Ka-band numbers that show both current utilization and capacity and are represented as transponder counts.

Within the Arctic there are two main service providers, NorthwesTel, and SSi Micro.

NorthwesTel operates and provides service in all three territories while SSi Micro only serves Nunavut and the Northwest Territories.

CANARIE, Canada's Advanced Research and Innovation Network, does not currently own or operate infrastructure in the Arctic, but they do purchase services from NorthwesTel, and then provide that service to research and educational institutions in the North.

Nunavut aggregate backbone services

The table below shows the aggregate bandwidth capacity currently in place between the two primary service providers in Nunavut. Items of note are the complete absence of any land based backbone services and that C, Ka, and Ku bands are available in all Nunavut communities.

Community	Service Providers	Backbone Services (Mbps)					
		Satellite (C-Band)		Wireless	Micro-wave	Fiber	VHF Radio
		Inbound	Outbound				
Arctic Bay	2	91.6	21.6				
Arviat	2	91.6	18.6				
Baker Lake	2	91.6	17.6				
Bathurst Inlet	2	31.6	12.6				
Cambridge Bay	2	91.6	23.6				
Cape Dorset	2	91.6	17.6				
Chesterfield I.	2	91.6	16.6				
Clyde River	2	91.6	15.6				
Coral Harbour	2	91.6	28.6				
Gjoa Haven	2	91.6	17.6				
Grise Fiord	2	91.6	14.6				
Hall Beach	2	91.6	23.6				
Igloolik	2	91.6	16.6				
Iqaluit	2	111.6	82.6				
Kimmirut	2	91.6	17.6				
Kugaaruk	2	91.6	15.6				
Kugluktuk	2	91.6	18.6				
Pangnirtung	2	91.6	17.6				
Pond Inlet	2	91.6	15.6				
Qikqtarjuaq	2	91.6	16.6				
Rankin Inlet	2	111.6	41.6				
Repulse Bay	2	91.6	15.6				
Resolute	2	91.6	15.6				
Sanikiluaq	2	91.6	35.6				
Taloyoak	2	91.6	15.6				
Whale Cove	2	91.6	16.6				

The following table identifies where satellite backbone services are currently available in Nunavut expressed in terms of transponders.

Satellite Backbone Services - Nunavut (Transponders)						
Community	**Ku Band**		**Ka Band**		**C-Band**	
	Provisioned	**Capacity**	**Provisioned**	**Capacity**	**Provisioned**	**Capacity**
Arctic Bay	96	96	5	6	41	72
Arviat	96	96	5	6	41	72
Baker Lake	96	96	5	6	41	72
Bathurst Inlet	96	96	5	6	41	72
Cambridge Bay	96	96	5	6	41	72
Cape Dorset	96	96	5	6	41	72
Chesterfield I	96	96	5	6	41	72
Clyde River	96	96	5	6	41	72
Coral Harbour	96	96	5	6	41	72
Gjoa Haven	96	96	5	6	41	72
Grise Fiord	96	96	5	6	41	72
Hall Beach	96	96	5	6	41	72
Igloolik	96	96	5	6	41	72
Iqaluit	96	96	5	6	41	72
Kimmirut	96	96	5	6	41	72
Kugaaruk	96	96	5	6	41	72
Kugluktuk	96	96	5	6	41	72
Pangnirtung	96	96	5	6	41	72
Pond Inlet	96	96	5	6	41	72
Qikqtarjuaq	96	96	5	6	41	72
Rankin Inlet	96	96	5	6	41	72
Repulse Bay	96	96	5	6	41	72
Resolute	96	96	5	6	41	72
Sanikiluaq	96	96	5	6	41	72
Taloyoak	96	96	5	6	41	72
Whale Cove	96	96	5	6	41	72

Northwest Territories aggregate backbone services

The table below shows the aggregate bandwidth capacity currently in place between the two primary service providers in the Northwest Territories. Items of note are the mixture of land and satellite based services and the introduction of VHF radio coverage for a number of communities. Additionally, all communities have C, Ka, and Ku band services available through satellite coverage however that does not mean the required ground facilities are in place.

Community	Service Pro-viders	Backbone Services (Mbps)					
		Satellite (C-Band)		Wireless	Micro-wave	Fiber	VHF Radio
		Inbound	Outbound				
Aklavik	2	12	5		24		MTS
Behchoko	2	12	5		3	155	MTS
Colville Lake	2	72	9				
Deline	2	72	27				
Dettah	2			5	155		MTS
Enterprise	2	12	5			2500	MTS
Fort Good Hope	2	12	5		155		MTS
Fort Liard	2	12	5			622	MTS
Fort McPherson	2	12	5		24		MTS
Fort Providence	2	12	5			1700	MTS
Fort Resolution	2	12	5			622	MTS
Fort Simpson	2	12	5		622		MTS
Fort Smith	2	12	5			622	MTS
Gameti	2	72	10				
Hay River Res.	2			12		155	MTS
Hay River	2	12	5			5155	MTS
Inuvik	1				310		MTS
Jean Marie River	2	12	5		155		MTS
Kakisa	2	12	5			2500	MTS
Lutselk'e	2	72	10				
Nahanni Butte	2	72	9				MTS
Norman Wells	1				155		MTS
Paulatuk	2	72	9				
Sachs Harbour	2	72	9				
Trout Lake	2	72	9				
Tsiigehtchic	2	12	5		24		MTS
Tuktoyaktuk	2	12	5		155		MTS

Community	Service Pro-viders	Backbone Services (Mbps)					
		Satellite (C-Band)		Wireless	Micro-wave	Fiber	VHF Radio
		Inbound	Outbound				
Tulita	2	12	5		150		MTS
Ulukhaktok	2	72	9				
Wekweeti	2	72	9				
Whati	2	12	5		24		MTS
Wrigley	2	12	5		24		MTS
Yellowknife	2	12	5			2500	MTS

The following table identifies where satellite backbone services are currently available in Northwest Territories expressed in terms of transponders.

Satellite Backbone Services - NorthWest Territories (Transponders)						
Community	Ku Band		Ka Band		C-Band	
	Provisioned	Capacity	Provisioned	Capacity	Provisioned	Capacity
Aklavik	96	96	5	6	41	72
Behchoko	96	96	5	6	41	72
Colville Lake	96	96	5	6	41	72
Deline	96	96	5	6	41	72
Dettah	96	96	5	6	41	72
Enterprise	96	96	5	6	41	72
Fort Good Hope	96	96	5	6	41	72
Fort Liard	96	96	5	6	41	72
Fort McPherson	96	96	5	6	41	72
Fort Providence	96	96	5	6	41	72
Fort Resolution	96	96	5	6	41	72
Fort Simpson	96	96	5	6	41	72
Fort Smith	96	96	5	6	41	72
Gameti	96	96	5	6	41	72
Hay River Reserve	96	96	5	6	41	72
Hay River	96	96	5	6	41	72
Inuvik	96	96	5	6	41	72
Jean Marie River	96	96	5	6	41	72
Kakisa	96	96	5	6	41	72
Lutselk'e	96	96	5	6	41	72
Nahanni Butte	96	96	5	6	41	72

Satellite Backbone Services - NorthWest Territories (Transponders)						
Community	Ku Band		Ka Band		C-Band	
	Provisioned	Capacity	Provisioned	Capacity	Provisioned	Capacity
Norman Wells	96	96	5	6	41	72
Paulatuk	96	96	5	6	41	72
Sachs Harbour	96	96	5	6	41	72
Trout Lake	96	96	5	6	41	72
Tsiigehtchic	96	96	5	6	41	72
Tuktoyaktuk	96	96	5	6	41	72
Tulita	96	96	5	6	41	72
Ulukhaktok	96	96	5	6	41	72
Wekweeti	96	96	5	6	41	72
Whati	96	96	5	6	41	72
Wrigley	96	96	5	6	41	72
Yellowknife	96	96	5	6	41	72

Yukon aggregate backbone services

The table below shows the aggregate bandwidth capacity currently in place in the Yukon. Items of note are the almost complete absence of satellite-based services and the VHF radio coverage for most communities. Additionally, all communities have C, Ka, and Ku band services. Additionally, it is important to note that the Yukon has a single service provider.

Community	Service Providers	Backbone Services (Mbps)					
		Satellite (C-Band)		Wire less	Micro wave	Fiber	VHF Radio
		In-bound	Out-bound				
Beaver Creek	1				24		MRS, MTS, YARA
Burwash Landing	1				50		MRS, MTS, YARA
Carcross	1					3500	MRS, MTS, YARA
Carmacks	1					2500	MRS, MTS, YARA
Dawson City	1				155		MRS, MTS, YARA
Destruction Bay	1				50		MRS, MTS, YARA
Faro	1				155		MRS, MTS, YARA
Haines Junction	1					2500	MRS ,MTS, YARA
Keno	1				3		MRS, MTS, YARA
Marsh Lake	1					155	MRS, MTS, YARA
Mayo	1				155		MRS, MTS, YARA
Old Crow	1	17	15				MRS
Pelly Crossing	1				155		MRS, Marginal MTS, YARA
Ross River	1				155		MRS, MTS, YARA
Tagish	1				45	622	MRS, MTS, YARA
Teslin	1				135	2500	MRS, MTS, YARA
Watson Lake	1				45	2500	MRS, MTS, YARA
Whitehorse	1				270	10000	MRS, MTS, YARA

The following table identifies where satellite backbone services are currently available in Yukon expressed in terms of transponders.

Satellite Backbone Services - Yukon (Transponders)						
Community	**Ku Band**		**Ka Band**		**C-Band**	
	Provisioned	**Capacity**	**Provisioned**	**Capacity**	**Provisioned**	**Capacity**
	96	96	5	6	41	72
Beaver Creek	96	96	5	6	41	72
Burwash Landing	96	96	5	6	41	72
Carcross	96	96	5	6	41	72
Carmacks	96	96	5	6	41	72
Dawson City	96	96	5	6	41	72
Destruction Bay	96	96	5	6	41	72
Faro	96	96	5	6	41	72
Haines Junction	96	96	5	6	41	72
Keno	96	96	5	6	41	72
Marsh Lake	96	96	5	6	41	72
Mayo	96	96	5	6	41	72
Old Crow	96	96	5	6	41	72
Pelly Crossing	96	96	5	6	41	72
Ross River	96	96	5	6	41	72
Tagish	96	96	5	6	41	72
Teslin	96	96	5	6	41	72
Watson Lake	96	96	5	6	41	72
Whitehorse	96	96	5	6	41	72

Northwestel network architecture

Northwestel (NWTel) operates a network that is a combination of fiber, microwave and satellite services, and spans all three territories and northern British Columbia. The connections between communities are of varying speeds and types. Physical and logical network diagrams based on data provided by NWTel were created. The physical network diagram on the next page shows the actual physical connections that exist between communities and does not necessarily show the path that a particular packet of data may take to move from one community to another or to the Internet.

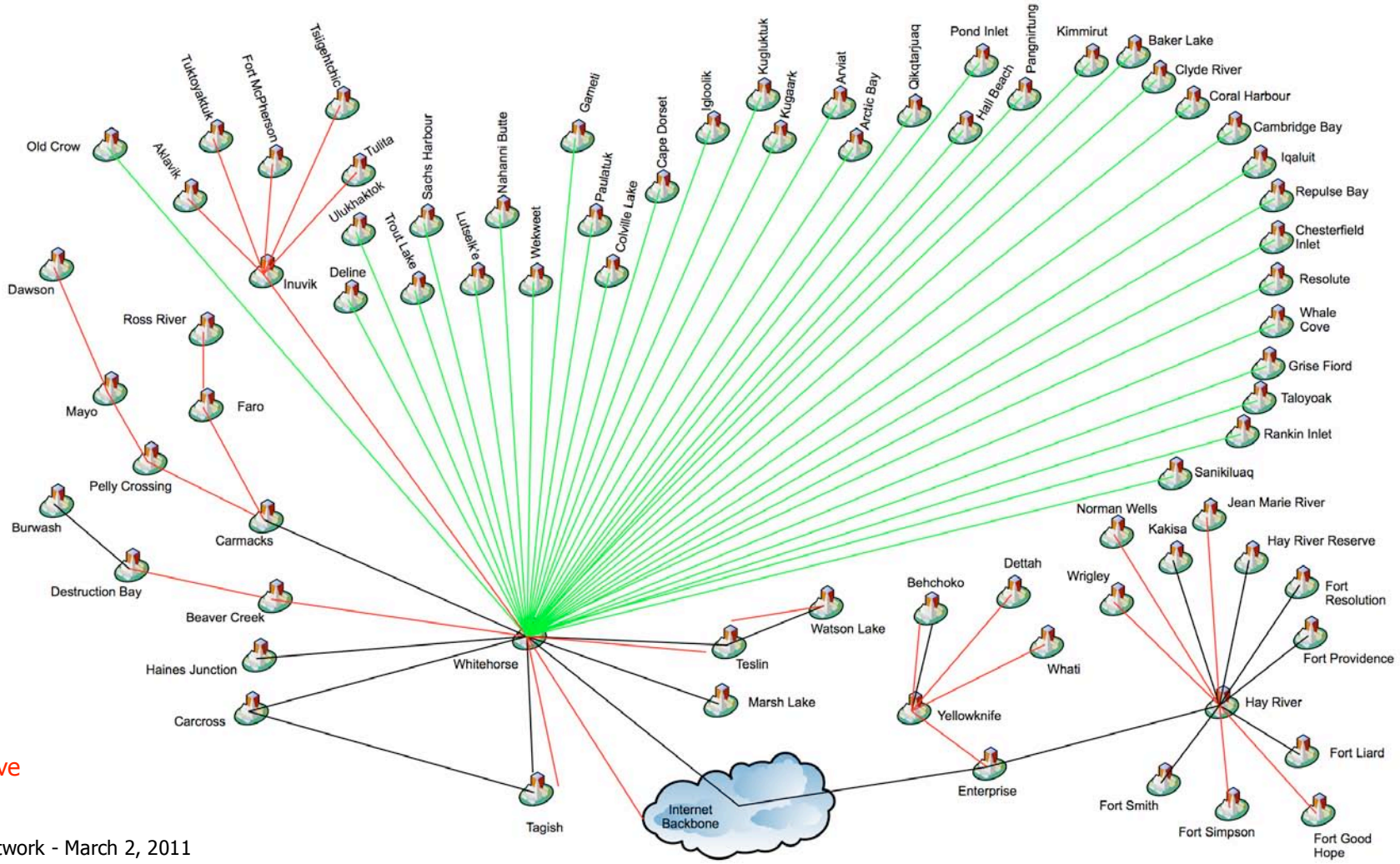
The logical network diagram (page 67) provides a description of how data is routed over the physical network. Both diagrams must be reviewed in order to have a complete picture of the NWTel infrastructure. NWTel has reviewed these diagrams.

As can be seen from the diagram on the next page, most connections between communities and into southern Canada are single paths. In those cases where there are diverse paths the technology is different and as a result there is a significant difference in the amount of available bandwidth. The limited redundancy is likely due to the difficulty and costs associated with deploying wireline infrastructure in the Arctic.

To clarify understanding we will discuss the land based components of the NWTel network separate from the satellite based components. The land based network can be thought of a series of links that connect one community to the adjacent communities, similar to the highways that connect the communities in the Yukon and Northwest Territories. In fact, most of the land based communications services utilize the highways as a sort of conduit. The northern geography forms these connections into a series of chains. Data traveling from Dawson to Whitehorse must traverse the links that connect Dawson to Mayo, Mayo to Pelly Crossing, Pelly Crossing to Carmacks, and finally Carmacks to Whitehorse.

The satellite based services operated by NWTel can be thought of as a hub and series of spokes with Whitehorse as the hub and all satellite served communities as spoke endpoints. Data traveling from one of the spokes to the Internet travels first to Whitehorse via satellite and then to the Internet over a land based connection. Data traveling between spoke communities must first travel to the hub. As an example, data traveling from Old Crow to Sachs Harbour must follow the path Old Crow to Whitehorse and then Whitehorse to Sachs Harbour.

NorthwesTel physical network



Legend
Fiber
Microwave
Satellite

NWTel Network - March 2, 2011
Based on data provided to ACIA

The NWTel logical network operates as four hubs as can be seen in the logical network diagram on the next page.

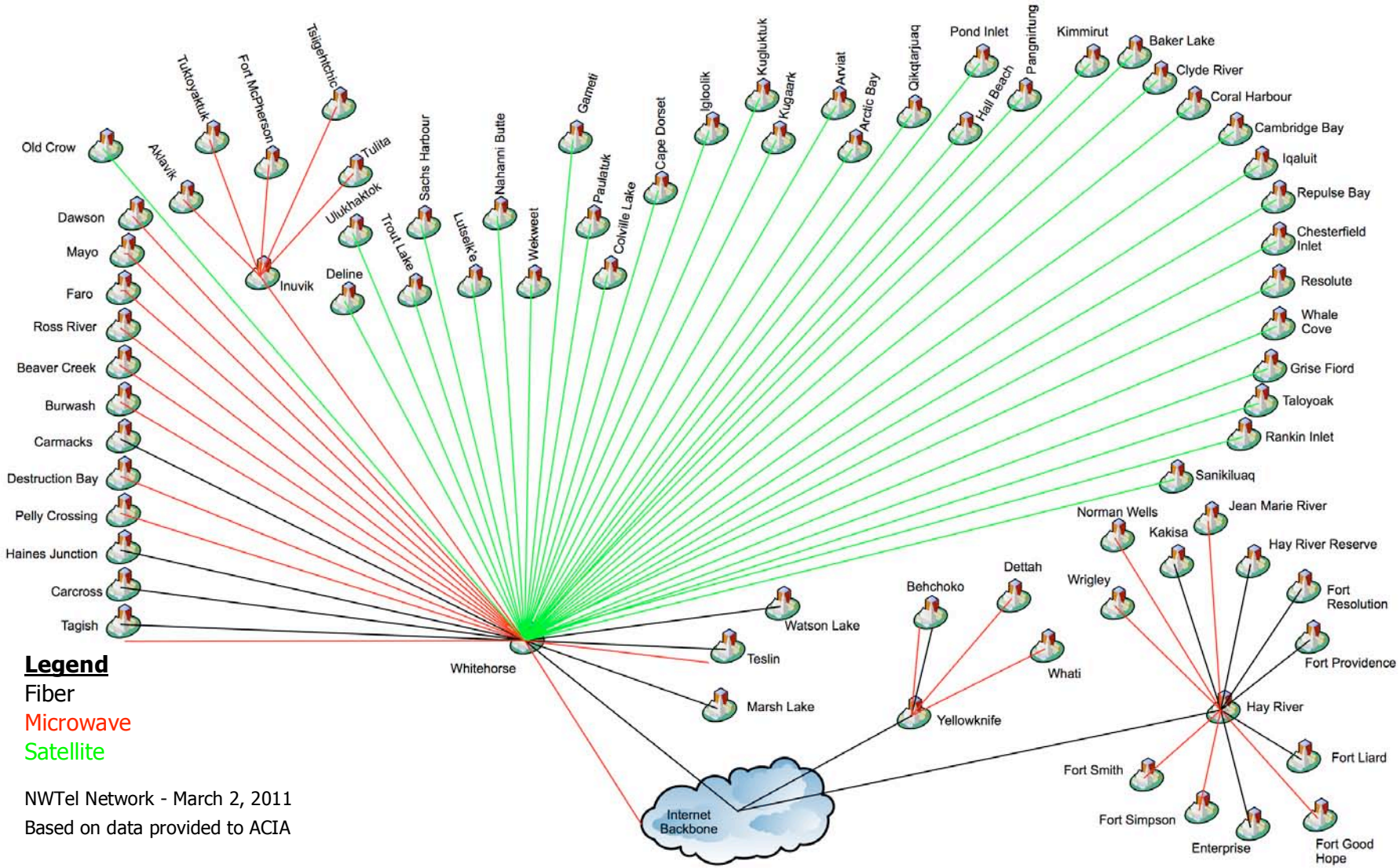
In this logical hub architecture, all data traffic from a community first travels to its hub and is routed from there to its next destination. Specifically, the four hubs currently in operation are:

- Whitehorse
- Inuvik
- Yellowknife
- Hay River

As can be seen, a vast majority of the communities, including all those that are satellite served, use Whitehorse as their hub. The result is that all Internet or southern bound traffic from these communities will be traverse the fiber and microwave links out of Whitehorse.

The Government of Nunavut is currently migrating from NWTel to SSi Micro for their WAN services. The current GN WAN services provided by NWTel utilize Yellowknife as a hub. As this service is being decommissioned it has not been presented in the diagrams in order to avoid confusion.

NWTel logical network diagram



SSi Micro infrastructure

SSi Micro operates a satellite-based backbone that can essentially be thought of as two distinct clouds. The first cloud is for Internet based traffic and the second is for community to community (mesh) traffic. The SSi Micro Internet cloud services communities in both the Northwest Territories and Nunavut while the mesh cloud provides services to all communities in Nunavut. SSi Micro does not provide service to any community in Yukon. The cloud analogy is applicable as all available bandwidth can be utilized by any of the communities requiring the service. The diagram below illustrates the current SSi Micro network.

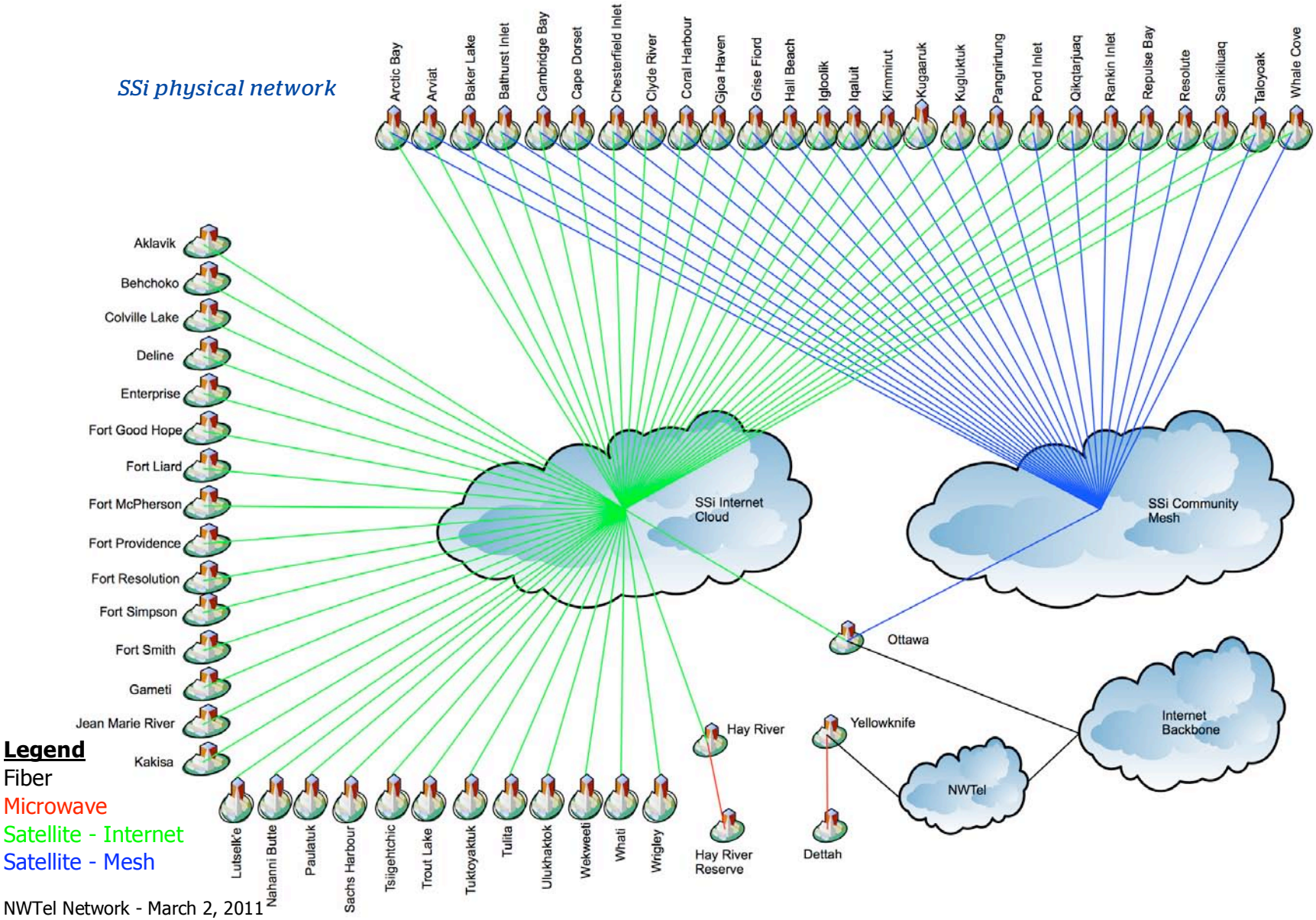
The SSi Micro network is largely a homogenous network with a common set of tools and infrastructure components deployed throughout Nunavut and the Northwest Territories. This common infrastructure allows SSi Micro to remotely manage and configure the network remotely from their headquarters in Yellowknife. Both the Internet and Mesh clouds support bursting so that any community could consume as much bandwidth as possible and available. The Internet and Mesh clouds are segregated at a certain level to prevent overlap and interference ensuring quality of service for each service. Although not currently in place, the Mesh network currently servicing communities in Nunavut could be similarly configured for the Northwest Territories. One of the benefits of the Mesh network is the ability to offload traffic bound for other communities from the Internet traffic improving overall performance and minimizing unnecessary Internet bandwidth. Additionally, local community traffic is captured and routed locally to avoid unnecessary backbone traffic. Quality of service parameters are enforced through packet painting and associated routing.

As cloud type networks, the SSi Micro networks provide the additional benefit of reducing the number of hops required to deliver data to its target destination. A piece of data placed on to the cloud from community A is automatically available in all other communities on the cloud eliminating the need for data to be delivered to a hub and then rerouted to its final destination.

To further reduce unnecessary satellite traffic the SSi Micro network could be readily connected to any other local network through mutual agreement and BGP routing. In addition to data the SSi Micro network currently supports Voice over IP services and could readily carry additional digital traffic as required.

As can be seen, almost all communities route all southern or Internet bound traffic through the SSi Micro Ottawa teleport.

SSi physical network



Legend
Fiber
Microwave
Satellite - Internet
Satellite - Mesh

NWTel Network - March 2, 2011

Telesat infrastructure

Telesat operates a fleet of geostationary satellites that provide services around the globe to a variety of customers. For the purposes of this assessment only those satellites providing service to the Arctic have been considered. Of the 12 satellites currently being managed by Telesat, only three provide coverage of the Arctic. The current utilization and capacity of each satellite is described below. The numbers indicate transponder counts.

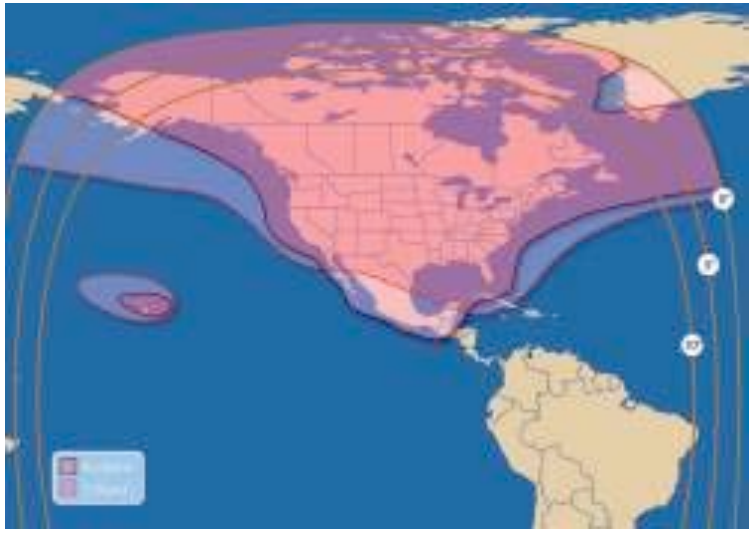
Satellite	C-Band		Ku-band		Ka-band		X-Band		Launch Date	Expected Retirement Date
	Provisioned	Capacity	Provisioned	Capacity	Provisioned	Capacity	Provisioned	Capacity		
Anik F1R	18.5	24	32	32					08-Sep-05	2020
Anik F2	14.0	24	32*	32	3	4**			17-Jul-04	2019
Anik F3	8.5	24	32	32	2	2			09-Apr-07	2022
Anik G1		-	16	16		12	0	3	2012	
Telstar 14R			2.5	10					2011	

As can be seen, there remains unused capacity in the C-band service area. It is important to note that both SSi Micro and NWTel are resident on the Anik F2 satellite. Migrating to another satellite would require a significant investment in both time and capital costs.

In addition to the capacity and utilization numbers, the table indicates the relative age of each of the satellites and their expected retirement timelines. Migration from a current satellite to a new satellite would require the same level of investment as migrating between existing satellites. Based upon the indicated retirement dates this order of investment will be required in the next 8-11 years in order to ensure continuity of satellite based services.

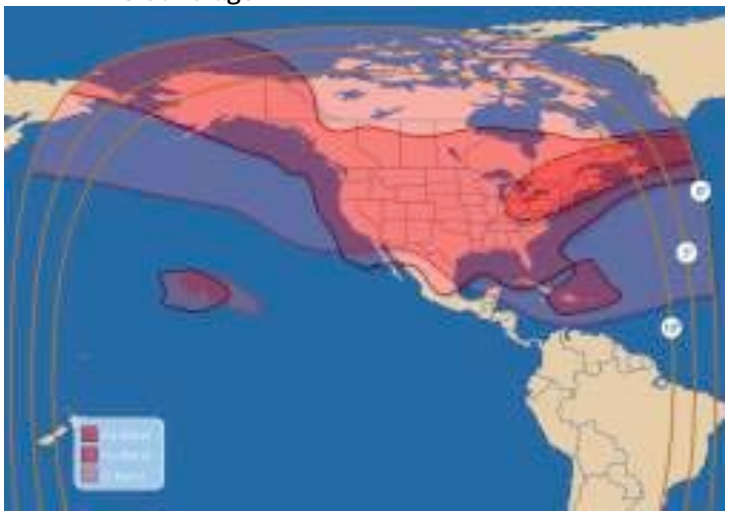
Telesat has indicated that all communities in all three territories are covered by the three satellites described above. Coverage maps for the three satellites are provided on the next page.

Anik F1R Coverage



Anik F2 Coverage

Anik F3 Coverage



4.8 UHF and VHF Radio

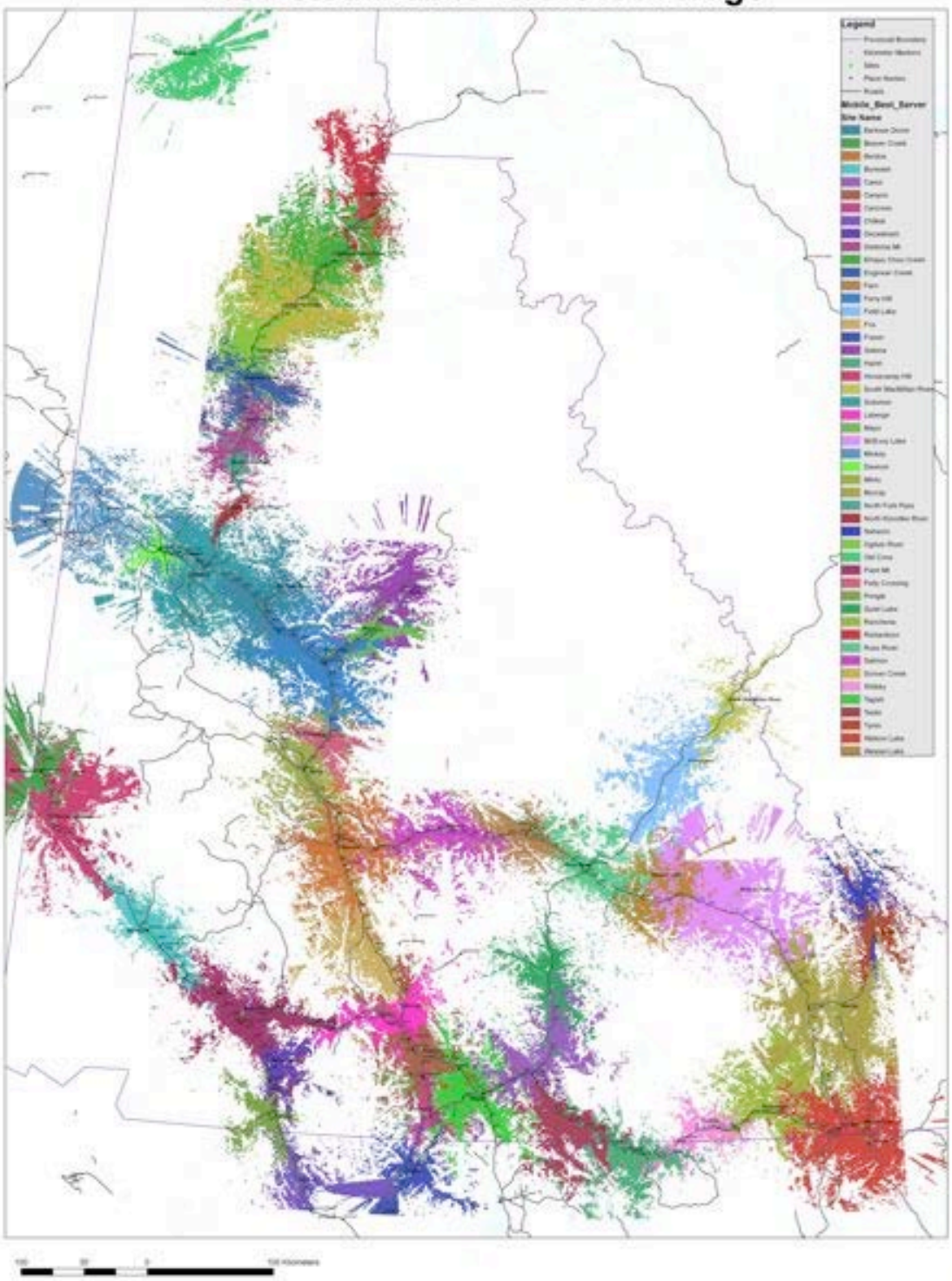
Government of Yukon mobile radio

In 2006 the Yukon Government issued an RFP to have a replacement built for the aging Multi Department Mobile Radio System (MDMRS). The RFP was awarded to NWTel who began construction of the Mobile Radio System (MRS) in 2008 and completed in 2010. Under the 15 year agreement NWTel built and will operate and maintain the MRS on behalf of the Yukon Government. Although the MRS is not owned by NWTel and therefore not available for resale, it does provide an integral service to the entire Territory and is therefore included in this report. The MRS is utilized by the RCMP, health and safety professionals, public safety volunteers and other government personnel.

Partnering with NWTel in the MRS is EF Johnson Technologies that provide the radios, equipment and software. The MRS utilizes the Project 25 compliant Conventional IP25 infrastructure system along with Project 25 compliant portable and mobile radios. The technology utilizes industry-standard Voice over IP (VoIP) providing a secure, reliable and scalable infrastructure.

As the coverage map below shows on the next page, MRS coverage follows the highway system that crosses the Yukon. The mountainous landscape clearly affects the radio coverage, as the thin strips on the coverage map show how the coverage follows the valley floors.

Yukon MRS
Predicted Mobile Radio Coverage



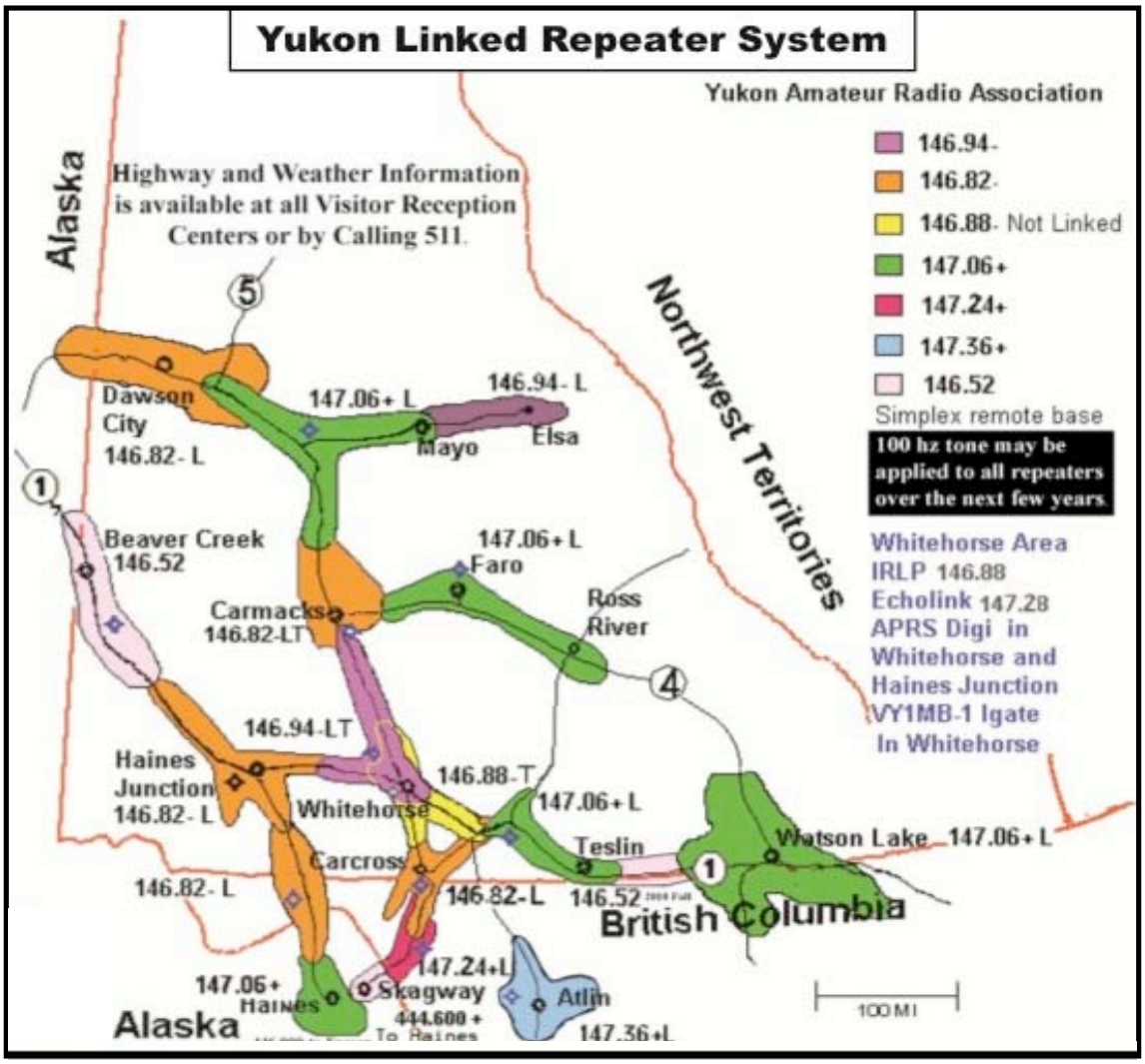
Yukon Amateur Radio Association infrastructure

The Yukon Amateur Radio Association (YARA) builds, maintains and operates a network of mountaintop repeaters covering all major highway corridors in the Yukon. Several of the units are above 7,000 feet in mountaintop shelters. The YARA system is completely independent of commercial power.

The Yukon Amateur Radio Association is also heavily involved in supporting the Marine Distress System. YARA has partnered with several organizations in setting up this VHF radio safety network for boaters in the Yukon and northern British Columbia.

Website: http://www.yara.ca/

The YARA coverage map is included below.



The infrastructure is operated and maintained by volunteer resources using a variety of refurbished, donated and purchased equipment. YARA generates an annual operating budget through the provision of services in support of annual community based events. Additionally, YARA operators are engaged with the Yukon Emergency Measures Organization providing their expertise during emergency exercises.

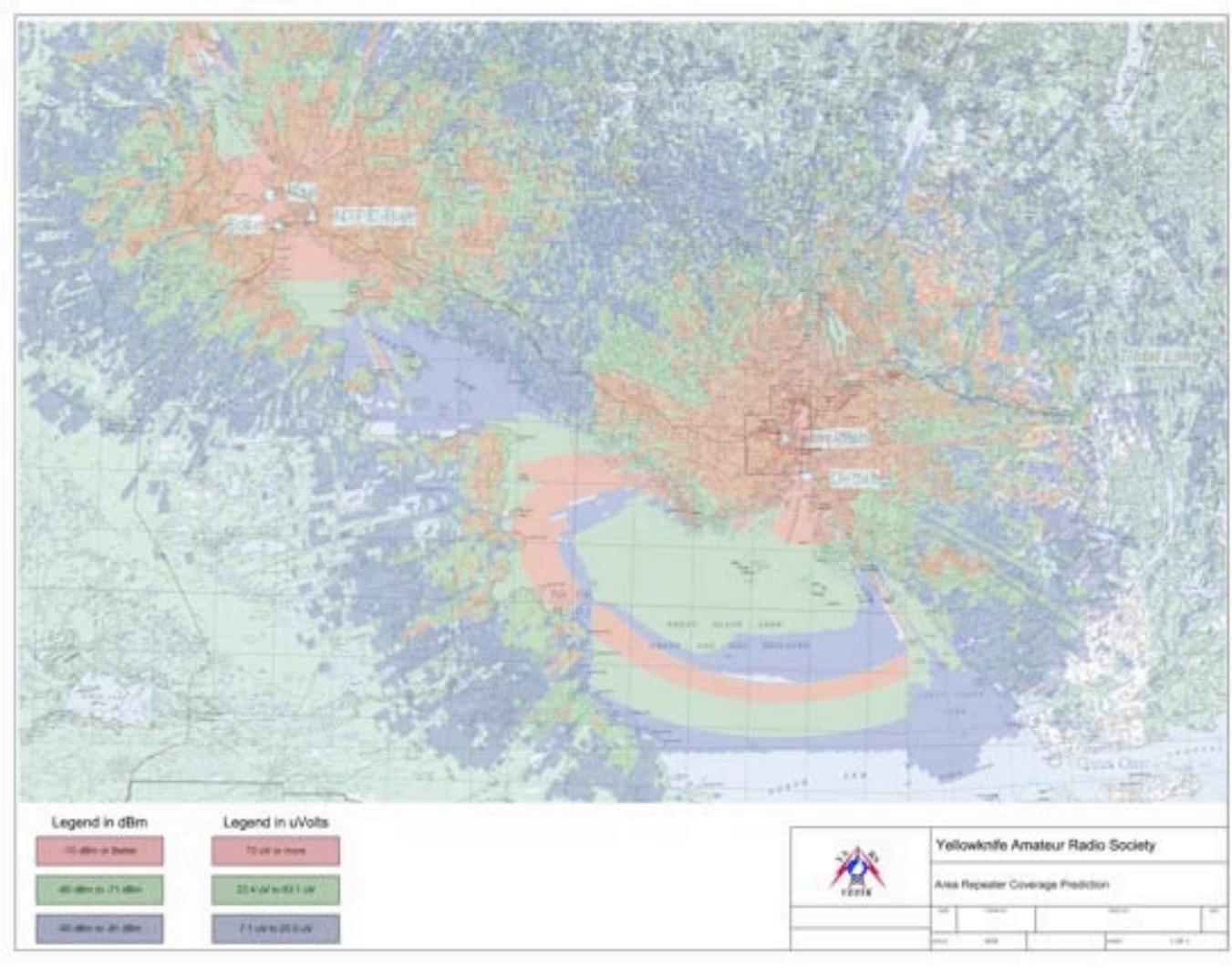
In addition to the network described above, YARA is heavily involved with the support of the Marine Distress System for the Yukon and northern British Columbia. A coverage map of this system is included below. A consortium of individuals and organizations developed this communications infrastructure with YARA taking responsibility for most of the initial implementation and the ongoing operation and maintenance.

Yellowknife Amateur Radio Society

The Yellowknife Amateur Radio Society (YARS) is an organization of amateur radio enthusiasts with a mandate to promote radio knowledge and the hobby of electronics and to assist the community in times of crisis through the provision of emergency communications. YARS is affiliated with the Radio Amateurs of Canada and cooperates with YARA.

YARS currently operates two permanently linked VHF repeaters, one in Yellowknife and the second in Bechoko. A third repeater, to be located in Hay River, is under evaluation.

The current YARS coverage map is included below.



5 Issues Today

5.1 Introduction

Government participants and service providers outlined many of the challenges and issues they face today, in attempting to use and develop a communications infrastructure that can properly serve the Arctic.

This chapter of the Assessment attempts to identify and explain the communication issues across the three territories. An analysis provides detailed background that leads to the corresponding recommendations outlined in Chapter 9.

To put the specific Arctic issues in context, there are three fundamental challenges that weave their way through the nine issues outlined in this chapter.

Challenge 1: Economically challenging region to serve

First and foremost, it should be recognized that the Canadian Arctic is an extremely high cost area to serve. With difficult terrain, vast distances, a short construction season, and a very low population of 100,000 people spread out over 75 distinct communities on more than 1/3 of Canada's land mass, it should be no surprise that the market cannot sustain the development and maintenance of a robust 21st century communications network.

The geographic facts make the entire Arctic region a challenge from an economic perspective for building, maintaining and evolving communication services that meet users' needs at an affordable price.

Over half of the Arctic communities have no road links at all, necessitating a 100% reliance on satellite. Even road linked communities suffer, as huge distances, difficult terrain, and few customers means minimal investment in redundancy and upgrades to meet rising customer needs. This makes it very difficult for commercial service providers to deliver affordable, ubiquitous communication services across the North.

Challenge 2: Rapid pace of technological change

The existing network investment models in the North are not meeting the rapid pace of increasing change and convergence of communication services available in the South. The existing subsidy models do not evolve fast enough to reflect Northern users' needs for critical modern communications services, nor allow for service providers to respond.

Competition and cross-subsidy models have failed to properly provide needed funds for new networks and upgrades that support new technologies in economically challenging regions.

Service providers operate in an extremely uncertain environment, with both technological change and funding changes that are unpredictable, making it difficult to invest and plan for the future.

There have been targeted, one-off investments to northern networks from various government programs aiming to provide public access, or upgrade networks for government use. This has unintentionally led to uneven access within territories and between territories and the South, increasing service parity gaps in access to new communication services.

Regulatory regimes have not been able to adequately address new technological changes, through funding formulas, nor are there consistent quality of service (QoS) requirements for new services being implemented under one-off programs.

Challenge 3: No comprehensive Arctic communications infrastructure strategy

There is currently no comprehensive strategy for connecting all Arctic communities to the level of service required within communities or between communities. There is no comprehensive needs analysis across the territories, nor are there specific targets setting out the minimum level of 21st century communication services an Arctic community needs to thrive. There is no organization responsible for ensuring all Arctic communities get connected, nor are there appropriate funding models for the development of services to meet the needs of government or the public.

The territories and federal government departments buying services often work in relative isolation from each other in attempting to address their internal user needs. Economic development-focused government agencies attempting to address the needs of the public and business for affordable access work independently of the departments purchasing services to meet government needs.

Without a comprehensive investment strategy that addresses the unique cost challenges for building, maintaining and evolving services for the region, communication networks will not be able to keep pace with change and user needs.

Overall result: Inadequate communication services in the Arctic

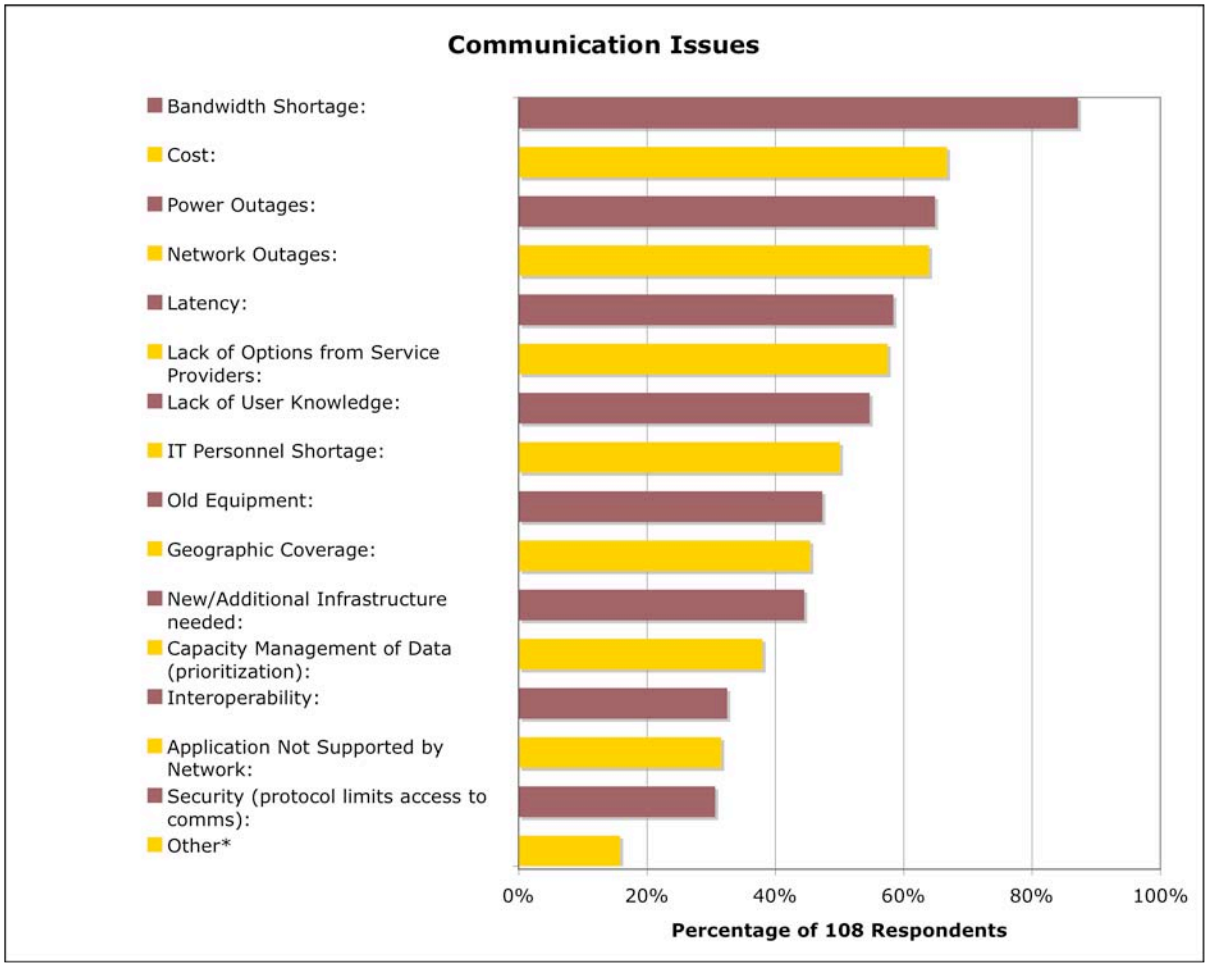
Since 1996, government investors (both as users and investors for public access), service providers and community organizations have struggled to finance, upgrade and build the networks needed to use 21st century communication tools.

The geographic reality, historical approach to new communications network development, and the rapid pace of technological change and its corresponding expectations have combined to create an Arctic communications infrastructure that is inadequate to meet current needs and future needs.

5.2 Communication Issues Identified by NCIS-WG

The NCIS-WG originally identified some of the key communication issues facing those government departments which are attempting to use the infrastructure in delivering government services in the Arctic.

In a detailed questionnaire conducted as part of this Assessment, over 100 government program managers answered, providing quantitative data from a wide range of respondents that supported the issues identified by NCIS-WG members in 2010.



To understand the challenges being confronted, users provided a very long list of specific communication issues that help to illustrate why challenges such as a bandwidth shortage, high costs, lack of options, and other problems are being experienced. These real-life challenges have been grouped into eight themes, in order to reflect the issues facing governments in obtaining services, and help explain why everyone, including

Service Providers, are challenged with developing an infrastructure that meets Arctic needs.

Issues fall into one or more categories, explained in detail in the remainder of this section.

These factors have led to the definition of the following issues, corroborated and fine-tuned by the participants in this Assessment, with input from government users, policy makers and service providers. The nine themes below are presented in detail in the following pages.

1. No service parity within Arctic, or between North and South
2. Affordable bandwidth shortage and latency
3. High costs to end user
4. Reliability, network outage problems
5. Geographic coverage between communities inadequate
6. Emergency response challenges
7. Rapid pace of technological change leaves Arctic scrambling to catch up
8. Lack of choice, procurement challenges, regulatory system challenges
9. Human resource shortage

5.3 No service parity

The goal of service parity is to ensure all Arctic residents can engage in activities on par with other Canadians, regardless of the type of backbone they must use due to geography.

It is clear from the data that Arctic access to communication services is not keeping pace with southern access to communication services. This is not simply a matter of people having to wait an extra few seconds or even minutes to get a web page to load. It is the difference between being able to actually do the job at hand, or not being able to do it at all.

This section looks at the differing levels of service parity between the North and South, between the territories, and within the territories and provides examples of the impact on the safety, security and quality of life for Arctic residents.

Many Arctic communities are connected to the Internet using infrastructure that is fundamentally different than in southern urban centres, (ie reliance on microwave and satellite rather than fiber etc. See Chapter 4 for detailed network information.) Even though physical connections may be different, there is a great need to aim for service parity in all communities.

One of the Ottawa workshop groups had a long discussion on the concept of 'service parity'. When discussing communications services within the context of 'parity', we are referring to the 'functional equivalence' of communication services between jurisdictions, not the specific 'physical equivalence'. Not every Arctic community can be connected to fiber, so there will be differences in the physical infrastructure, but there should not be differences in people's ability to engage in using communication tools. For example, if the goal is to be able to enter and access data in a database in order to deliver a government service in a timely fashion - that is the goal. But the physical method to enter and retrieve the data may be different, depending on the design of the service. Different types of backbones will rely on different routing and architecture, different speeds or latency, or they may rely on replication of data on local servers to get around some of the inherent challenges facing certain types of connectivity.

Growing gap between North and South

While service availability in Yukon is somewhat faster than the other two territories, even service to Whitehorse, arguably the best-served location in the Arctic, is falling further and further behind what is available in southern communities of similar size and importance within a region. Whitehorse currently has the 'gold standard' of communication services in the Arctic - but it is not keeping pace with southern services.

Service Canada (part of Human Resources and Skills Development Canada HRSDC) employees need to be able to connect to the hundreds of computer applications located on southern servers to search for and enter data as they do their work. Service Canada is on the leading edge of the national trend where federal services are increasingly reliant on robust broadband networks to connect staff to the necessary resources to do their jobs. Service Canada requires high capacity communications with centres in the south to process data - whether they are communicating from a northern capital city, or from a community doing outreach work.

The 45 HRSDC representatives in Whitehorse do not have access to the necessary speed and response times required to properly interface with the government databases on southern servers. They also do not participate in national videoconferencing sessions. This situation will only continue to worsen as southern technology evolves.

Support personnel based in Ottawa who are responsible for supporting federal staff in Yellowknife routinely are unable to solve trouble tickets issued by northern staff. Many help desk employees based in the South have difficulty resolving technical problems that occur in the

> *"To meet HRSDC requirements, we currently need 10 to 30 MB capacity, and we can foresee the future requirements for 100 MB into Whitehorse. Without facing prohibitive costs or contracting limitations, we can only procure a 1.5 MB line through our current vehicle. The HRSDC staff and the people they serve in Yukon are left out. We can't really support the staff properly."* --- Louis Varin, Human Resources and Skills Development Canada, Government of Canada

North, and simply close the trouble tickets unresolved, leaving northern federal employees unable to access necessary communication services to do their job effectively.

Many federal departmental representatives in the Ottawa visioning workshops had examples of being unable to adequately support their staff in the Arctic regions to the same levels as southern federal employees. New software is often designed to run on networks assuming typical fiber speeds and latency, presenting challenges to both southern and northern IT support personnel.

One southern participant reported that they frequently fly northern federal employees south to learn new virtual desktop applications for data entry and retrieval into national systems. When they return to the North, these applications do not work the way they did on southern networks because of bandwidth constraints, and so they are unable to interact with the data effectively.

There are many examples of direct support from southern employees to northern employees that rely on robust communication networks. From Environment Canada and Correctional Service of Canada (CSC) staff to military personnel and Canadian Border Service Agency agents, all require access to communication support services and data that originate in the South.

Territorial governments also experienced challenges being able to take advantage of broadband tools that assume higher levels of connectivity than what is available in all three territories. Territorial governments need reliable communication networks for its citizens that are on par with southern cities. They cannot operate effectively with less.

> *"I am nervous when we use the word "expectations" in referring to service levels. We can inadvertently create an expectation that we can do without services that are on par with the South - but it is not true. Connectivity is critical to business, government, and emergency organizations in Yukon too. We are no different than any other government - we are looking at more online services with more availability to the public - it's not special. We know bandwidth requirements are going to go up, it's just a question of how fast its going up - how do we adapt as a territory?"* --- Steve Rose, Economic Development, Government of Yukon

In Nunavut, there is currently an out-migration of youth from communities, mostly Inuit moving to southern centres (or even Iqaluit) for schooling and not returning to their home community. In order to ensure educated youth return to the North, participants in the Iqaluit workshop felt that certain 'southern' elements will be required to attract the best and brightest back to Nunavut communities to live, and decent connectivity was one of the key requirements.

Gap within the North

When focusing on the gap between North and South, it is easy to overlook the challenges within the North itself, where communication infrastructure services are unequal between communities.

Whitehorse and Yellowknife do not have service parity with the South in terms of speed, latency and affordability. But many of the communities within their territories have significantly poorer connections than the capitals. So when new programs are introduced by territorial governments, difficult decisions have to be made. Should the government invest in software that can work in Whitehorse to deliver a service that might not work in Old Crow? Do people in Sachs Harbour have access to the same level of government services as are available in Yellowknife?

We already accept that people in smaller communities do not have the same level of physical access to services locally, such as tertiary care hospitals, government offices or brick-and-mortar banks. But robust communication infrastructure to smaller communities offers the potential of narrowing the gap between service delivery in larger centres and smaller centres.

Yet when communications services cannot support the necessary access to smaller communities, options for alternative delivery of services using new communications tools are not available.

Nobody would suggest that these two territories should select inefficient communication tools to ensure service parity within their territories. It is an absurd idea. But as new communication tools and software increasingly requires higher levels of bandwidth and lower levels of latency to operate, difficult decisions are being made.

Within the NWT, groundbreaking work is being done within schools and health centres for children requiring Speech and Language Therapy in communities outside of Yellowknife using videoconferencing within schools. This connects children to Speech Language Pathology services without requiring them to leave their home community or even the school. Satellite served communities cannot yet support these services reliably.

In the Yukon Government, the Department of Health and Social Services will be using British Columbia's implementation of Panorama, a Pan-Canadian Public Health Information System. The data will be stored and served up from Vancouver. Tools for tracking and improving public health outcomes are one of the keys to improving the long term public health of Canadians. While Panorama works on the network within Yukon, and between Yukon and BC, IT managers are concerned there may not be enough capacity to handle the increased data flows between communities and Whitehorse and between Yukon and BC.

In Nunavut, government routinely moves larger data files on memory sticks via plane, and have been forced to shelve custom software that needs more robust communication

networks to operate. Many departments continue to rely on paper-based data collection systems.

The one advantage Nunavut has over NWT and Yukon is that service to all communities in Nunavut all rely on the same satellite infrastructure, so services are equally constrained in all communities. Therefore decision makers based in Iqaluit are required to find solutions that can work in all 25 communities, including the capital.

> *"On direction from the Auditor General, Nunavut implemented a centralized 'self-service' system for payroll management. HR staff in communities would enter one line of data and have to wait for a full 5 minutes for the centralized system to respond. Others could not log in at all due to bandwidth constraints. We were forced to go back to using spreadsheets. The less intelligent the system, the more manual interventions required, the more mistakes, and ultimately higher cost to government."* --- Omar Zahabi, Human Resources, Government of Nunavut

Conclusion on service parity

As federal and territorial governments implement more and better services that rely on broadband networks, the gap will only expand between well-connected and poorly connected communities.

If poorly-connected communities consistently do not receive basic services that become available elsewhere via high speed networks, one could argue the very existence of these communities are threatened over the long term, as traditional service delivery (paper/fax based, fly-in, or even lack of access entirely) become unacceptable or unsupported alternatives.

Access to modern networks will not necessarily result in increased opportunity in every facet of community life. However, lack of appropriate access will ensure that communities can not take advantage of what better communications access can help to provide - including improved health care, education, business opportunities, governance, engagement in development, and the hope of a better future for residents.

5.4 Affordable Bandwidth Shortage

Affordable bandwidth shortage: terrestrial and satellite

> *"The idea that we have to tell the North to slow down its economic development, to monitor how much they use the network, is not the message we want to convey if we want our Territory to succeed."*
> Lisa Badenhorst, Economic Development, Government of Yukon

The number one communication issue listed by NCIS-WG members and survey respondents was 'bandwidth shortage'. Certainly this was raised in every workshop as a key challenge in obtaining services, and was not directed to just satellite served communities.

In Yukon, where all but one community is connected via a terrestrial network (fiber or microwave) bandwidth availability to communities is substandard to services available in Whitehorse. Healthcare, education, and justice services are all affected. Terrestrial networks suffer from 'hard wired' architecture challenges, and natural choke points occur, which affect every community down the line.

One participant said "Maybe there is 1.5 MB connection within a community via an ADSL link, but we know for absolute certainty that the signal going down the road to the next community is nowhere near that fast."

Many examples of choke points in delivering services in health care, education, justice and even library services in Yukon were provided in the survey data.

In NWT, with their mix of terrestrial choke points, and satellite connected communities, there are even more bandwidth challenges. Yellowknife workshop participants said that providing any services over satellite communications 'is a killer' due to latency problems, and cost of bandwidth.

> *"We have a state-of-the-art vehicle pulled by a team of dogs."*
> Kathleen Lausman, Community and Government Services, Government of Nunavut, referring to the new driver licencing software that produces files that are transferred by plane on a memory stick.

In Nunavut, there are abundant examples of world-class software purchased to solve a unique challenge, that then will not operate over the current communications network. For example, it is very difficult to obtain picture ID in most Nunavut communities, with no professional photographers or processing facilities. Issuing driver's licenses or some form of ID that will allow people to travel on an airplane outside of Nunavut is extremely difficult. So the Government invested in an easy-to-use state-of-the-art system where a relatively inexperienced worker can take a top-quality photo, enter relevant data, and then immediately send the file to a larger centre to produce an ID card. But as it turns out, the lack of affordable bandwidth serving most communities means the workers must

put the file on a memory stick and send it out by plane to be processed causing multi-week delays.

Satellite latency

In an Ottawa group, participants discussed the challenge of latency over satellite, quoting gaps in delivery of packets anywhere from 800 milliseconds to 4 seconds. Latency problems ensure that many communication services simply will not work.

Satellite latency is 750 milliseconds when a signal goes via satellite directly from point A to point B. At this speed, most applications will not suffer from that level of latency. But in many cases, signals are not routed from point A to point B - they sometimes hop multiple times on the satellite, or traverse choked terrestrial links To achieve the least amount of latency between two points, the route must be direct. Relying on older end point gear that forces a signal to do multiple hops, or connect via older choked terrestrial networks, all affect the latency of the signal.

Satellite ground station equipment and network architecture design requires regular upgrading to assure the least amount of latency and fewest number of hops for latency-affected services, such as videoconferencing, webpage retrieval or data carried on Virtual Private Networks (VPNs). Upgrading ground station equipment in remote communities is expensive, and there is no sustained funding to help pay for required infrastructure upgrades.

Understanding satellite bandwidth constraints

Most of the NWT and Nunavut satellite traffic for government use is on C-band. C-band is the band of choice in the Arctic, as the footprint, technical reliability, and delivery to all parts of the Arctic are assured.

Satellite space segment running on C-band is sold by Telesat by the MHz, on a contract term. Buyers of space segment (service providers) are required to purchase a set amount of bandwidth for a certain length of time, at much higher rates than are typically charged on fiber networks. Once locked into a contract, the buyer must continue to pay for the MHz ordered, whether they use the bandwidth or not. This makes it very difficult to expand networks incrementally, or offer end users affordable solutions for one-time events. Service providers are required to buy bulk services that they must then obtain a return on. So service providers aim to fill their capacity in order to obtain a return on their investment - which eventually leads to choked networks during busy hours and an inability to scale up inexpensively. Before buying another block of space segment, they must have a long term buyer in place before committing to another investment, or they stand to lose a great deal of money if capacity is unsold. It is a high-risk investment, because if the space segment is not used, it still needs to be paid for, and there is no way to generate revenue once time has passed.

For high-bandwidth applications like videoconferencing, occasional use bandwidth is available for purchase, but the per MHz cost is extremely expensive, and administratively costly to set up, test and use. It is not just a matter of turning on more bandwidth to the satellite - service providers have to have already arranged enough capacity with Telesat in order to have that capacity available. This means having extra capacity that is not being paid for by anyone but the service provider, so when sales do happen, they must price it accordingly. In addition, ground station architecture, and even physical changes to ground station gear may be required, at significant expense.

When seeking quotes for occasional-use on satellite, new government buyers are always shocked at the pricing, set up and management fees, as the prices are so much higher than southern fiber services, particularly if they are comparing prices for the same service in Toronto with the price for service in Inuvik.

There are certainly solutions to scalability problems inherent in Arctic satellite communications. Solutions can be found in investments in ground station architecture and next-generation satellite capabilities. But significant up-front investment will be required in order to take advantage of better, scalable options for both service providers and their customers.

Perceived shortage of satellite transponder space on C-band

Telesat has indicated they have only sold 41 of the possible 72 transponders that footprint the North, showing that there is 31 available transponders - in other words, no shortage of satellite transponder space on C-band.

However, there is a perceived shortage of C-band transponder space from Telesat, which is understandable once one learns more about the setup in the Arctic. Unfortunately, both SSi and NWTel point their dishes at the same antenna on the same pole (A-pole), of the same satellite, which is now at capacity. Neither of the two major providers can buy new contiguous bandwidth from Telesat to meet rising bandwidth requirements, causing the perception of a shortage of satellite bandwidth for sale, further eroding users' faith in satellite.

In order to purchase more contiguous bandwidth, SSi or NWTel will need to move their networks to the B-Pole of the satellite, or point to an entirely different satellite, freeing up more transponder space on the A-Pole. Moving to B-Pole or to a different satellite will require significant investments in upgrading their ground station equipment. If vendors are required to make investments in every ground station in order to move to another satellite, the real cost to deliver that bandwidth will certainly rise, and vendors will be forced to pass that cost onto the consumer. This situation has led many to believe there is a lack of bandwidth available for purchase from Telesat. It is clear there is more C-band capacity for sale, but neither SSi or NWTel can affordably upgrade to connect to the available Telesat capacity.

Fiber versus satellite?

It is tempting to think that bandwidth problems can be solved if only fiber can connect every Arctic community as it connects southern communities, and some of the road linked communities in the west.

There is no question that the cost of recurring satellite bandwidth far exceeds the cost of recurring fiber bandwidth - once the initial fiber build has been paid for.

The challenge is obtaining the funds to put in fiber in remote communities. Initial rough estimates in the Arctic Link Project planned by Arctic Cable Company LLC for linking a necklace of 15 communities (4 in NWT and 11 in Nunavut) via the Northwest Passage are estimated at $250,000,000. Initial estimates of laying fiber down the Mackenzie Valley connecting less than 10 NWT communities is $60,000,000. (A full study on the Mackenzie Valley project is currently being completed due in late spring, 2011.)

Laying the fiber itself (whether on a road, down a river, or under the sea) is the first step. Each one of the many fibers in the cable needs repeater power and electronics every 300-500 kilometers and that electronic equipment ages just like the electronics in other solutions. Planners must properly estimate user demand for the future to avoid having to engage in expensive upgrades to electronics at either end of the cable to meet unexpected demand.

Another challenge for fiber in an Arctic environment is in its maintenance. Experience in Greenland has ongoing repair incidents due to ice damage costing millions per break and they experienced several breaks in the first two years. (The fiber cable is vulnerable in the last few kilometers where it lands at each community as ice scrubs the bottom far out from the water's edge. This problem is a significant part of the capital cost of fiber in the North.)

Conclusion on affordable bandwidth

Vast geography, lack of roads, expensive maintenance on terrestrial connections, aging earth station equipment, and the high cost of laying fiber and purchasing satellite space segment all conspire to keep bandwidth costs incredibly high in the Arctic.

No matter how you slice it, delivering affordable bandwidth to Arctic communities is an expensive business, that cannot be borne by the purchasers of service alone, nor by private sector providers that require a return on their investment to stay in business.

5.5 High Cost to End User

The number two issue identified by users was high cost, just behind bandwidth shortage.

It is possible to buy more bandwidth to serve many of the needs of northern government users. The challenge to end users is that bandwidth costs are simply too high for many departmental budgets. So users are forced to purchase what they can afford, which is not enough to meet demand. Thus the link between high cost and bandwidth constraints.

This section outlines the concerns of government participants, and briefly examines some of the reasons why the costs to purchase services in the Arctic are so high.

In order to illustrate why the challenge is so great to purchase affordable services, this section will look at three things:

1. historical investment in phone infrastructure

2. government procurement initiatives for government use

3. public access initiatives

These three items provide a systemic explanation as to why government departments face the challenges they do, in an effort to provide some insight into the current situation today.

Government purchasing investment not enough

There was dissatisfaction in both the written surveys and visioning workshops from government participants with what they perceived as impossibly high prices for the services they receive.

Even after investing in private networks to meet government needs with long service contracts or direct infrastructure funds, it is still difficult for many of the departments to purchase the services or capacity they need.

Many departmental representatives stated they cannot afford to purchase the service they need, either because it is simply not available, or the quoted cost from existing service providers to build out the service far exceeds their budget. Some government users felt their government had already invested significant public funds to develop networks to meet governmental needs, and felt they should not have to pay again for what they saw as an infrastructure investment they already paid for.

Government is the largest single purchaser of communication services in the north. Because of the high cost of the build, and the relatively low numbers of people being served in 75 different communities, there is no possible way government purchasers alone can cover the real cost of building, maintaining and evolving robust infrastructure in any of the three territories. Government purchasing could never cover the full cost of

rolling out phone services in the past and they cannot do it for broadband services today.

Part of the challenge is in the way funds have been made available for the development of modern networks.

Historical investment in phone infrastructure

There have been numerous investments in an effort to help meet governmental communications network needs over the past 15 years, both through direct investments and long term service contracts to private sector providers.

However, there has not been significant, consistent, sustained investment to build and evolve modern communications infrastructure networks in any of the three regions that can meet governments' increasing need for service.

Contrast the lack of sustained investment in new communications services (such as broadband networks) with basic phone service investment in the Arctic. Since the 1970s, there has been support via the CRTC controlled National Contribution Fund to ensure basic dial tone phone services are available in all Arctic communities. The fund was set up to ensure 'uneconomic regions' in Canada would be assured basic phone services.

Today NWTel must deliver to the "Basic Service Objective (BSO)" standard. The BSO includes: local service on an individual telephone line, access to low speed (dial up) Internet at local rates, operator and directory assistance services, access to the long distance network, enhanced calling features and a copy of the local phone directory. NorthwesTel receives a subsidy from the National Contribution Fund which helps with delivery of basic phone services, service improvements in their regulated, high cost serving area, and which allows NWTel to plan and run their services into the future.

The following chart provides an overview of the CRTC controlled fund used to support the phone system. *These funds do not include private sector investment from NWTel or customer revenue.*

Year	CRTC National Contribution Fund	Notes		Reference
2001	$15,100,000	Basic Phone Services, Service Improvement plan: effective 1 January 2001, the CRTC determined that it would continue regulating Northwestel on a rate base/rate of return basis and set the company's rate of return on equity at 10.5 percent.	The Commission approved a four-year service improvement plan (SIP) for the years 2001 to 2004 to improve and extend phone service in the North. CRTC approved supplemental funding from the National Contribution Fund of	CRTC decision 2000-746
2002	$13,400,000			CRTC decision 2003-39
2003	$9,600,000			CRTC decision 2004-64-1
2004	$9,300,000			CRTC decision 2005-54
2005	$9,100,000			CRTC decision 2005-54

Year	CRTC National Contribution Fund	Notes		Reference
2006	$9,800,000	In 2007, the system to determine the investment amount changed to a price-cap framework, a cost-based subsidy based on the difference between the cost and price of providing residential local access in all communities except Yellowknife and Whitehorse.	$15.1 million for 2001 and determined that it would conduct annual reviews of the supplemental funding required by NorthwesTel.	CRTC decision 2006-10
2007	$18,900,000			CRTC decision 2007-5-243-244
2008	$18,900,000			
2009	$20,900,000			
2010	$20,900,000			
2011	$20,900,000 (estimated, not in public statements)			CRTC Decision 2010-789

Without the National Contribution Fund, the vast majority of communities in the Arctic would not likely have basic phone services. Government relies on these phone services and would be in no position to install phone services for their own use only, if there was not a public system from which to purchase.

Today, as Arctic residents cry out for more affordable bandwidth to support their modern communication needs, it is useful to look at the public investment in IP based communications networks compared to phone networks to help explain some of the high costs. There is currently no corresponding, sustained fund from any source to support the development, implementation, and evolution of communication services to develop 21st century data, voice and video services in the Arctic.

Government procurement initiatives for government use

Investments led by government to connect government to modern data services include three main initiatives:

1. DCN (Digital Communications Network): In 1996, the Government of the NWT ran an RFP to get a vendor to develop the Digital Communications Network. The aim was to connect all communities (including Nunavut before Division), so that government workers would be properly connected to high speed networks. The GNWT entered into a 5 year managed service contract for government connectivity with the winning vendor of the DCN RFP. The intent was that in paying for network construction and by signing on as an anchor tenant, the vendor would then be able to provide wholesale connectivity services to ISPs, who in turn would provide affordable Internet access to the public. While some ISPs were able to offer services in larger communities, smaller communities were never adequately served under this model. The DCN contract for GNWT government services was renewed in 2003 and 2010. Establishment of ISPs in all NWT communities was not realized through this model.

2. Connect Yukon: In 2003, the Connect Yukon project saw the Yukon Government make significant investment to connect all communities for *both government access and public access*. This investment enabled most communities in Yukon to have a reasonable level of access at 2003 expectations. Service contracts for government access since this original investment has kept the network operational, and customer revenue continues from public consumers. But further investment is clearly required if all of Yukon is to upgrade to a level that meets increasing needs for both the general public and government.

3. Public Benefits Transponder: Industry Canada controls some no-cost bandwidth (space segment) as a condition of the satellite "parking slots" awarded to Telesat. Some of this no-cost bandwidth has been allocated by Industry Canada to the governments of NWT and Nunavut (and others in provinces) to deploy to schools and health centres in satellite-served communities. The 18.5 Mhz of satellite bandwidth is worth a great deal on the open market. The estimated commercial value* of the benefit is $7,524,000 for 6 Mhz provided to the GNWT and $15,675,000 for 12.5 Mhz provided to Nunavut over the life of the program (2003-2022). The Public Benefit capacity is welcomed by governments struggling to provide adequate access to schools and health centres. Governments paid a small amount to initially implement the program (eg. $400K in the NWT), and service providers supplied the necessary earth-station equipment and management of the free bandwidth at a cost that was passed onto government. The NWT implemented the program in 2003, but in Nunavut, it took a few more years to take advantage of the 'free' bandwidth as service providers and government worked out the physical and financial details required to deploy the bandwidth.

   **Note: commercial bandwidth costs quoted in the Public Benefits information on the chart on the next page are based on 2010 rates of $5,500/Mhz.*

The chart below does not include investments by the private sector, nor amounts paid by governments for purchased services.

Government Investments for Government Connectivity

Project/ Program	Source	Year	Public Contribution	Purpose	Region Served	Cash Flow Notes - Capital	Cash Flow Notes - Operations
Digital Com-muni-cations Network (DCN)	GNWT/ GN	1996, 2003, In 2010 NWT only	$12,900,000 in 1996 $17,400,000 in 2003 $25,000,000 in 2010	connect government offices to high speed internet. Renewed contract in NWT and Nunavut in 2003. NWT only in 2010.	NWT - all 58 communities (1996 included Nunavut at the time. In 2003 GNWT and GN were separate contracts)	The 1996 managed service contract included a capital component. Proposed 5 year contract in 2010	Resulting infrastructure owned by network operator
Connect Yukon	YG	2003	$23,000,000	public high-speed internet access to 95% of Yukoners, both government and public	Yukon - all communi-ties	$13M build - $10M YG	Agreement covered leased services between communities
Public Benefits Trans-ponder	Industry Canada (IC) and GN	2003 to 2022	$15.675M (commercial value of capacity over life of program)	satellite capacity for schools, health centres	Nunavut	12.5 MHz of C-Band satellite capacity for life of transponder to 2022	licensing fees payable to Telesat
Public Benefits Transpon der	Industry Canada and GNWT	2003 to 2022	$7.524M (commercial value of capacity over life of program) GNWT contributed $ ~400,000 at start up	satellite capacity for schools, health centres	NWT	6 MHz of C-Band satellite capacity for life of transponder to 2022	licensing fees payable to Telesat

Project/ Program	Source	Year	Public Contribution	Purpose	Region Served	Cash Flow Notes - Capital	Cash Flow Notes - Operations
Cellular services	YG	2006	$5,750,000	introduction of cellular service to 17 Yukon communi-ties, for both government and public use.	17 Yukon commun-ities	Initial capital investment was $4M for 17 com-munities, plus $1.75M for five additional sites.	The Northwestel-Dakwakada team owns and operates, this system with a 12-year service agreement
Financial Mgt System	Finance/ INAC/ GN	2008	$15,000,000 federal, $7,200,000 territorial	Strengthen-ing Financial Manage-ment with infrastruc-ture investments (amts don't include trng and process work)	Nunavut	Amts include backbone infrastuctur e, hub infrastructu rein Ottawa/IQ, and last mile fiber within communitie s	This new investment is not fully imple-mented yet, but develop-ment of infrastruc-ture is underway.
Know-ledge Infra-structure Program (KIP) for Nunavut Arctic College	Industry Canada/ GN	2009	$5,500,000	Better connect adult learning centres	Nunavut	Ka band infrastructu re	Additional bandwidth to be purchased by GN.

Public access initiatives

While this report looks at needed government services, it is important to see the link between the general publics' access and the ability of government to be able to procure what they need.

First, government needs to be able to reach the public in their homes and businesses, providing direct service online. It is in the government's interest to ensure the general public is connected. In the Arctic, these connectivity initiatives are usually led by economic development arms of the government under the 'building business' banner, but general public connectivity benefits all departments' efforts - from public health to education, licensing, transportation, environment, governance etc.

Second, the infrastructure required to support public access provides an important foundation and revenue stream from which vendors can build out networks, that enable them to respond in innovative ways to government RFPs. It allows them to share infrastructure and bandwidth in efficient ways, delivering better services at a lower cost to everyone.

Third, traveling government workers need access while 'on the road'. Publicly accessible networks are the most efficient method of hooking into their government's infrastructure, as people connect into their government systems over virtual private networks carried over the public Internet.

In order for government to meet its connectivity needs into the future, robust public access will play a critical role.

History of public access

The Connect Yukon project in 2003 project combined government needs for procuring services with the public needs for connectivity, and invested in the vendor to deliver a level of service to all communities for both government and public access.

Access to services in NWT and Nunavut for the general public took longer to organize than in Yukon. In the NWT and Nunavut, the general public, businesses, NGOs and Aboriginal groups located outside of Yellowknife simply did not have affordable nor adequate access, facing problems similar to many rural and remote communities across Canada.

In response to lack of connectivity for the public, Industry Canada set up the Broadband for Rural and Northern Development (BRAND) program. They then launched the National Satellite Initiative (NSI) in conjunction with Infrastructure Canada and the Canadian Space Agency to help defray the costs associated with satellite and reduce the price for the end user.

The BRAND program stipulated that funds could not go directly to governments. Priority funding was given to community-based organizations to manage the investments to connect the public to a network that was to be self-sustaining from customer revenue into the future.

Three main projects were carried out during the BRAND and National Satellite Initiatives in the territories:

1. Nunavut Broadband Development Corporation (NBDC): NBDC was set up as a not-for-profit organization with membership from the general public, the GN and Nunavut Tunngavik Inc. RFPs were issued in 2003, a vendor was selected and the service launched in 2005. Investments were renewed in 2008 due to the explosive demand for service among the public, far exceeding the original support negotiated in the 2003 agreement. These upgrades were in response to the increased level of user subscriptions and demand for additional services.
2. Falcon Communications Group Ltd: In NWT, Falcon was created as a for-profit group by a consortium of Aboriginal organizations. An RFP was issued in 2003, reissued in 2004, a vendor was selected and services launched in 2007.
3. YukonNet: In Yukon, YukonNet is a not-for profit organization with a long history of ensuring the public can obtain affordable access, having been involved in Connect Yukon. Their involvement with Burwash Landing completed the public access work started with Connect Yukon.

Certain rules governed the BRAND agreements, with technology neutral RFPs to select vendors, stringent matching funds requirements and long term sustainability plans. NSI also had stringent matching funds rules. In Nunavut and NWT, because services to customers were subsidized, selling services to government buyers at the subsidized prices was forbidden to both avoid market disruption to the vendor holding the government contract at the time, and to preserve the limited satellite subsidy for general public use. So government purchasers of general connectivity through these systems are to be charged at the "real cost factor", which is 2.5 times higher than the general public.

Amounts in the following table do not include private sector investment or debt financing that is to be paid back from customer revenue over the life of the project.

Government Investments to Support General Public Access to Broadband Services

Project/ Program	Source	Year	Public Contribution	Purpose	Region Served	Cash Flow Notes - Capital	Cash Flow Notes - Operations
Nunavut Broadband Dev Corp (NBDC): QINIQ - capital	IC - BRAND	2003	$3,884,850	public high-speed access to homes and offices, not for govern't use	NU - all 25 communities (Iqaluit not funded by IC)	capital build over 2 years.	N/A
NBDC: QINIQ - satellite capacity	INFC - NSI	2005 - 2012	$7,830,000	defray the costs of satellite to consumers	NU - all 25 communities	N/A	satellite capacity over 8 years
NBDC: QINIQ - upgrade capital	INFC - NSI	2008	$2,600,000	upgrades to QINIQ network	NU - all 25 communities	$2.6M capital up-grades	N/A
NBDC: QINIQ - satellite capacity/Generic projects	INFC - NSI	2008 - 2012	$21,600,000	procuremen t of satellite capacity, new broadband mgt tools	NU - all 25 communities	N/A	$18M satellite capacity over 4 years
Falcon: Airware - capital	IC - BRAND	2004	$5,068,317	public high-speed access to homes and offices.	NWT - 31 communities (YK and Inuvik excluded)	capital build over 2 years	N/A
Falcon: Airware - satellite capacity	INFC - NSI	2005 - 2012	$7,000,000	defray the costs of satellite to consumers	NWT - 31 communities	N/A	satellite capacity over 8 years
YukonNet Operating Society*	IC - BRAND	2004	$222,806	public broadband access to Burwash Landing	Burwash Landing	capital build over 1 year	N/A

*Please see first chart that details Connect Yukon, that connected both government networks and the general public.

Compare the funds committed to basic phone service support to funds committed to building out broadband - both for government and public use. Clearly, the basic amounts of investment are not equal - understandably as phone services have been considered essential for two generations, while some people still think broadband is a luxury item.

The important difference between phone service investment and broadband investment to date is in the process. Support for broadband networks is inconsistent, and the rules for obtaining investment year in and year out change, making it very difficult to plan and evolve services. It is not difficult to see the challenge that face governments, the public, and service providers in obtaining adequate, consistent funds to develop critical broadband networks with the current program-based one-off approach to investment.

Conclusion to high cost

All of the initiatives to date to connect the public and government in the three territories are very important, and have provided minimum levels of connectivity. There has been good progress over the past decade, but it simply is not enough, as evidenced by the challenges outlined by both NCIS-WG members, the participants in the workshops, and the service providers.

Today's needs for connectivity are expanding at a much faster rate than what networks are able to provide with the funding models available. Reliance on older satellite technology and ground station architecture adds to the challenge and cost of providing affordable services to the end user.

Lack of sustained, consistent funds for public access and government initiatives, combined with the need for constant network upgrades to meet expanding demand, makes it difficult for service providers to invest enough to meet future needs for both government and the general public.

5.6 Reliability and Quality of Service Gap

Network and power outages

Yukon participants in workshops spoke at length about the damage to their economy, government operations, and danger posed to the public when their single fiber line was cut three times in 2010, cutting off Internet, cell phone, and point of sale to Whitehorse and beyond for

> *"Now that we are so dependant on our communication networks, being cut off from communications today actually causes the emergency, a similar phenomenon when city residents lose power. We don't heat our homes with wood anymore, so when the power goes out, people are at risk. It is the same for communication networks today - they need to be reliable."* Yukon Visioning Workshop group

up 8 hours or more. It caused damage to the tourism industry, and participants agreed that in fact, the accidental cutting of communication services actually caused 'an emergency' of sorts. It was ironic that the topic of conversation was about communication's role in responding to emergencies.

The Yukon fiber cuts also affected services in NWT, and Nunavut (as some traffic from NWT and Nunavut is routed through Whitehorse's fiber link south) but participants did not raise these cuts as an issue. When asked if the service interruptions in the summer of 2010 were a significant problem, one Yellowknife resident simply said "We are so used to being cut off, that we didn't even see it as a unique event worth raising."

Connect Yukon was a forward-thinking, important investment that has provided Yukoners with a badly needed service. However, in today's increasing reliance on connectivity to the backbone to conduct business of all kinds, there is very clear need for redundancy of backbone connectivity.

According to one participant at the Whitehorse workshop, the City of Whitehorse will not make plans to provide online services until they know there is a redundant service, so that communication service interruptions will not shut down their capacity to provide service.

Satellite services are also at risk, even with two different vendors in NWT and Nunavut, that have two distinct sets of ground station equipment connecting to a satellite. Ironically, both service providers connect their ground station equipment to the same pole (A-pole) on the same satellite.

> *"We have had numerous network outages between communities and Whitehorse - all single lines as well. When they open the new hospital in Watson Lake, redundancy between Watson Lake and Whitehorse will become more important. Same for Dawson City. As we get more and more traffic between communities and Whitehorse, it gets more and more important to build in redundancy."*
> - Janet Nyberg, Health and Social Services, Government of Yukon

When a rogue satellite wandered through the space reserved for other commercial satellites in 2010 there was real concern that the transmissions from and to the Telesat satellite that serves the Arctic would be interrupted. If this were to happen, both NWTel and SSi satellite provided services would be knocked out in both Nunavut and NWT (as both suppliers use the same satellite and the same segment (A-pole) of that satellite). All communications would utterly fail to all satellite served communities, including phone and data services.

Lack of transparency

Data managers in government require information for planning and utilizing their resources, and many felt they didn't get the information they needed from service providers. They need the ability to prioritize certain traffic on networks, and some felt they should be able to do more in managing the services they purchase.

Some participants felt that service providers did not provide enough data on services delivered. One participant in Yellowknife said there was no way to measure the utilization and level of service he was paying for, and that too much information was hidden from the client - from where the hops are, to the oversubscription rate applied to bandwidth purchases.

In response to transparency concerns expressed by participants in various sessions, government stakeholders were provided a questionnaire concerning the implementation of a Service Level Agreement (SLA) for their current WAN services, as part of this Assessment. The Northwest Territories and Nunavut governments have an SLA in place with the service provider that includes standard monthly reports, financially driven remediation clauses and repair time targets.

However, the Yukon government indicated that they do not have an SLA currently in place and have stated that they are operating under a grandfathered agreement which contains only basic service levels.

It was not possible to obtain information from every Federal department regarding SLAs, but from the few that responded, SLAs were in place with vendors.

Conclusion for reliability and quality of service

There is a formal process in most jurisdictions for the sharing of information between service providers and clients through Service Level Agreements. Even so, based on input received from various participants, reporting methods between service providers and users of the networks could be improved to address some of the concerns over lack of transparency and questions of quality of service delivery.

In order to ensure services are not knocked out in a single communications event, there needs to be redundancy built into the backbone connectivity. Every satellite served community requires connectivity to two different satellites. Terrestrially served communities require a second point of entry - either with a second terrestrial line, or satellite back up that could be brought online immediately.

It is simply not acceptable to have a single point of failure when public safety and lives are at stake. Redundancy should extend beyond the consumer level service and include the ground equipment and the satellite used.

5.7 Geographic Coverage Inadequate

Another issue identified by NCIS-WG was lack of geographic coverage between communities, with over 40% of survey respondents identifying it as an issue.

The departments most concerned with lack of coverage between communities included emergency responders, military, environmental researchers, and some sites where government workers are required to work outside of communities.

For example, when someone from Alaska is crossing the border into Yukon, Canada Border Service Agency agents man the remote border crossings, outside permanent communities. Agents must reference the Critical Query Service (that is served from the South) to determine a person's eligibility to cross the border. They are unable to reliably connect to the southern server with their consumer satellite service, and are routinely forced to use satellite phones to call in the request to another CBSA person to log onto the system to look up the information, causing delays and security challenges at the Yukon/Alaska borders.

> *"Our experience in the field is that there are spots where satellite phones simply don't work in the NWT. So our ability to communicate is limited. It's hard to be safe in the field, and get important information back to people in order to respond."*
> --- Participant in Yellowknife Visioning Workshop

Satellite phones don't have enough bandwidth to enable use of network-based applications required for everything from highway patrol to researchers. In the NWT, bioresearch is conducted on the land. In an ideal world, researchers would be able to collect the data on site, and upload it. Instead, they cache data, and forward it when they return to communities. Much of this information is not time-sensitive, but they need to be able to connect within communities. For safety reasons, they also require communications with the researchers to ensure safety while they are on the land.

Environment Canada is mandated to provide advice to those responding to an environmental issue in the field. The only option is satellite phone in NWT, and this does not always allow for the transfer of images or data that is necessary to make informed decisions on both ends of the connection.

Cell coverage along highways in NWT and Yukon is not readily available. This was an issue raised by participants in Yukon, as a goal to be met in the future. In Yukon, government workers traveling the highways frequently use HF radio systems if necessary.

In emergencies, there is a huge need for connectivity between communities. There is more on the issues faced by emergency responders in Section 5.8.

On the land connectivity not complete

In the Yukon, the government invested in a new digital MRS (Mobile Radio System) for law enforcement agencies, emergency services, health officials, and transportation services. The MRS was awarded to NWTel through a competitive process in 2008 and completed in 2010. Under the terms of the 15 year contract NWTel and EF Johnson Technologies built and operate this communications infrastructure on behalf of the government of Yukon. The MRS solution replaces the Multi Department Mobile Radio System.

The new system was put to the test in a recent exercise simulating an earthquake in Dawson City. Technically, the MRS system worked, but users of the system had to follow specific procedures for using the system or communications quickly broke down. With frequent use of the system by all responders, the MRS will become an important communications tool for first responders in Yukon. It will be important that the system is used widely, that there be many exercises in preparation for an event, and that strict protocols are followed to ensure the system supports the communications needed.

Also in Yukon, the Yukon Amateur Radio Association maintains remote repeater sites linked via UHF. Civilians with VHF radios are able to connect to others over much of Yukon (largely following the road system), as detailed in Section 4.8. As a not-for-profit association working with a very small budget, they have accomplished a great deal, but YARA does not claim to be an emergency response service, as they do not constantly monitor airwaves. YARA works with many organizations in partnership to keep its network going, and is working with its volunteers and partner agencies to determine its future growth and role in providing connectivity between communities. YARA formally participated in the recent simulation of the Dawson earthquake, in a back-up role.

The Yellowknife Amateur Radio Association operates in Yellowknife and Rae-Edzo, with two 80 km circles centred on these communities.

Most government access to services on the land in NWT and Nunavut use Iridium satellite phones or temporary Ka-band satellite dish setups.

Rangers and reconnaissance teams deployed by military operating in the field carry groundwave HF radio systems gear, plus Iridium phones connected by satellite. Each night Rangers are required to set up and call in their coordinates. Setting up the HF Radio takes time, but it operates at a fraction of the cost of the Iridium phones, so people in the field continue to rely on HF Radio gear for every day communications to keep costs in check.

This older HF radio service covers much of the Arctic for military use, with a number of coverage holes. The military is considering putting in a new capital project to upgrade its HF radio system across the entire Arctic with a new digital HF radio system. This system could be made available to other federal and territorial government departments to use.

Conclusions for geographic coverage

As governments determine they need better geographic coverage, lessons can be learned from one agency to another.

For example, Yukon's MRS system is the newest mobile radio system. The service provider, together with Yukon government officials responsible for using the system may offer the NWT, the military and Nunavut some insights into how they deployed the new digital system, made use of repeater station technology in cold weather, and challenges in protocol linking non-military users of mobile radio services.

Emergency responders are experimenting with a wide range of satellite-connected systems as described in the next section. These systems may be applicable across a wide range of users.

Federally sponsored research by Communications Research Centre (example in Section 3.3) needs to be connected with commercial service providers in the Arctic so they can help develop and commoditize successful services that can then be made available to others across the North. Solutions in Resolute Bay may provide robust solutions at CBSA crossings at Pleasant Camp (on the way to Haines) or Mickey (Top of the World Highway into Alaska).

5.8 Emergency Response Challenges

Understanding emergency management

Emergency situations are dealt with first by individuals. If they become overwhelmed they call upon local officials (i.e. ambulance professionals, hospitals, fire departments, police and municipalities).

When a primary responder is called upon to respond to an emergency situation they do so as a normal course of business. When the emergency exceeds the normal capability of primary responders or lead agency, the local government authority (such as Hamlet, Town, City) calls upon the Territorial Government to respond.

The initial assessment of the incident, the development of short and long-term action plans, the assignment of resources to priority needs and the provision of urgent care and support to the community must be coordinated. If a local government or municipality is called upon to respond to an emergency situation they may choose to activate their local Emergency Operations Center (EOC) to help manage the emergency.

When an emergency is beyond the ability of the lead agency or local government, Emergency Management Organizations (EMO) becomes involved. The Director of Territorial Emergency Management Organizations may then activate Territorial Emergency Operations Centre (TEOC) and Emergency Coordination Groups in order to

pool government and community resources and personnel to manage the emergency situation.

EMO's are responsible for coordinating the territory's preparedness for, response to, and recovery from, major emergencies and disasters. Historically, emergency situations in the North have involved fires, floods, power failures, toxic spills and extreme weather, although other hazards exist. As the territorial authority for emergency preparedness, it is incumbent upon EMO to provide leadership to ensure that the appropriate contingency plans are in place to deal with foreseeable risks and hazards. Under the general coordination of EMO during an emergency, departments will implement departmental plans that provide an internal system for notification of key departmental personnel and coordination of departmental responsibilities in emergencies.

Federal departments frequently manage emergencies or provide support to a territory for events related to their specific mandate, within their own authorities and without requiring coordination from Public Safety Canada. However, territorial representatives share pertinent information with the Government Operations Centre and Federal Coordination Centre in order to maintain situational awareness.

For emergencies requiring an integrated Government of Canada response, the Public Safety Regional Office coordinates the response on behalf of federal government institutions in the region. This is known as the "single window" concept. It is intended to facilitate interdepartmental and intergovernmental coordination, without unduly restricting operations.

During an emergency the respective regional Federal Emergency Coordination Group (FECG) is the primary means for consultation, emergency management planning, advice and provision/management of information flow and requests for federal assistance within a region.

The Public Communications Coordination Group is comprised of federal and territorial public communicators from affected government departments, who work together and in partnership to enable horizontal coordination in responding to an emergency. Primary activities include:

- information gathering,
- advising senior officials,
- providing regional context and input to public communications products being delivered,
- providing support for and delivering their department's activities and products.

Robust, reliable communication tools to link the various governmental agencies at all levels are the foundation to effective emergency response.

Communication challenges in emergency response

Operational realties on-the-ground require first responders, territorial EMOs and federal government departments to work together when responding to a disaster event. During such times, connectivity becomes the life line (sending/receiving situational reports, risk assessments, resource requests, etc) for an emergency response and recovery effort.

Communication infrastructure in the Arctic is fragile, creating a high level of vulnerability that can jeopardize the safety and security of Canadian citizens. Information is key for responders to be prepared. Early identification of requirements for emergency services is important to avoid 11th hour problems accessing services.

Public Safety Canada (PS) is one of the primary departments behind the Arctic Infrastructure Communications Assessment, as they try to ensure communications are adequate to properly respond to an emergency.

There are many stakeholders that have responsibilities to respond to an emergency and are based in different geographical locations across Canada. Responders at all levels must be able to connect with people quickly and efficiently using reliable, robust communication networks from wherever they are.

In order to maintain constant communications between emergency management stakeholders spread out across the country a virtual emergency operations centre (essentially an emergency management communications platform linking various departments into a network via teleconference, video conference, GIS, etc) is required in order to aid Public Safety staff in coordinating response and recovery efforts.

New hardware, like the Canadian Space Agency Ka-band dish, is small enough to be transported easily, and offers sufficient bandwidth to supply a team with both voice and data. Combined with technology like Voice over IP, DMVPN routers and wireless equipment, a hotspot could be created with all of the essential services, including connectivity back to the home department, Internet access and BlackBerry data and voice communications.

Local capacity overwhelmed

Basic Internet and phone services that most Canadians would expect in a community are not necessarily available across the North. There may or may not be cell phone services, or Internet connectivity at speeds that support what is required by visiting personnel. As mentioned at the beginning of this report it does not take very many outside people landing in a community to crash a local cell network, crippling the ability of some responders to coordinate response efforts.

During an emergency, the local telecommunications infrastructure is often overwhelmed, even in major urban centers. In remote locations, the infrastructure is extremely fragile, and so responders try to bring what they require for communications equipment with them.

For this reason the Public Safety's Arctic regional office has created 'office to go' kits that can be deployed with staff within communities to ensure that they are self sustained with tools required to coordinate their response activities.

For NWT and Nunavut kits they have added 'Airware' wireless internet modems which provides internet connectivity in 32 NWT communities (all but Inuvik) and in all 25 Nunavut communities via the 'QINIQ' network. During exercises and emergencies, additional modems have been rented temporarily to provide other federal departments with Internet capabilities as part of their coordination function and responsibility. This service allows responders to interface with decision makers and provides connectivity within communities, and sometimes up to a few kilometres outside of communities. These services are not available in Yukon and alternate solutions are required. This practical northern solution has allowed the PS team to become better prepared. However these kits need to be maintained and should be re-evaluated regularly to ensure equipment and technology is kept up to date. Financial and IT resources need to be committed to ensure they are kept current.

It should be noted, that if 250 responders arrived in a community, and hooked up to the QINIQ or Airware networks, or linked into a cell phone network that normally only served 500 customers, service providers would need to increase capacity in advance in order to ensure the network could handle the additional load. With good planning, it is possible for service providers to quickly employ burst capacity that will allow for an increase in response capabilities in times of need.

When emergency events happen, media inquiries can quickly overwhelm an organization's ability to respond. Furthermore, for an organization's reputation to remain intact, crisis communications protocols are necessary. However, in order to employ effective crisis communications protocols connectivity to the region, territory and local community would be paramount. Without connectivity and effective lines of communication media inquires would halt and public concerns would increase exponentially.

"Increases in development activity will increase potential for major releases of contaminants into the environment (e.g. oil spills). Gathering information on these events and planning and coordinating responses will require reliable and robust communications systems. A challenge will be providing bandwidth necessary to stream data and video, linking to remote locations, and a capacity to maintain systems such that they work when most needed." --- Ray Case, Environment and Natural Resources, Government of the NWT

Military communications isolated

During an emergency the military may be called upon to provide support under the integrated government of Canada response.

Once the military is deployed, they generally set up their own, temporary, satellite-enabled networks to connect to military command. For security reasons, they do not provide access to non-military personnel to their temporary systems. Once they have completed the disaster response, they remove their gear.

The Army also relies on a network of thousands of Canadian Rangers, who act as the local 'eyes and ears' of the military. Rangers conduct surveillance and sovereignty patrols, report unusual activity or sightings, and collect local data of significance to the Canadian Forces. They also provide local expertise, guidance and advice during operations and exercises, conduct North Warning System patrols, and provide local assistance to search and rescue activities. There are currently 58 patrols across the North, and plans to hire another 1,000 recruits in the coming year.

Military services operate in places with civilian populations, including Resolute Bay (a new training centre), Iqaluit, Rankin Inlet, and Yellowknife (forward operating locations for the Air Force). As military makes purchasing decisions for permanent communication services in places with civilian populations, they want to find a way to ensure their investment benefits the local population wherever possible. Military also works with service providers to develop and purchase permanent communication services in locations with no civilians, such as Alert.

Joint Task Force North, (JTFN) headquartered in Yellowknife, is responsible for Canadian Forces operations in the North, encompassing approximately four million square kilometres, or 40 per cent of Canada's land mass and 75 per cent of its coastal regions.

The military conducts annual operations, including Operation Nanook, Operation Nunalivut and Operation Nanukput. While the precise objectives of each operation differ, they all share the same overarching purpose: to exercise Canada's sovereignty in the region and to advance the Canadian Forces' capabilities for Arctic operations. These operations continue to provide platforms and opportunities for interdepartmental cooperation and training.

In responding to emergencies, military communication services need to be able to interconnect with local networks securely and reliably in order to properly coordinate with civilian agencies, who will almost always be deployed before military arrives.

Military has standing offers arranged in order to purchase additional bandwidth as required when setting up communications to respond to an emergency. On average, it takes military procurement anywhere between 90 and 180 days to procure bandwidth. As one military participant said, "Whoever is required to go in and set up satellite services in an emergency situation better have bandwidth in place in order to be operational on the ground quickly. Otherwise, starting from scratch would take way too long." Military also

has internal staff to set up dishes, organize the connectivity, and ensure the service works. But these are temporary set ups that are removed at the completion of the exercise or emergency.

JTFN is one of the lead agencies behind the Arctic Communications Infrasructure Assessment in its efforts to improve communication networks that benefit both the military and northern residents.

Interoperability problems

A number of participants in visioning workshops were involved in the development of the Communications Interoperability Strategy for Canada released in January, 2011. The strategy's intent is to assist the federal, provincial and territorial agencies responsible for emergency management and first responders to work in a coordinated manner to respond to emergency situations across jurisdictions.

Participants on workshops identified challenges such as differing security requirements preventing the use of shared networks, gear that does not interoperate with other jurisdictions, and a lack of practice with procedures using certain communication equipment in response to disaster.

The Interoperability Strategy identifies some key strategies that if adopted, would assist Arctic jurisdictions in solving some of the interoperability challenges faced by emergency responders. Strategy objectives of the plan include:

- Governance: developing a clear governance structure;
- SOP: adopting Standard Operating Procedures;
- National system: promote the development of a national public safety communications systems, with open architecture and adoption of open data exchange standards;
- Training: support integrated training and exercises; and
- Usage: promote daily use of common processes so that responders are familiar with protocols and equipment during an emergency.

Item 7 in the corresponding "Communications Interoperability Action Plan" calls for allocation of some of the 700 MHz spectrum be permanently allocated just to emergency responders. Industry Canada is currently reviewing submissions made in response to its call for consultation. Comments are sought on general policy considerations related to commercial mobile broadband spectrum use, competition issues and on the use of the 700 MHz band for commercial mobile services. In addition, Industry Canada is seeking comments on spectrum use for public safety broadband applications. This valuable commercial spectrum is sought after by communication service providers across Canada.

For additional information see the Industry Canada website at

http://www.ic.gc.ca/eic/site/smt-gst.nsf/eng/sf09997.html

One Ottawa participant suggested there should be the ability to prioritize access to services during an emergency, so that first responders could be guaranteed access to the spectrum they need. This 'prioritization' approach is being recommended by northern service providers too, so that they can harness the powerful 700 MHz spectrum for last-mile delivery of robust communication services in the future. In order to use the 700 MHz spectrum, last mile connectivity would have to be installed in every community at significant expense so there is an argument to be made to ensure this spectrum is well utilized at all times.

Networks operating now in the three territories range from legacy designs that have little opportunity for prioritization or traffic shaping to state-of-the-art networks that can identify and prioritize individual packets on a millisecond by millisecond basis. Given state of the art equipment and software, it is possible to turn on and off the access, speed and priority by individual user, type of user, by community or by type of traffic. It is completely possible to divert basic commercial networks for emergency use just like a fire truck can suddenly take priority on an ordinary road.

According to one service provider, with state of the art in communications equipment, there is no reason to build special-purpose communication networks within communities. They believe civilian use of the 700 Mhz asset should be the norm until needed by the emergency responders.

Conclusions for emergency response

Emergency response organizations and communication infrastructure service providers can work together to identify ways to quickly link emergency responders into existing, publicly accessible networks when responders first arrive in communities. Protocols could be developed to request surge capacity, prioritization and access for first responders utilizing local networks, to avoid overloading local networks.

When responding to emergencies, the ability to quickly establish a virtual emergency operations centre is critical to maintain constant communications with various emergency management organizations. This will require the development and testing of portable communications systems that can be deployed quickly in an Arctic environment, and support all forms of communication, linking all responders.

Military participants of the Assessment are interested in collaborating with civilian agencies in finding communication solutions that both help the military and northern communities.

Interoperability strategies apply in the north, and many of the participating organizations are interested in signing onto the interoperability strategy. Northern application of 700 MHz spectrum is important to service providers too, and working with emergency responders, northern solutions can be found.

5.9 Cannot Keep Pace with Technological Change

Rapid technological evolution

As one Yukon participant said "bits are bits". The challenge is to deliver robust services delivering bits properly and ubiquitously. With convergence, it no longer makes sense to separate vendors who provide voice services from vendors who provide Internet services - eventually all will be on the same pipe as IP networks begin to offer robust voice services.

A clear example of convergence is occurring as governments look for ways to move their voice traffic currently on older phone networks to IP telephony systems to save money and access new services.

HRSDC has a national plan to connect Service Canada workers via IP telephony, bypassing old phone systems entirely to provide support to the public.

The Technology Service Centre (TSC) in NWT is responsible for help desk support, connecting government departments and supporting their initiatives, evergreening and planning services. They have recently built a new data centre in Yellowknife that will be available to GNWT departments. When it is time to replace their old phone system, they will be investigating phone services in an IP environment to determine if significant cost savings and improved voice service performance can be achieved.

The Nunavut government's recent awarding of its data services to SSi Micro (an ISP), will eventually see government voice services move over to an IP environment as well, carried on the government's new network. As stated in a NWTel brief to the CRTC (see Section 8.5 of this report , without government phone business as a revenue stream, NWTel will find it increasingly hard to offer phone services in smaller communities.

Convergence is affecting the North - as traditional voice traffic starts to move IP networks, requiring fundamental changes in network design and deployment in a very short space of time.

Changing consumer expectations, networks fall behind

While this report looks at governmental needs to run its services, government also needs the public to be able to connect from homes and businesses in order to interact with government services.

Only a few years ago, there was no YouTube, no FaceBook and no movies on demand. Governments were not relying on robust networks to deliver services, educators were still relying on text books instead of online networks for course material, health care was delivered locally or by flying people from place to place, and elections did not rely on twitter feeds to engage the electorate.

Most importantly, telephones ran on a POTS (Plain Old Telephone System) network, Internet access was provided by an ISP, and television service was delivered on coaxial cable from a cable provider or via satellite to the home.

Today, urban residents are disconnecting their POTS phones, relying more on their Smart phones than their old cell phones, following events on their iPads, connecting with friends over Facebook on their laptops instead of using email, and watching movies they downloaded over their Internet connection on their flat screen televisions. Convergence has arrived. In urban markets, the old phone company is competing with the old cable company to convince consumers to buy all their IP services from them.

So how is this playing out in the Arctic, in a market that does not have the population base to naturally stimulate competition or innovation?

People in Nunavut are using social media tools at an incredible pace, and with job growth expected as mines come online over the next 10 years, there will be an increased call for new communication services for the general public, as purchasing power of the general population goes up.

It will be challenging for network development to keep up with public demand for affordable services in the future.

Government need to connect with the general public

Governments are launching initiatives to engage the public, knowing the people they need to reach may be online.

Various federal agencies such as INAC and Industry Canada need to be able to provide information to the public, and make use of electronic submissions for things like economic development applications. INAC workers in Yukon look forward to better reaching youth via social network sites, as government departments learn to harness social media.

One recent site, at http://www.uranium.gov.nu.ca/ has been launched by the Government of Nunavut in four languages inviting Nunavut residents to provide their input on uranium mining, an extremely controversial topic in Nunavut. The site invites residents to submit their ideas via an online feedback form, email response, toll free phone, fax or to attend a community meeting, with times and locations posted online. Residents can learn more about uranium mining, with links to relevant documents in four languages. This website is a simple, yet effective way to engage residents in topics of great importance. This site assumes the public are connected, and they largely are.

Public health initiatives such as the Inuit Tobacco-Free Network utilizes youth videos produced and posted on YouTube, with links to FaceBook, and an interactive website to reach Inuit youth within schools.

HRSDC has an outreach program where a local federal agent goes to community that does not have an HRSDC office to provide in-person services. They travel with a laptop, but require a fast data connection to interact with databases in Moncton and Montreal.

In Yukon, public health workers regularly need to connect to networks from the field. They need to use publicly accessible Internet points of access to interface with secure databases on the backbone.

Libraries in Yukon are struggling to meet consumer demand, as visitors quickly reach the caps that have been set to keep bandwidth costs under control. Library users are not allowed to stream video or audio of any kind, even in a community with a fiber link, as costs are simply too high.

The demand for more and more services will only continue, with users' expectations and needs evolving, and networks struggling to keep up.

Regulatory regime not moving quickly enough

A number of participants felt the current CRTC model is not working well in the North, as they believe the regulator is not able to move quickly enough to respond to the changing communication realities of the Arctic.

While the CRTC is not as responsive to the rapid pace of change as many users would like to see, it is nonetheless a key player in examining how subsidies, competition and innovation will be stimulated in the Arctic.

As stated on the CRTC website, the CRTC's role in telecommunications policy development is as follows:

> *In telecommunications, the CRTC ensures that Canadians receive reliable telephone and other telecommunications services, at affordable prices.*
>
> *But the CRTC's role in telecommunications is evolving. In many telecom markets, several consumer choices are available. This natural competition results in better prices and packages for consumers. In these cases, CRTC allows competition, not regulations, to drive the market. The CRTC regulates only where the market doesn't meet the objectives of the Telecommunications Act.*

The CRTC is faced with increasing responsibilities in determining how to solve the challenges faced by Northerners in accessing affordable services in not just phone service, but telecommunications on a wider scale.

There are three important hearings that will set the stage for the next round of development in the Arctic, as the CRTC moves forward, gathering and analyzing the submissions they from interested parties across the Arctic.

1. Obligation to Serve and Other Matters (CRTC 2010-43): Submissions have already been made for the Commission to rule on the Obligation to Serve and the Basic

Service Objectives for phone services, asking the question where these obligations apply, and whether or not wireless phone services will be able to satisfy these requirements. The same hearing will also attempt to determine the Commission's role in regulating high-speed access to the Internet, and if there should be a fund associated with ensuring a basic level of service. They also posed the question if it was necessary to evaluate the local subsidy regime currently in place for uneconomic regions. The decision was announced as the ACIA report was completed. This decision may have an enormous impact on Arctic services.

Background: http://www.crtc.gc.ca/eng/archive/2010/2010-43.htm

Decision posted May 3, 2011 at; http://www.crtc.gc.ca/eng/archive/2011/2011-291.htm

2. NWTel Regulatory Framework Hearing: (CRTC 2010-274) In May, 2010, the CRTC extended Northwestel's current price cap regulatory framework without modifications until the outcome of the Obligation to Serve proceeding is known. They will then initiate a review of Northwestel's regulatory framework. This next review and subsequent rulings on NWTel's regulatory framework may have a profound impact on future development of Northern communications.

   http://www.crtc.gc.ca/eng/archive/2010/2010-274.htm

3. Proceeding to Review Network Interconnection Matters (CRTC 2011-206): The third relevant hearing (with submissions due November 14th, 2011) examines the issue of network interconnection, reviewing the local, wireless, and toll network interconnection regulatory regimes. The hearing will attempt to determine what extent existing interconnection regimes can be simplified, what changes are needed to enhance competition, (thus benefiting consumers), and what changes are necessary to ensure technical neutrality. The decisions from this hearing may have a huge impact on competition in the Arctic, as it could change the rules so that new entrants could more affordably interconnect to existing networks and compete to provide services at the last mile, but at the same time, may threaten existing services.

   http://www.crtc.gc.ca/eng/archive/2011/2011-206.htm

Conclusions on technological pace of change

The rapid pace of technological evolution combined with rising consumer expectations across the Arctic has left network operators scrambling without the necessary resources to meet the needs of both government and the public.

Because of the North's small population and large geography, consumers don't drive competition and evolution of service in the same way as southern urban centres. So growth is partially dependant on subsidy frameworks, and regulatory initiatives aimed at ensuring affordable access to consumers.

In order to keep pace with change, the reality of the northern marketplace combined with consumer and government needs must be understood by all players, and ongoing subsidy support and regulatory action must be taken in a timely fashion to ensure affordable services can be developed and delivered to the population.

5.10 Lack of Choice

NCIS-WG members identified the lack of choice of services as a major problem facing them in obtaining services. Respondents to surveys also identified this as a problem, and workshop participants elaborated on this theme, identifying issues such as limited competition, their perception of being served by risk-averse service providers, and their constraints in purchasing software that can operate in their environment.

Service providers who participated in this Assessment also saw challenges in procurement practices, that limited their ability to respond with innovative options, ultimately leading to lack of choice for government buyers.

Limited competition

Currently the North has two suppliers (Northwestel and SSi) that provide services in many communities. A third company (Omniglobe) was attempting to provide services in 3 communities in the NWT but recently filed for bankruptcy. From time to time other small companies come and go. Clearly whether the North has one, two or more network operators, no network operator can survive without contributions from Canada, the territorial governments and/or diversion of southern customer funds through CRTC rulings.

Yukon participants focused on the challenge of working with a monopoly provider. NWTel owns all of the offerings - from phone to cable to Internet service provision to ownership of the backbone infrastructure. Participants recognized that their levels of service were higher than in the other two jurisdictions. However, they were not happy with the lack of competition, as they felt competition would lead to more innovative solutions.

Of all three Territorial governments, the NWT is the only jurisdiction where both major service providers (NWTel and SSi) have offices. Government service contracts are with NWTel, but the GNWT has also supported efforts made to connect the public to SSi's system through support to Falcon, the community champion for the BRAND project.

> *"Rearranging service delivery models in Nunavut is relatively easy compared to jurisdictions with more legacy infrastructure. If people, companies and governments innovate, beta testing can happen overnight. There are lots of challenges to testing products -- but if they work here, they will work anywhere."* -- Kathleen Lausman, Community and Government Services, Government of Nunavut

The Government of Nunavut has taken a different approach from Yukon and NWT, being the first jurisdiction to select a new entrant to provide its critical infrastructure. As a 100% satellite dependant jurisdiction, they will be locating their data centre in Ottawa, and working with SSi to implement a system that takes advantage of advancements in satellite delivered services. There is certainly risk involved for both the government and the service provider.

As SSi becomes an increasingly major provider in Nunavut, it is entirely possible that NWTel may not engage in competition in that region, leaving a monopoly provider in Nunavut too. It is a well-accepted economic principle that a lack of competition leads to a lack of innovation. (See Section 8.5 for more on this concept.)

Lack of risk and innovation

Some participants said it is difficult getting service providers to engage in solving specific challenges facing government departments.

One participant summed up the challenge: "Some vendors are not always interested to go out of their way to meet the needs of the client. They limit what they engage people on… once they determine it won't be a business case, they stop trying."

Customers can expect risk-averse behaviour from operators when a service provider's future depends on the details of how they are subsidized - which is currently an open question. (See Section 5.8 on various CRTC hearings, and Section 5.4 on program-based one-off investments in new networks.)

NorthwesTel is supported on a cost based contribution and will naturally focus on cost control. Assistance provided to SSi so far has been tied to delivery of new services so SSi must focus on new service delivery. Both these companies have significant investment in many northern communities, have extensive employee and personal ties to the North and we should expect both will survive provided assistance continues. Neither could survive in the long term without continued financial investment to provide services in the high-cost Arctic region.

While government users tend to lament what they perceive are risk-averse service providers, it should be recognized that government itself is also a naturally risk-averse buyer. If the main purchaser of services in a given market is risk-averse, they are less likely to pick newer entrants who they perceive as a more 'risky' choice. Some Yellowknife participants expressed concern that by selecting smaller, newer entrants in the marketplace for core services, government would be taking a risk. They worried that going with the "small elephant" instead of the "big

> *"When we are looking to improve a service…we hope the creativity comes from the service provider to solve the problem. We understand that if they can't commoditize a service, they can't deliver it."*
> --- Terrel Hobbs, Technology Service Centre, Government of the NWT

elephant" might be too risky when determining the purchase of critical services.

The focus group in Yellowknife spent a great deal of time discussing the challenge of engaging service providers to take on a challenge. Participants recognized that if a service provider cannot commoditize a service, they simply can't develop and provide it.

Procurement challenge

In the Ottawa sessions, there was a lot of discussion around challenges of procurement. Many federal departments are locked into national procurement processes, selecting vendors for national delivery of services that do not operate in the North. This poses serious challenges in properly connecting staff in Northern communities.

Many of the federal participants said they required more flexiblity in procurement for purchasing services in the North, without having to use the same solution that was selected in a national procurement process - because often times the selected service is not available in the North. Recognizing the unique nature of the infrastructure in the Arctic is required in order to improve choice for federal government buyers.

Arctic service providers also outlined challenges they face in responding to government RFPs. Both service providers participating in this Assessment said that innovation was best stimulated when government procurement focused on their actual business needs and outcomes, rather than prescribed technical solutions. By focusing on outcomes, service providers would be able to offer more innovative solutions that would bring down the cost, and provide better service. Both service providers cited examples where government departments prescribed a technical solution, when there may have been a better, more innovative solution that could have been found if service providers were invited to address the need, rather than just provide a quote using a more prescribed solution.

Procurement officers in the Ottawa sessions recognized the potential of technologically-neutral, outcomes-based RFPs, but pointed out the complexities of properly evaluating bids that are difficult to compare, and may not actually provide the necessary solutions. At the same time, service providers expressed concerns that RFP evaluators are not able to truly evaluate the relative merits of any innovative technical solution.

It is possible for government procurement offices to stimulate innovation through their procurement process. For example, in British Columbia, they use the Joint Solution Procurement Process that uses a more collaborative process allowing the sharing of ideas between potential vendors and the hosting ministry through iterative and joint development of the overall solution. It is more time consuming up front, but can result in long term benefits to both the government and service providers, as they work to develop solutions that reflect a 'win-win' result for the partners involved. See http://www.saip.gov.bc.ca/satp/Joint_Solutions.htm for more details.

Custom applications costly

Communities without adequate access cannot effectively access off-the-shelf centrally managed software systems running on Citrix and Java, that require good connectivity and increasing amounts of bandwidth.

In Nunavut, there are only 33,000 people. Participants in the Iqaluit workshop suggested that one custom-built repository could be built to track key services, events, and data for each citizen, that was designed to run in a satellite served environment. This approach would begin with defining business requirements and build from there, including addressing the inclusion of Inuktitut syllabics within any custom software.

The Department of Culture, Language, Elders and Youth (CLEY) also wants to develop a cultural repository in a rapidly changing Arctic. These files will require significant bandwidth to transfer around the Arctic, and any design needs to take the reality of satellite into account in its architecture.

While custom applications are likely the best option for Nunavut, they can be very costly.

These challenges are most pointed in Nunavut, but certainly affect the other Territories.

In Yukon, IT managers are struggling with the new iPad - as it poses challenges to security if connected to government networks. But this small device may have a huge impact on the development of inexpensive applications for use in the North. There is just one catch - connectivity. The iPad can interface with data that is not resident on the iPad itself, connecting to a server in another location.

According to "Digital Communities" an online newsletter aimed at government IT professionals, the iPad tablet is accruing a legion of fans, from government agencies to police and fire departments. With tens of thousands of iPad apps available, public employees may be able to use these apps to improve workplace productivity and efficiency. In Texas, one government IT manager is experimenting with the iPad app JumpDesktop, a multiprotocol remote desktop client. In theory, a government could virtualize all desktops and manage them centrally, and then give employees iPads and zero clients as their workstations. In the South, this is seen as a cooler, more mobile technology at a lower cost. (See http://www.digitalcommunities.com/articles/iPad-Apps-Government-Workers.html?elq=f2273d2ef8604a518f41f3f9570c115e for more.)

In the North, this kind of change in application development opportunities, access and deployment may reduce application development costs, but will be seriously hampered by network constraints if real-time connectivity is required to operate these types of applications.

Conclusions on lack of choice

In southern markets, consumers drive innovation and choice through their buying power.

In the North, governments are expected to drive innovation through their buying power. But most government buyers are required to be risk-averse and make long term decisions that do not typically allow for rapid technological evolution of networks to meet their evolving needs.

It is unrealistic to expect that government procurement will drive innovation and expansion of networks. However, procurement processes could help improve innovation with some steps, including:

- pan-Arctic efforts to share best-practices in procurement;
- focusing on outcomes-based RFPs that are technologically neutral;
- consider innovative procurement strategies such as Joint Solution Procurement;
- allow flexibility in federal procurement within the Arctic, recognizing the unique infrastructure challenges that are different than the south.

Public demand for more services fuel innovation faster than government buying. Real innovation will occur if financial incentives are put in place for delivering services to the public through competition for subsidies that lead to better, more ubiquitous services to the Arctic public. The public will benefit, and ultimately so will government procurement processes, as the existence of multiple providers may be made possible, leading to more competition and innovation to meet governments' needs in the long run.

5.11 Human Resource Gap

Network connectivity substitutes for human resources

There is a severe shortage of certain types of expertise in the Arctic. There are no Universities in any of the three Territories, there are a handful of small hospitals serving the entire region, very few banks, and a lack of specialized knowledge in all kinds of fields from finance to environmental protection.

Northerners sometimes need to find ways to obtain specialized services from people outside of their communities in order to access some of the expertise or services they need.

People in communities turn to communications networks to link to health care professionals in Whitehorse and Yellowknife and beyond. They obtain banking services over the Internet, and complete university degrees from their homes.

> *"There are not enough people or resources to provide services in person, so we are increasingly throwing technology at it to get around the people resource issue."*
> --- Terrel Hobbs, Technology Service Centre, Government of the NWT

The trend is to increasingly rely on network connections to link to services that would not be available due to a lack of human resources in Northern communities. In other words,

network connectivity substitutes for having human resources in place. In some cases, human resources that used to be in the North are being outsourced altogether.

In the Northwest Territories, the Department of Health is successfully 'outsourcing' certain medical services to available professionals that live outside of NWT, due to a lack of certain health professionals in the Territory. Digital x-rays sent to Edmonton for radiologists' interpretation means that patients in communities with adequate connectivity can take advantage of fast turnaround in diagnosis. Plans to roll out advanced services to those living in satellite-served communities are planned for future implementation.

Human resource shortage in communities

In the area of IT support, participants said that both Yellowknife and Whitehorse are able to attract needed personnel, but other Arctic communities continue to face a dearth of IT support professionals.

> *"We need to acknowledge the capacity levels of community governments, and ensure they have the necessary skills and support in order to benefit from new technologies."* --- Gary Schuarte, Municipal and Community Affairs, Government of the NWT

As NWT moves to conclude devolution negotiations a number of people raised the issue of human resource capacity both in communities and Yellowknife to take on this new challenge. Training will play a huge role in preparation, and robust networks will be critical.

All Nunavut communities suffer from a lack of IT personnel to support information systems, including Iqaluit.

In Nunavut, many of the government positions in Iqaluit and the decentralized communities are unfilled, in a combination of housing shortages and inability to attract and retain the necessary personnel.

In Nunavut, participants reported that it takes an average of 318 days to hire one new person to work for the Nunavut government. Many IT jobs remain unfilled. Turnover is high as well, with some new hires not even staying as long as it took to fill the job.

And many departments, such as Health Education and Municipal Community Affairs in NWT, are planning to deliver more training to employees in their workplaces, making use of advanced communication tools.

Even in situations where human resources are in place, such as Service Canada employees in the three capitals, there is a need to provide training to them while in the North, rather than sending them South for training, because they cannot afford to be away from their work for extended periods of time. Again, people are looking to network connectivity to help solve the shortage of human resources.

"Many northern locations have limited staff and sending these to our southern training facilities is costly, time consuming and difficult without jeopardizing the quality of the service delivered to the local population while staff are away. Increased pressure is coming to use technical systems to facilitate the delivery of training with videoconference and remote training being requested. This implies the need for collaboration tools, two-way conferencing technologies, white board sessions, NetMeeting and others." --- Louis Varin, Human Resources and Skills Development Canada, Government of Canada

Conclusion on human resource shortage

Communication networks can solve some human resource challenges in communities for improving training opportunities for local staff, as well as providing connectivity to the expertise required in other locations.

When designing and building communication networks, it is important to recognize the existing capacity of the people who are already living in communities, and ensure systems can be maintained with local support. Successful network managers will avoid installing systems that require high levels of narrow expertise to manage and maintain locally, as it is expensive to put IT specialists in communities on a permanent basis.

Designing systems whereby local people can learn the basic maintenance and support roles will allow local people to grow into the jobs, and evolve their skill levels over time. Corresponding training for network support people in communities can be delivered as needed, even using communication tools for distance training.

Objective B: Future State

6 Government Future Needs

All governments are looking to take advantage of advancements in communications technology and services to improve and enhance program delivery, and to connect to people working on the land between communities.

This Chapter lists some of the trends identified by federal and territorial participants regarding their future needs.

Each section also provides a listing of some of the initiatives and needs participants highlighted while participating in the workshops or in the online survey. It was not possible to gather every single initiative and future need of every government department operating in the Arctic in the time frame of this report. *The list of initiatives and needs are not comprehensive.*

These listings are provided with the intention of highlighting the wide range of communications needs and initiatives being considered by some departments serving the Arctic, so the reader can get a sense of the road ahead, and the challenges departments face, and some of the efforts being made to improve communications for the future.

6.1 Federal Departments Serving Territories

All federal departments struggle with implementing services in the Arctic that comply with national service standards. Whether they are attempting to serve the general public, communicate with head office, coordinate with other government departments, or connect on the land, there are a number of trends in communications that were brought forward in the visioning workshops and in the online survey.

Online service to public

A major focus at the federal level is for increasing use of online applications for public use, in an effort to bring more and better services to the public. This of course, will necessitate improved connectivity in order for the public to have access.

Real-time access to databases

In terms of program delivery at the federal level, the march of progress continues, regardless of whether or not the territories can keep up. Increasingly, federal government employees require real-time access to databases that are tuned to run on a fiber backbone in order to work. This trend will only continue.

Many federal departments tasked with serving the Arctic try to conduct the same operations and offer the same services to the citizens of the Arctic as they do for all citizens across Canada. As one federal participant noted, the challenges of the North should be accounted for in all federal processes but are often overlooked or ignored.

More field operations

For departments that require connectivity between communities, such as military, Environment, Public Safety, Coast Guard etc, there is a renewed call for improved coverage and bandwidth options for field support activities.

Mobile communications

The increased and ubiquitous use of mobile communications by federal employees in the South necessitates a significant investment in infrastructure for northern employees to keep up. As well, when southern-based federal employees travel to the North, their BlackBerries do not work in the vast majority of the northern communities. This will only get worse with time, as there is no current business case for installing the latest cell network technology in either the larger or smaller centres in the North.

Social networking to reach the public

Finally, a number of northern federal staff raised the need for the federal government to learn to use social networking tools to reach the public. We can expect to see these kinds of initiatives start to occur in the next few years, and there will be a corresponding need for improvements to public networks as the general population connects to these new services.

New federal needs, programs/applications

The following list of possible applications and programs is *not an exhaustive list*. Data was compiled from surveys and comments collected during the visioning workshops. This list is intended to demonstrate the breadth of applications presented by departments at an ACIA workshop or in a survey. Appendix C itemizes some of the specific computer applications planned for the future.

Citizenship and Immigration --- Looking at enhancing and expanding client service by moving to electronic-based services, virtual learning, and options for online self-service. Enhancing accessibility to their applications, allowing people to make electronic submissions, and accessing updates on the status of citizenship/immigration (application) processing.

Canadian Coast Guard --- Must match eNavigation being implemented internationally by all maritime nations, matching how maritime nations offer services to marine industry digitally including the Arctic. They will also have to maintain their legacy systems to ensure ships with older technology can continue to use navigational aids.

Corrections Services Canada (CSC) --- Offenders need to be able to contact their families while away from their community - to maintain their connections to their families. Improvement in videoconferencing is required in Arctic regions. CSC is looking at strategies, like telehealth, to address this need.

Department of National Defence (DND) --- There are many new initiatives being considered. This is a non-comprehensive list.

- Looking at development of a Northern Port. Anticipate expansions in current military locations, including Nanisivik port, Alert, Fort Eureka (shared with link with Environment Canada) Forward Operating Locations in Inuvik, Iqaluit, Rankin, and Yellowknife, and training facility in Resolute Bay. All sites will need increased communication capacity.
- Operation Nanook will be experimenting with implementing a cellular network using equipment installed in balloons (for example to respond quickly in the event of a Major Air Disaster)
- Winter warfare centre is being set up in Nunavut.
- Unmanned Aerial Vehicles (UAVs).
- Real-time maritime surveillance in next 3 to 5 years;
- Polar Epsilon project. uses information from RADARSAT-2 to produce imagery for military commanders)
- permanent ground station in the North (Federal Ground Infrastructure for Satellite missions, like Norway's Svalgaard, location to be determined, allows for monitoring data in real time)
- better support packs for Canadian Rangers.
- Improving ship and aircraft terminals.
- Need to be able to perform (interoperable) ship-to-ship communications.
- Iqaluit, Whitehorse, Resolute Bay sites to have improved communication links back to National Defence HQ.
- Need ability to prioritize service in an emergency.
- HF radio technology is evolving into sites and stations that can be remotely operated. This evolution is generating two types of system connectivity requirements. Inter-site (intra-community) connectivity is required between transmit, receive, and control sites that make up each station (resident in a community such as Yellowknife). New HF radio systems have tighter delay and latency tolerances than previously permissible.
- From Canada Command's perspective, sharing of classified and unclassified information between DND and the other Government Departments, and key stakeholders, in both voice and data forms, is the desired end-state.
- Rangers need better connections to maintain communications with them while on patrols --- with 58 patrols, and 1,000 additional Rangers to be recruited. (Rangers call in using a satellite phone once every 24 hours --- usually around 7 p.m. If that call is missed, usually have to wait 24 hours before the next communication --- too long to wait if there is a problem).
- Need to improve tracking devices. Military units are pushing farther and farther out from communities.
- Looking for smaller communications equipment, capable of communicating over bigger bandwidth, at smaller cost. Looking at transferring information from small

reports to imagery (e.g., photos from a disaster). Cannot afford to lose connections during transmission. Losing connections could mean losing files.

Environment Canada --- Examples of some future initiatives include:

- Implementing an Environment Emergency Management System (E2MS) into a northern site. E2MS should provide one common set of tools for regional environmental emergency teams, one system for recording information, and be able to leverage data and services of participating organizations (e.g., the Canadian Geospatial Data Infrastructure (CGDI) and the Open Geospatial Consortium, (OGC). Data included in system should include incident data, imagery, thematic data, and model data, presented as layers. They are also looking at engaging in remote sensing for scientific and other purposes, which would involve small packets of data transmission.
- Need to collect more data re. weather and other information from the field for communities and for resource companies. (Weather and land are more unpredictable than in the past; hunters and trappers need more weather predicting between communities, not just in communities).
- Iceberg tracking, using beacons.
- Collaborating with DFO on a new geological navigation and weather program.
- Coordinating with Canadian Space Agency.
- Collaborating with DND and Coast Guard in areas of environmental emergency, especially in Beaufort Sea (e.g., oil and gas).
- Staff in the field need to be able to access information from centrally-located websites.

Fisheries and Oceans --- This department plans to implement office conferencing/collaborating tools, complemented by (electronic) document management as a means to reduce paper and the number of servers required. They also have a GIS project on the horizon.

Human Resources and Skills Development Canada --- In order to answer the obligation to deliver services in remote locations, currently have employees traveling to remote locations have to set up temporary offices in local facilities like communal centres using the local ISP (when available) and VPN. There is a need to find a transportable solution --- wireless, satellite or other, that would be fast, cost effective, and offer a two-way network performance that allows corporate applications to run efficiently.

Indian and Northern Affairs Canada --- Some examples of future plans and needs include:

- Would like ability for citizens to access application forms online.
- "status cards" coming into effect within communities --- will need ability to process/provide support at community level.

- would like to be able to use social media and cell phones as a means to reach youth.
- Is developing a map-staking application. (Would like to make this application available/accessible for use anywhere in the world.)
- Development/installation of a Canadian High Arctic Research Station (new hub) in Cambridge Bay within the next 5 years.

Industry Canada --- Like many federal departments, Industry Canada is providing more online services, and want to ensure northerners can utilize these services equally. They also want to ensure companies in the North participate in spectrum auctions.

NavCanada --- Planned improvements to management of weather data collected in collaboration with Environment Canada include many projects, such as:

- installing 100 new weather observation sites, and need the ability for this information to be received at various sites, independent of Environment Canada.
- The Human Weather Observation Service (HWOS) will increasingly be automated, to be completed in 5 years. Human resources will continue to be used to report on cloud height and visibility.
- NavCanada will add their equipment to DND's 38 air surveillance sites.
- NavCanada is installing cameras in numerous sites (when it's dark out, they don't see anything; in daylight can see the runway). Need communications to transmit camera data.
- Installing cameras at AWOS (Automated Weather Observation System) locations. Where there is human presence, cameras are not planned to be installed. Because of the limited daylight in some communities, not necessarily a business case to install cameras everywhere.

Public Safety Canada --- The Arctic Regional Office new initiatives and needs include:

- Need deployable option so that hotspots could be created in remote areas for emergency management personnel. New hardware, like the Canadian Space Agency Ka-band dish, is small enough to be transported easily, and offers sufficient bandwidth to supply a team with both voice and data. Combined with technology like Voice over IP, DMVPN routers and wireless equipment, a hotspot could be created with all of the essential services, including connectivity back to the home department, internet access and BlackBerry data and voice communications.
- Thin client web based applications like Citrix and OWA should be used when possible to conserve bandwidth. Need to ensure remote accessing equipment can utilize these applications in all three territories.
- The office-to-go kits maintained by the EMNS offices should be re-evaluated, and the equipment updated. As well, new equipment that would give basic communication ability, configurable without the aid of an IT technician, should be added.

- Create an IT working group to further investigate technologies that can be used in times of emergency, as most of the standard equipment used by Public Safety won't work during an emergency due to local infrastructure being insufficient or unavailable. Equipment should be picked for its ability to tie into a variety of underlying infrastructures, as each region supports a different set of technologies. Further, shipping equipment is costly and unpredictable, so small, mobile technologies that can be moved with the responders should be used whenever possible.
- Create capabilities for a Virtual Emergency Operations Centre (VEOC) in order to utilize latest communications technology for timely and efficient operations with emergency management partners. Many federal partners do not reside in the North –therefore many events are coordinated and responded from a distance from northern and southern locales. Robust, deployable equipment is required to ensure that we can stay connected in an environment where communications infrastructure is fragile.
- Utilize Geographic Information System (GIS) related technology to increase situational awareness, risk assessment, planning, logistics, operations and communications efficiencies.

RCMP --- The RCMP is working to upgrade their mobile telephony in all communities. New initiatives include:

- High-Speed Downlink Packet Access (HSDPA), an enhanced 3G mobile telephony communications protocol to help have higher data transfer speeds and capacity.
- a digital radio architecture that will allow RCMP to add encryption, better meet policy, and meet members' needs.
- Working on Multi-Protocol Label Switching (MPLS) upgrade to high speeds in many areas, as a means to speed up the flow of traffic on their network by making better use of available network paths. Switching all to Cisco VoIP systems. Security will be video over IP.
- Doing a full switchover from Novell to Microsoft, including modern server upgrades in all communities, server virtualization, adding senior radio personnel and looking at bringing back more senior radio people.
- Requires more cell coverage with latest technologies.
- Infrastructure funds would be available if the RCMP installs a dedicated satellite connection for the VOIP project.

Canada Space Agency

- Assessing installation of an imaging station (110 Mb/s continuous to Yellowknife, Inuvik, and all uploaded to E2MS. (Canadian Centre for Remote Sensing, Canadian Space Agency, and other agencies involved.)

- Polar Communications and Weather (PCW) Constellation Mission (with Environment Canada and international organizations) --- to help imagery needs for latitudes 55 to 90 degrees, to provide reliable communication and navigation services to ensure security, sustainable development, safety of air and marine navigation, and Arctic science, and to provide meteorological data.
- Canadian Centre for Remote Sensing --- Implementing new dishes in Inuvik satellite facility. One antenna can bring down half a terabyte of data a day. Need a communication link (at least a 500 Mb fiber link) to bring data south. Fiber link must not be subject to Patriot Act (i.e., not flow through U.S.) Some of the data is time-critical. Non-critical data is shipped now through Canada Post.
- Experimenting with portable KA-band dishes.

6.2 Yukon

A robust tourism industry, a relatively developed road infrastructure, and a largely terrestrial communications infrastructure all help to define the next few years of communication needs and investment in Yukon.

The majority of the population in Yukon live in Whitehorse, along with government workers, yet participants in the Assessment made it clear that communication services to communities need to be increased in order for everyone to properly benefit.

This listing of trends are focused on showing what is unique about Yukon, but certainly many of trends listed in NWT and the federal agencies also apply to Yukon.

Better connectivity along the roads

Yukon has cell phone service in all of its communities today, but not between communities. With a great deal of road traffic (tourists, community members, students on school buses and government workers such as home care providing support to the smaller communities), there is an increased need for cell service along highways for safety purposes. They also collect data from telemetry stations installed along the highways, with ice sensors, wind, and weather data being collected and fed back to a 511 service for real-time weather and road conditions.

Better continuity of service between communities and backbone

There is a great deal of concern around improving continuity of service after fiber cuts and other terrestrial failures in the middle-mile infrastructure linking communities to the Internet backbone. It is likely that Yukon will be investigating fail-over services and redundant link options to develop back-up options to their largely single-line terrestrial system, as they become more and more dependant on advanced communication services.

Keeping pace with southern networks

A vibrant expanding economy, increasing consumer wealth and demographics that mirror southern Canada, Yukoners are looking to engage in rich content and video capabilities, just as urban dwellers in southern Canada. This expectation of parity to the south is important for realizing educational, economic and lifestyle opportunities for the residents of the territory. This expectation will help to drive attempts to deliver better services that help the territory achieve service parity with the South.

Increase services for all

New government services enabled by technology need to be available to all communities - particularly in health, education, and justice. There are also calls for more self-service, where citizens are able to effectively interact with government services no matter where they live.

Improved emergency response

Fire, land, wildlife and emergency services in Yukon are continuing to improve their emergency response capabilities via improved communications options. This trend is expected to continue as the Yukon government focuses on preparations for large-scale emergencies such as earthquakes.

New Yukon needs, programs/applications

The following list of possible applications and programs is *not an exhaustive list*. Data was compiled from surveys and comments collected during the visioning workshops. This list is intended to demonstrate the breadth of applications being considered by various departments in the Yukon that submitted their thoughts to the Assessment team either at as workshop or in a survey. Appendix C itemizes some of the specific computer applications planned for the future.

Education --- The department is working to integrate more communication tools into the education system, with initiatives such as one (computer) device per child, interactive whiteboards, and wireless for the Department and services it provides. A list of some of the newer initiatives includes:

- Interactive whiteboards on the network (new)
- Wireless for staff on YESnet network Whitehorse (18 sites) and the communities (13 sites)
- Wireless capacity for Dept. of Ed Administration (near future)
- Student wireless for YESnet network (near future)
- Remote desktop support with video and voice (YESnet, video only for Ynet)
- Labour Market Development Assistance project is moving forward (to be completed by March 31, 2012)
- New school bus system (implementation over the next 6 months. Ultimately will allow for parents/students to view bus routes on web site)

- New school, (FHC school construction in 1 or 2 years)
- 1 device (iPad/laptop) per child (near future)
- Student Financial Assistance - systems upgrade to a web app (near future)
- YG SharePoint (near future)
- Podcasting of educational content

Emergency Measures Organization --- They plan to improve their ability to manage fire emergencies from remote (central) location, and need the ability to link all responders in an emergency/catastrophic situation, improving disaster management through communications enhancement.

Health and Social Services --- This department relies heavily on communications infrastructure for many services in social services for income support, alcohol and drug services, home care, patient safety, emergency medical services including the extension of hospital services to smaller communities, by relying on the transfer of digital data. Some new services include items such as:

- eHealth Project - Interoperable Electronic Health Record (iEHR) supporting all Yukon Communities:
- Lab, Drug, Diagnostic Imaging Information Systems
- Point of Service Integration (Infoway HIAL model), Patient Health Record Viewer
- Client and Provider Registries
- Physician & Community Nursing Electronic Medical Records
- Two new Hospitals in Watson Lake and Dawson City
- Advanced Hospital Clinical Systems Project:
- Bedside Medication Verification, electronic Medication Administration Record, positive patient ID/clinical barcoding
- Electronic Clinical Documentation, Provider Order Entry
- Surgical Services Management, Emergency Department Management
- Integrated case management system to support social service program delivery
- Panorama Health record system

Intergovernmental Affairs -- Ability to meet without need for distance traveling; interest in use of Skype-like applications. Ability to connect and exchange information with other countries.

Justice --- There is an opportunity study underway to assess Video Conferencing requirements over the 1-5 year timeframe. Video conferencing could add significant new services throughout the territory such as video remand court, video visitation (inmates), case conferencing, JP training, etc. Court Services has used video conferencing for the past decade but there is a growing need for improved and additional services. Also, with

the advent of the new jail in Whitehorse, there is a large expectation for VC services for that program.

Public Libraries --- Libraries predict that in the coming years, Wi-fi connections will become the dominant mechanism used by library patrons to access the web in all community libraries. Libraries will also be bringing in more eResources such as e-books, database access, social networking and media (growing demand). They also provide access throughout Yukon to their library database and related functions (circulation system to loan materials).

Yukon College --- The Distributed Learning Department utilizes a wide variety of educational technologies and media to provide convenient access to College programs and services, regardless of a student's location, schedule or other commitments. They will continue to expand distance learning, making use of computer conferencing technologies such as Adobe Connect, Teleconferencing, Video-conferencing and email and on-line portal and Learning Management Systems available through student desktop computers, laptops and portable communications devices.

6.3 Northwest Territories

While many of the trends in the NWT are similar to Yukon and federal agencies, we have focused on trends that were raised in the workshops and surveys unique to the NWT.

With 10 fly-in communities that rely on satellite and uneven access to communication services within the territory, it is not surprising that many of the departments expressed an interest in finding ways to use communication technologies to improve access to all kinds of services that can be enabled by better communications.

More services to the edge

From being able to pay your water bill online, to registering your hunting licence, departments want to improve access to the very edge of the public network, providing interaction with government services right to people's homes, particularly in communities outside of Yellowknife.

More parity among communities to access programs

Many communities need much better access to take advantage of programs and services that rely on better connectivity to operate, from health care initiatives and access to specialized education courses for youth, to adult training programs targeted to municipal workers. With devolution on the horizon, the urgency to address parity of access for all communities to learning, services and opportunity only increases.

"Substitution" using technology to link to necessary human resources

With an actual physical shortage of people to do specialized jobs, NWT departments are implementing various communication services that link specialists to provide a service that would traditionally be done infrequently in person at huge costs. They see

communication technology as a tool that can help to drastically improve access to all manner of services into the more remote communities in NWT, and this trend promises to increase as they realize success with programs like Telespeech, analysis of digital x-rays and distance education initiatives.

Using communication tools to offset travel costs

Many government employees travel long distances by road or air at significant costs simply to attend a meeting that could be done effectively by videoconferencing.

Land and resource management

With devolution, the GNWT will be required to take an increasingly larger role in the management of the land and resources. The collection and dissemination of data collected in the field, and safety for those operating in the field are just some of the issues to be tackled as the GNWT gradually assumes additional land and resource management responsibilities from the federal government.

Human capacity in Yellowknife versus communities

Participants look to better communication networks as a fundamental requirement to enable needed training, support and options for those living in centres outside of Yellowknife, as they take on new and important roles in managing the future of their communities and regions. With over half the population of the NWT located outside of Yellowknife, there is a need to increase capacity-development opportunities for those living in communities.

New NWT needs, programs/applications

The following list of possible applications and programs is *not an exhaustive list*. Data was compiled from surveys and comments collected during the visioning workshops. This list is intended to demonstrate the breadth of applications being considered by various departments in the NWT who submitted their thoughts to the Assessment team either at as workshop or in a survey. Appendix C itemizes some of the specific computer applications planned for the future.

Aurora College --- The College would like to increase their capability to offer distance education in the smaller communities, and to communicate with southern partners through software programs such as elluminate. They also wish to better connect with students who are on practicums located outside of Yellowknife.

Education, Culture and Employment --- ECE is planning an SIS program to be delivered over Internet and thin client, with up to 8,000 users expected, to be launched in 2011. Because of latency and bandwidth challenges in satellite served communities, ECE has two standards they deliver via network, Internet or telecommunications. They are continually exploring alternatives such as upgrading hardware using thin client and virtualization, replication of databases, mobile apps and other options as they become

available. Education IT see challenges in satellite-connected communities as the single biggest issue they have in developing new services.

Health and Social Services --- They are actively implementing new technology that aims to improve service delivery to patients throughout NWT at lower costs. Some examples include (to name a few):

- increased telehealth for specialist connections;
- better electronic record management through PACS (Picture Archiving and Communication System);
- increased computing radiography rolled out in all communities; plus
- Telespeech projects in schools that link students by videoconferencing with speech therapy services for all communities.

Environment and Natural Resources and Industry, Tourism & Investment --- Initiatives and needs include:

- Would like to offer self-service online to consumers, such as applying for and receiving hunting and fishing licenses, online renewal of licenses, applying for ITI grants and contributions, and applying online for funding for small business. Would like to use data collected online to evaluate the effectiveness of ITI grants and contributions.
- Have an initiative underway related to information consolidation and management associated with land management and resource management, intended to help "tear down" the information silos and provide greater support to decision-making. This initiative will require large data sources to move over the networks, and land management decision making tools (to help understand future impacts, cumulative effects, regulatory, government position as to whether a diamond mine should go in or not.) This is not about asset management, as it is more about economic development, sustainable development, wildlife, forestry impacts, etc. GNWT has a small role in these areas, but with devolution, it will have a bigger role in land management.
- Would like to increase the use of videoconferencing as a means to offset travel (and travel costs), to allow government to be in greater touch with regional operations, and improve communications without the travel costs.
- Needs to improve collection of environmental field data toward a research ability to move away from paper-based studies and field notes (i.e., collect and load data at source instead of paper-based while in field).
- Need to be able to move "rich" content (e.g., GIS web mapping, video, consolidated information holdings) to decision-makers and the public (clients) in a timely fashion.

- Bioresearch taking place in the field is likely to occur in between communities. The hope here is to have the ability to capture that information in the field and transmit it (i.e., collect at the source, store, and upload; or, cache and forward when returning to a community base). Most of this information is not critical, other than that collected during emergencies.
- Pipeline: near shore/off shore - need infrastructure to respond to an event like the oil disaster that occurred in the Gulf of Mexico. How do we protect ourselves, by having the telecomm infrastructure to monitor and respond to pipeline activity and to support emergencies.
- Satellite receiving station: Inuvik has a satellite receiving station - if it is going to grow, there will be a significant upgrade required for data transfer.
- Remote data collection will increase. Increases in development activity will increase potential for major releases of contaminants into the environment (e.g. oil spills). Gathering information on these events and planning and coordinating responses will require reliable and robust communications systems. Bandwidth will be necessary to stream data and video, linking to remote locations, and capacity to maintain such systems.
- Would like to allow for social networking to engage public for conservation education and wildlife management issues, and allow the public to apply for wildlife research permits online and receive recommendations back from communities on the permits.

Municipal and Community Affairs --- MACA needs to be able to deliver modular training online to community government staff to assist in community capacity development, and to engage the department's clients in remote communities more actively. Looking forward to the day they could offer online university training to people in communities.

Public Works and Services --- On of their goals is to facilitate general public access to their government account statements so that people in all communities can make online payments for goods and services rendered.

Transportation --- Need to provide additional connectivity in remote areas, especially along highways. Using cellular or satellite is required for improving highway maintenance as well as for public safety. Need to access applications for managing highway construction.

6.4 Nunavut

There are many unique features to Nunavut that means that some of the communication trends are unique only to Nunavut. Some of these features include:

- A decentralized government;

- a uniquely young population;
- many Inuktitut-speaking residents;
- a widely distributed population across the territory (with 11 communities having more than 1,000 people - large by Arctic standards);
- no roads, and 100% reliance on satellite;
- an upcoming boom in mining that through Inuit Impact and Benefit Agreements must strive to provide real jobs to local residents;
- the impending government switch to a new communications service provider.

These realities in Nunavut help to define the communication trends in the future.

This listing of trends are focused on showing what is unique about Nunavut, but certainly some of trends (more services to the edge, access for all communities etc) listed in NWT, Yukon and the federal agencies also apply to Nunavut.

Common future needs identified in the workshops in Nunavut include:

Decentralized government operations improvements

The GN's move to a newer communications system will allow them to implement more bandwidth-hungry applications that were purchased or customized for Nunavut. The future trend is for more applications to be implemented for internal government operations that in the past would not work well on an older architecture. Because of weather and traveling challenges, Nunavut will likely see more meetings/collaboration through video conferencing, and messaging --- especially in emergencies.

Distance education, health, justice connections

From E-health records and Grade 12 biochemistry, to bail hearings and counseling, government departments are planning for a more robust communications system that can support videoconferencing-style communications to provide services that are either not available or only available intermittently at huge costs by flying people around.

Commerce in communities

Tourism, the arts industry, film, and businesses of all kinds are encouraged and supported by various Nunavut governmental agencies in efforts to help stimulate the private sector in all Nunavut communities. We can expect to see continued efforts from government to help support commerce in communities through new communication tool initiatives.

Language needs

Relatively recent efforts to develop online Inuktitut language tools (such as the Tusaalanga online Inuktitut learning site at http://www.tusaalanga.ca/) and learning materials will continue to flourish as Nunavummiut push for Inuktitut and Inuinaqtun language services. All government departments also need to access and collaborate with

translators online to help translate documents into Inuktitut, Inuinaqtun, English and French, necessitating robust connections to the homes of people living all over Nunavut. There will be a need to ensure computer programs of all kinds can support Unicode for the effective use of Inuktitut syllabics.

Connecting to southern services

With a clear shortage of human resources in Nunavut, and a close relationship with federal funding (over 90% of the Territorial budget is from Ottawa), and a data cetnre based in Ottawa, Nunavut hopes to take advantage of shared-services with federal agencies and other provinces where appropriate.

Nunavut new needs, programs/applications

The following list of possible applications and programs is *not an exhaustive list*. Data was compiled from surveys and comments collected during the visioning workshops. This list is intended to demonstrate the breadth of applications being considered by various departments in Nunavut that submitted their thoughts to the Assessment team either at as workshop or in a survey. Appendix C itemizes some of the specific computer applications planned for the future.

Community Government Services --- The LAN/WAN project, initiated in 2007, aims to create smooth, fast, reliable and effective communications and connectivity between the communities and government agencies. Through a bid process, a contract was awarded to Broadsky Communications Ltd., (a wholly owned subsidiary of SSi) to assist GN in implementing a new network with the following capabilities:

- Better stability, reliability and faster communication across the territory.
- Seamless email and data communications.
- Reliable and secure Internet access for all government agencies.
- Multi-layer video conferencing between major government agencies across major southern cities.
- Voice over IP as a potential Phase 2 implementation.
- GN switch from NWTel to SSi.
- Relative large WAN upgrade will be using satellite technology to connect the 25 communities.
- Main data centre will be hosted in Ottawa.

Culture, Language, Elders and Youth--

- every document needs to be produced in all four official languages used in the territory, requiring robust communications with translators located in many different communities from their homes;
- There is an increasing need to transfer files, with files getting larger, so bandwidth must increase proportionately;
- Need to facilitate collection of information from the public through online means.

- Need to create a repository/database of Inuktitut and Inuinaqtun terms used for standard communications across Nunavut;
- Need to develop an online cultural repository that can be accessed from all communities.

Economic Development --- Need ability to market and provide services to visitors through online communications. They also need more opportunities to enhance the arts and crafts industry, which has global interest and presents a significant opportunity for economic development. With banks in only three communities, there is a need for improved online commerce and communication for business.

Education --- The Department plans to use distance education tools to provide a broader range of academic courses to smaller schools, and to offer professional development for staff across the Territory.

Health and Social Services --- An eHealth project is in progress, with one community piloting a rollout. eHealth is a very important project for the communities due to the lack of physicians and cost of travel. Health is also in the process of moving to electronic health records (EHRs)

Human Resources --- HR needs to move to an online self-service system with a direct tie to Payroll system for internal employees.

Nunavut Arctic College --- Further development of distance learning (from/to 3 main campuses of Nunavut Arctic College, plus facilities in every community). They need a repository for education material, including materials on curricula, professional development, language development, with a need for access to this information in all communities.

7 Technical Future Needs

7.1 Introduction

The aim in this chapter of the Assessment is to predict how much bandwidth will be required in the Arctic, by community, to meet the future needs of government.

These projections are based on information gathered from the workshop discussions and responses to the ACIA survey, and simply provide a starting point for projecting bandwidth needs in the future. The data gathered during the short phase of this Assessment does not represent every initiative planned across the Arctic.

Predictions depend on accurate data being entered into a prediction model that will provide a guideline for planning. Of course, because predictions are based on assumptions in the future that may or may not turn out to be true, they are, by their very nature, inexact. But they do provide a starting point for discussion.

Section 7.2 describes the ACIA bandwidth prediction model developed for this part of the Assessment, in detail. It indicates the assumptions made in the many variables and explains the data input values.

Section 7.3 provides charts, divided by territory, indicating the specific amount of bandwidth required by community, based on the inputs to the ACIA Predictive Model.

One can easily see from Section 7.3, the gap between what is available now, by community, and what will be required in the future.

7.2 ACIA Predictive Bandwidth Model Development

In order to develop a model that can be used to estimate the amount of bandwidth required for a given community there are several components that need to be calculated or estimated. The next section called "defining variables" provides a complete list of each variable used in the model. Then each variable is described in detail, and provides the data used in the prediction model.

Defining variables

Knowing what applications people will use, how often they will use each application, where they use it, what time of day, and how long each application is used are just some of the variables that go into predicting how much bandwidth will be required to serve a specific community.

This section (7.2) of the report will provide an explanation for each of the variables used to predict the bandwidth that will be needed by each community.

If governments wish to refine their bandwidth predictions further based on additional data, the ACIA predictive model tool is posted at www.aciareport.ca.

The following table describes each of the parameters used in the ACIA predictive model including the variable name and whether the value is estimated or calculated. The remainder of this model explanation is provided throughout this section.

Parameter Description	Variable	Calculated/ Estimated
Inbound bandwidth required for a given application category	Bai	Estimated
Outbound bandwidth required for a given application category	Bao	Estimated
Number of applications for a given application category by user base	A	Calculated
Number of concurrent sessions for a given application category	C = n*L/T	Calculated
Length of the average day that an application category is used in minutes	T	Estimated
Average length of a given session for a given application category	L	Estimated
Number of users utilizing a given application category on a typical day	n=U*Pu	Calculated
The total number of users of a given type of application within a given community	U	Estimated
Percentage of users using a given application category on a given day	Pu	Estimated
Percentage of applications of a given category used on a given day	Pa	Estimated
Inbound bandwidth required for a given application category for a given user type within a community	IB	Calculated
Outbound bandwidth required for a given application category for a given user type within a community	OB	Calculated

Variables "Bai and Bao": Defining inbound and outbound values by application categories

Some applications like email, are not particularly sensitive to latency or heavily loaded networks, while other applications are very sensitive to any interruptions in the flow of data, such as videoconferencing.

In order to better predict the network resources required to support planned applications, the ACIA predictive model categorizes each application according to a common set of criteria. Each application is categorized as either 'casual' for less sensitive applications, 'critical' for more sensitive applications, or 'additional service categories' for specific applications.

Each of the inbound and outbound values listed beside each category of application represents the minimum Quality of Service (QoS) required per concurrent session. This provides us with all of the required values for ***Bai*** and ***Bao***.

The Casual Category includes applications such as email, web browsing, instant messaging, and other similar applications. Each of these "casual" services has an underlying design that can deal with uneven bandwidth, and can do so without truly impeding function or usability. To ensure some base level of functionality for casual services a "QoS" value of 128Kbps has been used.

'Casual' Category	Inbound (Kbps)	Outbound (Kbps)
Intranet	256	
Internet (work)	256	128

The Critical Category includes voice connections, live business video, and business related media streaming or file transmission, not including email. These categories require a minimum Quality of Service (QoS) level in order to function properly.

For critical services, QoS must be provided at all times, even during peak loads. For each of these services a QoS value for inbound and outbound bandwidth has been assigned based upon industry published standards. The following table describes the QoS for each of the critical services.

'Critical' Category Service	Inbound(Kbps)	Outbound (Kbps)
VoIP	90	90
Streaming video	256	
Video conferencing	512	512
Client/Server	256	256

These values represent the QoS bandwidth requirements per concurrent session. To estimate the total inbound and outbound bandwidth needed at any given time for a critical service the values above must be multiplied by the expected number of concurrent sessions.

Additional service categories (in addition to 'critical' and 'casual') were also used in the ACIA predictive model:

- Education – applications used to deliver rich content to students.
- eHealth – this is the eHealth application that would be deployed to remote communities to be used for remote diagnostics and examinations. This is a single application.
- Internet (population) – Internet browsing and email for the population of the community. (While public users were not part of this Assessment, in predicting community usage, it is important to include the public as a draw on the networks servicing the community. The model uses the 256 kb/s inbound and 128 kb/s outbound for end users – a low figure that will surely rise.)

'Additional Service' Category	Inbound (Kbps)	Outbound (Kbps)
Education	512	512
eHealth	512	512
Internet (population)	256	128

Variable "A": Number of applications for a given application category by user base

Specific data was collected from a wide range of government participants in this Assessment. Various departmental representatives were asked to submit information about the actual applications they were currently running and planned to run in the next 3 to 5 years.

Data was submitted by federal, NWT and Yukon government participants. In Nunavut, application data for all departments was provided directly by Community and Government Services. A summary of these applications are in Appendix C.

These counts are not an exhaustive list of every single application, but are used to provide a starting point based on data collected as part of this Assessment.

All applications identified through the completed surveys and workshops were captured into a consolidated dataset. Each application identified was then grouped by which government planned to use the application. Four user groups were identified:

- Government of Canada
- Government of Nunavut
- Government of Yukon
- Government of Northwest Territories

A count of applications within each category, separated by user group is below.

To predict needs in the future, this table includes both applications being used now plus applications planned for the near future. Note: the number below only include applications that were identified in the course of this assessment -- it does not reflect every application being run or planned in the Arctic.. This provides us with all of the required values for ***A***.

Category	Application Count			
	Federal	**Nunavut**	**NWT**	**Yukon**
Intranet	28	4	64	11
Internet (work)	1	1	1	1
VoIP	1			
Streaming Video	1	1	2	
Video Conferencing	2			1
Client/Server	32	35	70	17
Education				1
eHealth		1	1	1
Internet (population)		1	1	1

Variables "C = n*L/T": Calculating concurrent sessions by application category

The next calculated parameter is the estimated number of concurrent sessions for a given application category. In order to calculate this we assume a Poisson distribution for members of the user community connecting to a given application category over a given time period. The formula for the Poisson distribution is:

C = n*L / T

In order to calculate the number of concurrent sessions, ***C***, we first estimate the average length of a session, ***L***, and the length of a typical workday that the application category will be utilized, ***T***. The following table provides the ***T*** and ***L*** values, in minutes, for each of the application categories used in our model:

Category	L	T
Intranet	10	480
Internet (work)	10	480
VoIP	3	480
Streaming Video	10	480
Video Conferencing	30	480
Client/Server	10	480
Education	60	300
eHealth	10	720
Internet (population)	20	960

As indicated these are estimates and as such are relatively subjective. Manipulating these numbers will impact the number of concurrent users and bandwidth requirements.

Variables "n=U*Pu": Calculating user base and percentage of users utilizing a given application on a given day

Calculating the number of users utilizing a given application category on a typical day is by multiplying the number of users (U) by the percentage of users likely to access a given application category on a typical day, expressed in the parameter table as ***n=U*Pu***.

U is the number of users in a given user base with in a community. In order to obtain values for ***U*** the following data was entered into the ACIA predictive model for all communities:

- Total number of Federal government employees
- Total number of Government of Nunavut employees

- Total number of Government of Northwest Territories employees
- Total number of Government of Yukon employees
- Total number of students
- Total population

The charts listing this data are included in Chapter 3 of this Assessment.

Not every user in a user base in a given community will access a given application category every day so we estimate a percentage of users that will likely access a given application category on a typical day (***Pu***).

Additionally, not every application within a category will be accessed every day and so an estimate is also required for the number of applications within an application category that will be accessed on a typical day (***Pa***). The following table provides estimates for the ***Pu*** and ***Pa*** values for each of the application categories:

Category	Pu	Pa
Intranet	50%	50%
Internet (work)	80%	100%
VoIP	80%	80%
Streaming Video	30%	50%
Video Conferencing	1%	100%
Client/Server	10%	50%
Education	80%	50%
eHealth	1%	100%
Internet (population)	80%	100%

With all required parameters defined the consolidated table of values is below

Category	In-bound (Kbps)	Out-bound (Kbps)	L	T	Pu	Pa	Federal	Nunavut	NWT	Yukon
Intranet	256		10	480	50%	50%	28	4	64	11
Internet (work)	256	128	10	480	80%	80%		1	1	1
VoIP	90	90	3	480	80%	80%	1			
Streaming Video	256		10	480	30%	50%	1	1	2	
Video Conferencing	512	512	30	480	1%	100%	2			1
Client/Server	256	256	10	480	10%	50%	32	35	70	17
Education	512	512	60	300	80%	50%				1
eHealth	512	512	10	720	1%	100%		1	1	1
Internet (population)	256	128	20	960	80%	100%		1	1	1

Variables "IB and OB": Calculating inbound & outbound requirements by community

With all of the required parameters we can now calculate the required inbound (***IB***) and outbound (***OB***) bandwidth for a given application category for a given community using the following set of equations.

n = U * Pu

C = n * L / T

IB = C * Bai * Pa * A

OB = C * Bao * Pa * A

To calculate the total inbound and outbound bandwidth required we would sum the ***OB*** and ***IB*** values for each application category. This will provide us with the required QoS for a given community in order to adequately meet the expected demand.

The three territorial capitals require an additional level of consideration. As they host the Intranet and client/server applications, local traffic for these application categories would not leave the community and therefore should not be included in the bandwidth requirement. However, the aggregate bandwidth from all of the other communities in the territory for these two application categories will arrive in the territorial capital, excluding the federal government employees.

For the three territorial capitals the values for the Intranet and client/server application categories are the sum of the inbound and outbound bandwidth calculations for all of the other communities in the territory.

IB = sum(OB)

OB = sum(IB)

Architecture, hosting and routing impact on bandwidth requirements

The bandwidth numbers expressed by the provided predictive model are intended to be guidelines only - not final numbers.

In order to provide more accurate bandwidth predictions for network requirements a number of considerations must be included, including the network architecture, hosting decisions and routing of data.

Network architectural decisions, such as where the community's bandwidth terminates will have an impact upon the bandwidth required from a given community. As an example, bandwidth from a community may terminate in another community in the North or may travel out of the North bound for the Internet or another service hosted in the South.

Hosting more services in the North will reduce the bandwidth required with the South but increase the bandwidth required between communities in the North. Similarly, services hosted in the North that need to be accessed from the South will increase the bandwidth required between the North and the South. Careful consideration should be paid when considering where to host services based upon where the largest user base of the service will reside.

Traffic routing also affects bandwidth projections. The network architecture dictates how the traffic is routed. Routing all traffic through a centralized hub will increase the bandwidth required for the hub specifically and the overall bandwidth required across the network as traffic must first travel to the hub and then to the final destination.

Given the nature of land based communications and the realities of the North some of this may be unavoidable as the cost or feasibility renders the creation of any sort of land based meshed network impossible. Again, paying careful consideration to where services

are hosted in conjunction with the network architecture can have a dramatic impact on bandwidth requirements for a given community.

The cost of bandwidth and physical realities of the North must be considered when deciding on where to host services. The closer a given service can be to the largest user base the less bandwidth will be consumed routing traffic between the user community and the service. Additionally, the lower the number of hops required between the user community and the service the lower the amount of bandwidth that will be consumed. Consuming less bandwidth translates into lower costs and improved performance.

Adjusted Mbps

In the bandwidth projections on the next pages, we have provided a column titled "Total Mbps".

The 'Total Mbps" are the calculated Committed Information Rate (CIR) values required to support the expected applications and activities. The Total Mbps is not the final total that is necessary to support applications properly.

The next step is to calculate the "Adjusted Mbps" to allow for a reasonable amount of burst space, and an allowance for overhead. Using a rule of thumb that CIR should not account for more than 35% of available bandwidth the calculated Mbps was adjusted to arrive at the Adjusted Mbps by community.

7.3 Bandwidth Projections by Community

Yukon Bandwidth Prediction

Community	Federal Gov't		Yukon Gov't		Students		Population		Total (Mbps)		Adjusted Total (Mbps)	
	Inbound	Outbound	Inbound	Outbound	Inbound	Outbound	Inbound	Outbound	Inbound	Out-bound	Inbound	Outbound
Beaver Creek	0	0	2009	1716	256	128	956	734	**3.2**	**2.6**	**9.20**	**7.37**
Blanchard	0	0	583	498	256	128	512	512	**1.4**	**1.1**	**3.86**	**3.25**
Burwash Landing	0	0	389	332	256	128	956	734	**1.6**	**1.2**	**4.57**	**3.41**
Carcross	0	0	4408	3764	256	128	2351	1431	**7.0**	**5.3**	**20.04**	**15.21**
Carmacks	0	0	4537	3875	444	222	2581	1547	**7.6**	**5.6**	**21.61**	**16.12**
Dawson City	0	0	15167	12952	802	401	8538	4525	**24.5**	**17.9**	**70.02**	**51.08**
Destruction Bay	0	0	1296	1107	256	128	713	612	**2.3**	**1.8**	**6.47**	**5.28**
Drury Creek	0	0	259	221	256	128	512	512	**1.0**	**0.9**	**2.94**	**2.46**
Eagle	0	0	519	443	256	128	512	512	**1.3**	**1.1**	**3.68**	**3.09**
Faro	0	0	3241	2768	256	128	2176	1344	**5.7**	**4.2**	**16.21**	**12.11**
Fraser	0	0	389	332	256	128	512	512	**1.2**	**1.0**	**3.31**	**2.78**
Herschel Island	0	0	259	221	256	128	512	512	**1.0**	**0.9**	**2.94**	**2.46**
Haines Junction	0	0	8426	7196	559	279	3964	2238	**12.9**	**9.7**	**37.00**	**27.75**
Klondike	0	0	648	554	256	128	512	512	**1.4**	**1.2**	**4.05**	**3.41**
Marsh Lake	0	0	0	0	256	128	2462	1487	**2.7**	**1.6**	**7.77**	**4.61**
Mayo	0	0	5056	4317	260	130	2385	1449	**7.7**	**5.9**	**22.00**	**16.85**
Old Crow	0	0	1750	1494	256	128	1506	1009	**3.5**	**2.6**	**10.03**	**7.52**
Ogilvie	0	0	389	332	256	128	512	512	**1.2**	**1.0**	**3.31**	**2.78**
Pelly Crossing	0	0	2009	1716	256	128	1877	1195	**4.1**	**3.0**	**11.84**	**8.68**
Ross River	0	0	3565	3044	260	130	2014	1263	**5.8**	**4.4**	**16.68**	**12.68**
Stewart Crossing	0	0	454	387	256	128	512	512	**1.2**	**1.0**	**3.49**	**2.94**
Swift River	0	0	454	387	256	128	512	512	**1.2**	**1.0**	**3.49**	**2.94**
Tagish	0	0	65	55	256	128	1557	1035	**1.9**	**1.2**	**5.37**	**3.48**
Teslin	0	0	3500	2989	256	128	2487	1500	**6.2**	**4.6**	**17.84**	**13.19**

Community	Federal Gov't		Yukon Gov't		Students		Population		Total (Mbps)		Adjusted Total (Mbps)	
	Inbound	Outbound	Inbound	Outbound	Inbound	Outbound	Inbound	Outbound	Inbound	Out-bound	Inbound	Outbound
Tuchitua	0	0	519	443	393	196	512	512	**1.4**	**1.2**	**4.07**	**3.29**
Watson Lake	0	0	11408	9742	474	237	7019	3765	**18.9**	**13.7**	**54.00**	**39.27**
Whitehorse	25240	14742	60886	71300	17446	8723	114101	57986	**217.7**	**152.8**	**621.92**	**436.43**

NWT Bandwidth Prediction

Community	Federal Gov't		NWT Gov't		Students		Population		Total (Mbps)		Adjusted Total (Mbps)	
	Inbound	Out-bound	Inbound	Outbound	Inbound	Outbound	Inbound	Outbound	Inbound	Out-bound	Inbound	Outbound
Aklavik	0	0	6266	3622	623	311	3319	1916	***10.2***	***5.8***	**29.17**	**16.71**
Behchoko	0	0	18579	10738	2577	1289	9387	4949	***30.5***	***17.0***	**87.27**	**48.50**
Colville Lake	0	0	989	572	256	128	1186	849	***2.4***	***1.5***	**6.95**	**4.43**
Deline	0	0	4398	2542	572	286	2931	1722	***7.9***	***4.5***	**22.57**	**13.00**
Detah	0	0	0	0	256	128	1621	1067	***1.9***	***1.2***	**5.36**	**3.41**
Enterprise	0	0	1539	890	256	128	930	721	***2.7***	***1.7***	**7.79**	**4.97**
Fort Good Hope	0	0	4398	2542	499	250	3038	1775	***7.9***	***4.6***	**22.67**	**13.05**
Fort Liard	0	0	4507	2605	521	260	3017	1764	***8.0***	***4.6***	**22.98**	**13.23**
Fort McPherson	0	0	5937	3431	832	416	3904	2208	***10.7***	***6.1***	**30.49**	**17.30**
Fort Providence	0	0	7036	4066	836	418	3785	2148	***11.7***	***6.6***	**33.31**	**18.95**
Fort Resolution	0	0	4617	2669	435	218	2620	1566	***7.7***	***4.5***	**21.92**	**12.72**
Fort Simpson	0	0	23197	13406	1071	535	5931	3221	***30.2***	***17.2***	**86.28**	**49.04**
Fort Smith	0	0	54309	31388	2564	1282	11106	5809	***68.0***	***38.5***	**194.23**	**109.94**
Gamèti	0	0	1539	890	350	175	1796	1154	***3.7***	***2.2***	**10.53**	**6.34**
Hay River	0	0	31112	17981	3179	1589	16410	8461	***50.7***	***28.0***	**144.86**	**80.09**
Hay River Res.	0	0	2419	1398	303	151	1911	1212	***4.6***	***2.8***	**13.24**	**7.89**
Inuvik	0	0	54419	31451	2846	1423	15667	8090	***72.9***	***41.0***	**208.38**	**117.04**
Jean Marie River	0	0	220	127	256	128	815	663	***1.3***	***0.9***	**3.69**	**2.62**
Kakisa	0	0	220	127	256	128	747	629	***1.2***	***0.9***	**3.49**	**2.53**
Lutselk'e	0	0	2529	1461	346	173	1779	1146	***4.7***	***2.8***	**13.30**	**7.94**

Community	Federal Gov't		NWT Gov't		Students		Population		Total (Mbps)		Adjusted Total (Mbps)	
	Inbound	Out-bound	Inbound	Outbound	Inbound	Outbound	Inbound	Outbound	Inbound	Out-bound	Inbound	Outbound
Nahanni Butte	0	0	660	381	256	128	1024	768	***1.9***	***1.3***	**5.54**	**3.65**
Norman Wells	0	0	12863	7434	597	299	3994	2253	***17.5***	***10.0***	**49.87**	**28.53**
Paulatuk	0	0	2419	1398	354	177	1946	1229	***4.7***	***2.8***	**13.48**	**8.01**
Sachs Harbour	0	0	989	572	256	128	1084	798	***2.3***	***1.5***	**6.65**	**4.28**
Trout Lake	0	0	1319	762	256	128	939	725	***2.5***	***1.6***	**7.18**	**4.62**
Tsiigehtchic	0	0	880	508	256	128	1037	774	***2.2***	***1.4***	**6.21**	**4.03**
Tuktuoyaktuk	0	0	4617	2669	849	425	4420	2466	***9.9***	***5.6***	**28.25**	**15.88**
Tulita	0	0	3958	2287	589	294	2918	1715	***7.5***	***4.3***	**21.33**	**12.28**
Ulukhaktok	0	0	3408	1970	414	207	2526	1519	***6.3***	***3.7***	**18.14**	**10.56**
Wekw eèti	0	0	770	445	256	128	1114	813	***2.1***	***1.4***	**6.11**	**3.96**
Whati	0	0	2968	1716	614	307	2633	1572	***6.2***	***3.6***	**17.76**	**10.27**
Wrigley	0	0	1429	826	256	128	994	753	***2.7***	***1.7***	**7.66**	**4.88**
Yellowknife	114721	67006	152872	264510	14532	7266	86439	43928	***368.6***	***382.7***	**1053.04**	**1093.46**

Nunavut Bandwidth Prediction

Community	Federal Gov't		Nunavut Gov't		Students		Population		Total (Mbps)		Adjusted Total (Mbps)	
	Inbound	Outbound	Inbound	Outbound	Inbound	Outbound	Inbound	Outbound	Inbound	Outbound	Inbound	Outbound
Arctic Bay	0	0	1089	781	947	474	3695	2103	***5.7***	***3.4***	***16.38***	***9.60***
Arviat	0	0	3842	2756	3618	1809	10492	5502	***18.0***	***10.1***	***51.29***	***28.76***
Baker Lake	0	0	2238	1605	2526	1263	8887	4700	***13.7***	***7.6***	***39.00***	***21.62***
Cambridge Bay	0	0	4397	3153	1702	851	7450	3981	***13.5***	***8.0***	***38.71***	***22.82***
Cape Dorset	0	0	2317	1662	1566	783	6515	3514	***10.4***	***6.0***	***29.71***	***17.02***
Chesterfield I.	0	0	574	412	422	211	2146	1329	***3.1***	***2.0***	***8.98***	***5.58***
Clyde River	0	0	1149	824	1306	653	4446	2479	***6.9***	***4.0***	***19.71***	***11.30***
Coral Harbour	0	0	1069	767	1216	608	4224	2368	***6.5***	***3.7***	***18.60***	***10.69***
Gjoa Haven	0	0	2000	1435	1412	706	5367	2940	***8.8***	***5.1***	***25.09***	***14.52***
Grise Fiord	0	0	317	227	256	128	1169	841	***1.7***	***1.2***	***4.98***	***3.42***
Hall Beach	0	0	693	497	755	378	3575	2044	***5.0***	***2.9***	***14.35***	***8.34***
Igloolik	0	0	2891	2074	2125	1062	7706	4109	***12.7***	***7.2***	***36.35***	***20.70***
Iqaluit	15009	8766	32528	45352	5717	2859	30421	15467	***83.7***	***72.4***	***239.07***	***206.98***
Kimmirut	0	0	634	455	567	284	2453	1483	***3.7***	***2.2***	***10.44***	***6.35***
Kugaaruk	0	0	951	682	1067	533	3661	2086	***5.7***	***3.3***	***16.22***	***9.43***
Kugluktuk	0	0	2693	1932	1246	623	6601	3556	***10.5***	***6.1***	***30.11***	***17.46***
Pangnirtung	0	0	2555	1832	1613	806	6810	3661	***11.0***	***6.3***	***31.36***	***18.00***
Pond Inlet	0	0	3010	2159	1788	894	6763	3637	***11.6***	***6.7***	***33.03***	***19.12***
Qikiqtarjuaq	0	0	852	611	465	233	2790	1651	***4.1***	***2.5***	***11.73***	***7.13***
Rankin Inlet	0	0	8377	6008	3183	1591	12160	6336	***23.7***	***13.9***	***67.77***	***39.82***
Repulse Bay	0	0	871	625	1327	663	4245	2379	***6.4***	***3.7***	***18.41***	***10.48***
Resolute Bay	0	0	396	284	256	128	1600	1056	***2.3***	***1.5***	***6.43***	***4.19***
Sanikiluaq	0	0	1030	739	1126	563	3968	2240	***6.1***	***3.5***	***17.50***	***10.12***
Taloyoak	0	0	792	568	1088	544	4314	2413	***6.2***	***3.5***	***17.70***	***10.07***
Whale Cove	0	0	614	440	610	305	2219	1365	***3.4***	***2.1***	***9.84***	***6.03***

Objective C: Assess Community & Economic Development Implications

Chapter 8: Insight into the Economics of 'Broadband'

8 Insight into the Economics of 'Broadband'

In preparing the economic analysis for this Assessment, an economist based in NWT reviewed relevant literature from other jurisdictions and countries faced with similar challenges as the Canadian Arctic, and reviewed background documents specific to the telecommunications industry.

'Broadband' is the term used in many of the international documents use to signify a high data rate connection to the Internet, also referred to as 'high speed Internet'. 'Broadband' refers to a digital network infrastructure that is able to carry all manner of communications in a society where communications services have converged, and focuses on the services accessible to the end user. Broadband in this context includes mobile communications.

Because the economics review in this Assessment references international studies, this part of the report will use the term 'broadband'. For the purposes of this section, we use 'broadband' as essentially equivalent to 'communication infrastructure' used in other parts of this Assessment. (Traditional analog phone services and analog HF radio infrastructure is not included in the term 'broadband'.)

8.1 Introduction

It has become almost passé to talk about the role of broadband in the growth and prosperity of a modern society. It is quite simply understood as a necessity. Whether related to trade and commerce, education or health, government services, knowledge transfer or general enlightenment, social networking, or simply entertainment, we find that broadband is a deeply rooted part of our lives, our sustainability, our happiness. This is as true for someone living in London, Paris, or New York as it is for someone living in Dawson, Tuktoyktuk, or Repulse Bay. Our interest is, of course, the role of broadband in the latter communities where it can be argued that in relative terms it is more important for the quality of life and perhaps even the long-term survival of these communities. In the first section of this chapter of our report, the role of broadband in the economic development and sustainability of our northern communities is discussed.

But there is another side to the economics of broadband, one that is far more complex, especially as it relates to the northern context of this report. It is perhaps ironic that the true economic challenge for broadband and other communication infrastructure products is not in the ability or manner in which society will adapt to and make use of it, but rather the manner in which our markets have developed in selling these products and services to consumers.

The three territories represent a difficult environment in which to operate. They are characterized by a small consumer base located across a vast geographic range. A harsh climate and poor and sometimes absent community and transportation infrastructure further hinder development. Within the three territories are vastly different economic

conditions such as the differences in road access, degrees of remoteness, and size of communities. This all makes the North an unprofitable marketplace for communications service providers. Nevertheless, suppliers of broadband do operate on somewhat of a competitive basis, but a majority of that competition is for government subsidies.

Regulators must take these market conditions into consideration when outlining the rules in which the industry will operate. Between the market players and its regulators, an answer must be found for the growing demand from government and the general public for bigger, better, and faster Internet services. Meeting this demand will mean more innovation and large capital investments. How to facilitate these needs within an unprofitable marketplace where consumers cannot possibly afford to bear the associated costs is an enormous challenge. It will require unraveling the complex system in which these elements (competition, subsidization, innovation, and regulation) combine to create the northern marketplace.

This section offers a overview of the role of broadband in the pursuit of a higher quality of life, its role of developing sustainable communities, and provides a snapshot of the Territorial economies. In Section 8.5, we outline the market challenges, looking at the roles of competition, regulation, subsidization, and innovation in an effort to bring some clarity to the discussion on building an infrastructure for 21st century access.

Finally, the section wraps up with conclusions and recommendations from an economic point of view for a path forward.

8.2 The Role of Broadband in the Pursuit of a High and Sustainable Quality of Life in Canada's Territories

Internationally it is recognized that broadband access is significant to the development of a sustainable society.

IT use is considered not just a part of everyday life for most businesses, organizations and citizens, but also has an impact on growth, competitiveness and the development of a sustainable society. As already outlined in this report, more and more services are becoming digital, requiring businesses and households to be able to make use of these services. Northerners, just as all Canadians, must be connected in order to accomplish simple tasks such as financial reporting and banking.

In Sweden, policy makers see ease of access as a matter of democracy and rights. It's a matter of everyday life that it works smoothly so that people are able to shop, do business, keep in touch with friends and family, watch video clips or express opinions or comment on events and issues that affect them. This necessitates having access to broadband that makes it possible to connect to the Internet securely. (Government of Sweden, 2010, page 13)

Most recently, the United States released its National Broadband Plan which stated that

> *"…like electricity a century ago, broadband is a foundation for economic growth, job creation, global competitiveness and a better way of life. It is enabling entire new industries and unlocking vast new possibilities for existing ones. It is changing how we educate children, deliver health care, manage energy, ensure public safety, engage government, and access, organize and disseminate knowledge." (Federal Communications Commission, Exec Summary page XI)*

The American plan concluded that broadband is the great infrastructure challenge of the early 21st century.

If smooth-running, easy access to broadband for all citizens is considered a matter of democracy and rights, and is characterized as "the great infrastructure challenge of the 21st century" in other countries, there is certainly work to be done in the Arctic.

It is clear from the data in this Communications Assessment, that Arctic residents do not have adequate access to broadband services, and the gap continues to increase as more services are delivered via broadband networks everywhere. The GNWT, in its submission to the CRTC stated that

> *"As Canadians become ever more reliant on the Internet, this phenomenon will, if allowed to continue, result in the residents of rural and remote Canada becoming second class citizens who are increasingly disenfranchised from meaningful participation in Canadian society and the economy." (GNWT, 2010, page 6).*

This would be contrary to the most fundamental values of Canadians as reflected in the objectives of the *Telecommunications Act,* most particularly objectives (a), (b) and (h) of section 7 which provide that:

It is hereby affirmed that telecommunications performs an essential role in the maintenance of Canada's identity and sovereignty and that the Canadian telecommunications policy has as its objectives

> *(a) to facilitate the orderly development throughout Canada of a telecommunications system that serves to safeguard, enrich and strengthen the social and economic fabric of Canada and its regions;*
>
> *(b) to render reliable and affordable telecommunications services of high quality accessible to Canadians in both urban and rural areas in all regions of Canada;…..*
>
> *(h) to respond to the economic and social requirements of users of telecommunications services.* (GNWT, 2010, page 6)

In this chapter, the role of broadband in the development of Canada's northern most communities is discussed.

8.3 Community Sustainability

The Internet has become a necessity of life for much of the world's populations. Northern Canadians are no exception.

Internet services make northern, remote and isolated communities more sustainable and will aid in their long-term survival. IT and good electronic communications are essential for business, employment and efficient administration; all key components that increase the likelihood that people will live in remote communities.

Over the next 10 to 20 years, the territorial economies will grow significantly (see Section 8.4), contributing a larger portion of the nation's overall wealth.

Some of the growth and the socio-economic changes that it brings will affect and be affected by Internet services:

- population changes (most pronounced in Nunavut) will create greater demand;
- the development of mineral deposits throughout the North will mean more industrial demands for Internet services, generate greater wealth for Northerners who will spend it in part on or through the Internet;
- climate change and its impacts on (among other things) marine transportation through the Northwest Passage;
- sovereignty issues.

Despite the growing economy or perhaps because of it, there are real threats to the sustainability and survival of northern communities. Communication infrastructure can play an important role in mitigating these threats, such as:

- slowing Arctic deruralization (the outflow of people from smaller to larger centres);
- assisting business development;
- benefiting government service delivery.

Slowing Arctic deruralization and out-migration

If Canada wants vibrant Arctic communities, efforts must be made to improve their attractiveness to the people who live there. We heard from participants in workshops in Iqaluit that educated young people today are less likely to remain in an isolated community that has no physical or virtual link to the outside world.

Many Arctic communities were established on the basis of fur trading or mining, or were otherwise residential and/or administrative centres, established by the church or the government. With the fur trade gone as a viable economic pursuit, and old mines in Yukon and Nunavut decommissioned long ago, the sustainability of some communities is questionable, especially for those without a large government presence and those untouched by recent resource developments. These communities are very expensive to maintain from the perspective of public finance and given the absence of known

marketable assets this fact is unlikely to change. The unemployment rate in some communities exceeds 30 per cent.

Even for communities that can participate in the mining sector through the fly in/fly out work rotation, some people will be less inclined than others to pursue this. Not everyone can be a miner, or can tolerate being away from their families half the year. What's the future for these people and their communities? How long can they continue to exist?

But there are other considerations when discussing why and how Arctic communities can survive and thrive. We assume that Canada is 100% committed to Canadians living in these communities. Canadian sovereignty over the Arctic region is based largely on these people who live in remote and strategic areas and will continue to do so. In fact, some Arctic communities were created by the Canadian government specifically for the purpose of sovereignty. The federal government's Northern Strategy highlights all of these important points:

- Canada's Arctic communities are a major factor in our sovereignty claims;
- there is tremendous wealth in the natural resources found throughout the Arctic;
- there is a real opportunity for the Northwest Passage to become an international trade route; and,
- the Arctic is an important symbol of Canadian identity.

Regardless of how these communities are viewed politically or strategically, the sustainability and even existence of some are in jeopardy. Many are suffering from out migration of residents, particularly young and educated residents, who are moving to larger centers. This is a world-wide phenomenon known as "deruralization".

Deruralization is a term most Canadians associate with the movement of people away from rural farming communities and into larger metropolitan cities. It creates economic hardship on the small communities because of the lost tax base, fewer children to fill the local school, less commercial activity and reduced civic activity. Many of these communities have simply vanished or are now mostly residential areas in the country offering few if any services. Deruralization, though, is not a term specific to rural farming communities, but rather is a reference to the movement of people away from small, rural communities because of declining economic and social attractiveness of these towns. Canada's northern communities will not escape this trend.

There are no statistics available to confirm the impact of Internet on demographic movements, but we can assume that it is less attractive for young people to live in a community without access. To move to a remote community that is without modern communication infrastructure, namely broadband but also things such as cellular phone coverage, is akin to moving to a community in the 1980's that was still without telephone access. Few people would choose to make that move.

The prospect of moving to a remote or isolated community in Canada's territories can be enhanced by the existence of broadband. The remote communities in all three territories struggle to attract and retain doctors, nurses, teachers, engineers, and others. For these professionals, modern communication infrastructure means they can do their job and enhances their private life as well. In the same way that business investment will gravitate toward geographic locations that offer advanced Internet services, so will people.

Internet access is making life in communities increasingly livable, which should be a positive for net migration. Community life is improved through better communications with family members and friends, through the provision of entertainment and social networking, and access to shopping. While online shopping access is convenient in southern locations, for communities with only one small store, online shopping is the way to get a wide range of products. The interest in purchasing products online will only grow, especially in communities that are benefiting from resource development and where people have more money to spend. Without these modern conveniences, people with money in these remote locations are more likely to leave. Left unchecked, this out-migration will slowly drain these communities of their most valuable resource; the people who live there.

Business development

Several studies show that investments in IT and broadband have been favourable for social development and that countries that have invested heavily also have experienced higher productivity. The competitiveness and productivity of businesses can consequently increase through more efficient production of goods and services, logistics and new business processes. Collaboration is made easier. (Government of Sweden, 2010, page 5). Access to broadband makes it easier to work remotely. It enhances the possibility of launching and running a business from anywhere. It can reduce and sometime eliminate the need for travel. It means that people are able to work where they live instead of having to live where they work.

It is a major challenge for businesses to keep up with the changes resulting from technological advances, but by doing so a business can lower its costs and improve its competitiveness. In rural areas, poor access can leave businesses without any possibility of achieving these advances and in actuality, businesses won't even know what is possible or the extent to which they are disadvantaged it terms of their technological efficiencies. Businesses in Canada's territories will always have to contend with the physical realities of their operations, but higher-quality access to services through the Internet can help compensate for that.

Broadband can have a profound impact on how a community can benefit from economic opportunities

- Economic growth can mean business opportunities through joint venture or otherwise. Communications is a key element to any business, especially

partnerships. Communities with poor communication links will be at a disadvantage;
- For many communities, postal service, facsimile and memory sticks on airplanes are still the preferred communication modes since secure Internet service is often inadequate and large file transfer impossible. This can slow the speed of business, can be frustrating, and can cause disruption to communications on important issues;
- With the rest of the world working at broadband speeds, communities that are cut-off will not be desirable places for business;
- For the smallest and most isolated communities, their Development Corporations or Joint Ventures would be well advised to have their principal office of business in a location where modern communication infrastructure exists. This robs the community of an opportunity to improve its wealth and sustainability.

Benefits to government service delivery

There are three principal ways government benefits from broadband services into communities:

1. Day-to-day administration costs are reduced;
2. Enables government to provide essential services;
3. Improves the safety and security of the communities.

Internet services can lower the day-to-day cost of administration

So much of government's service approach assumes broadband into homes. When this infrastructure is not in place, these services must be conducted in a manner that is more expensive and labour intensive. It also means government must maintain two systems: one for those with broadband and one for those without. This duplication adds to the operating cost of government. It is made more expensive when a public servant must physically travel to a community to complete their business that could otherwise be conducted through the Internet.

In Nunavut, the government operates under a decentralized model of public administration. However, poor Internet service can be blamed in part for problems in the GN's operations. Its inability to use the Internet for large file transfer or for secure files has meant many government functions are still being carried out by hand-written logs. An example of this is the Department of Health, which does not yet use modern electronic filing systems for maintaining portions of its records. Not only is their system inefficient, but it can result in errors or lost information, and restricts the ability to investigate the economics of the department. Another example relates to the much-publicized Nunavut Housing Corporation $110 million shortfall in the Nunavut Housing Trust initiative. A portion of the problem which resulted in this error is said to be the lack of capacity to complete large file transfers from Arviat to Iqaluit.

The lack of broadband infrastructure in remote communities in the North also increases the cost of education and health services. In both cases, broadband can have an enormous positive influence on public expenditures, with obvious benefits to children and patients.

- Children can remain in their home community to complete their education. This greatly increases their chances of graduating and would allow them to receive skills training via distance education. The benefits to the individual, society and government when children are educated are significant and long term.
- Patients can receive care without having to wait for a traveling doctor or to physically travel to the nearest health centre themselves. The per capita spending on health is highest in Nunavut at $11,811, followed by NWT at $9,906, then Yukon at $8,013. In Canada as a whole, per capita spending is $5,452, less than half of what it is in Nunavut.
- Health care costs related to travel in the North are astronomical. In Nunavut, capital costs and travel (one category) eats up 29.5 per cent of the entire health budget. For the rest of the country, this line item requires 14.4 per cent of the health budget because very little goes toward travel.

The provision of essential services to all citizens

There should no longer be any debate over whether high speed Internet service should be a public good. It might be expensive, but the reality of our world is what it is, and it includes Internet service for all.

We have reached a point in the development of modern communications that the Internet is a part of our democracy. The Internet allows people to become engaged in debate and affect political change. In the recent election held by Nunavut Tunngavik Inc., candidates for president made extensive use of FaceBook and Twitter to lay out their platforms and engage the electorate.

In Australia, the government is investing $43 billion over 8 years through its National Broadband Network to bring an advanced, fast and reliable Internet backbone to the entire country that will include 12 Mb/s at a minimum to the most rural and remote regions of their country. (National Broadband Network, 2010a, page 1). Meanwhile, the US Federal Communications Commission is spending $4.3 billion for broadband deployment and support for rural and remote regions of the country in order that they can communicate effectively and efficiently (ITWorldCanada, 2010). These are signs that the rest of the world is making the investments to ensure their citizens' basic needs are met.

Very soon, social pressure will be too great for government to not act, so a clear plan in this regard will save millions in the near future.

Meeting safety and security needs

Residents in Canada have the right to feel secure in their own community, regardless of where they live. Communication infrastructure is playing an increasingly greater role in the provision of safety and security everywhere, including the Arctic.

With all the national and international debate over Arctic sovereignty, one might see security in that context only when in fact there are many aspects to safety and security that should be considered. One should think in broad terms when thinking safety and security. It can apply to national, regional, community or individual threats. Threats can be related to violence, property, extreme weather events, natural disasters, climate change, disease outbreaks (including pandemics) or international security threats.

There are endless examples to draw from. The fallout from Operation Nanook related to communications in the eastern Arctic was presented earlier. The need for modern, secure communication infrastructure has a significant value to national defence and Canada's Arctic sovereignty claims. But there are other stories of a break-down in communication links in Yukon and the NWT that could have resulted in real threats to people's safety and security had the timing of those events coincided with a natural disaster of some sort.

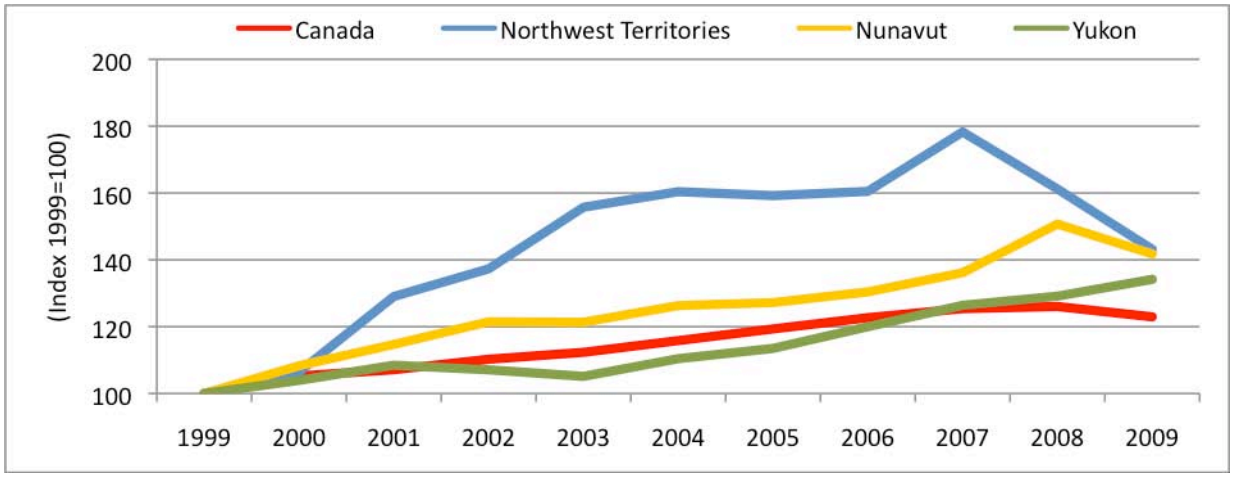
On a smaller scale, there are people in remote communities who are victims of domestic violence that feel unsafe because they cannot have call-display on their phones. During the SARS threat in 2007, we heard that a remote community without cellular coverage grew scared when they lost phone service for a short period of time and had no way of calling for a medical evacuation had they needed it. It doesn't matter that the SARS threat was not serious in the end. What matters is that over a hundred people were cut-off at a time when it was believed to be serious.

Government's responsibilities in preparing for and dealing with threats rely heavily on all aspects of the communications infrastructure. It is yet another area where public demands for this infrastructure and service will continue to grow.

8.4 Territorial Economics

The economic outlook for Canada's territories, if taken as a whole, is very positive. Much of this growth will come from resource extraction, but increased interest from the federal government in seeing the region developed may mean new opportunities for economic growth will emerge. Already, the territorial economies are growing faster than the Canadian average. (See Chart)

Gross Domestic Product, Chained (2002) dollars, Index 1999=100



Source: Statistics Canada, Economic Accounts Division

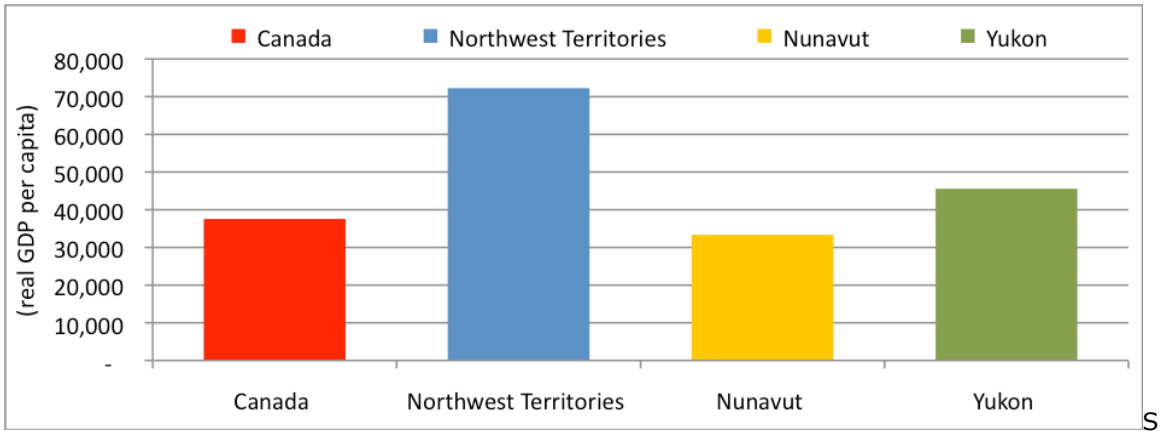
Mining and gas

In the NWT, a major economic transformation has taken place, which began in 1997 with the development of BHP Billiton's Ekati Diamond Mine. Since that time, two more diamond mines have opened—Rio Tinto's Diavik Diamond Mine and De Beers' Snap Lake Diamond Mine.

The pace of development in Nunavut and Yukon is now picking up as well. Resource development will add substantially to the employment and personal income levels in both of those territories.

As it stands today, the GDP per capita in the North is well above the Canadian average in the NWT and Yukon, and within a few years the same will be true in Nunavut. (See Chart)

Gross Domestic Product, Chained (2002) dollars per capita



Source: Statistics Canada, Economic Accounts Division and Demography Division

Resource development will continue in all three territories. In the next ten years, as many as 10 mines could open. The single largest project would be the Mackenzie Gas Project (MGP) if it is developed. The MGP would attract $16 to $50 billion in direct investment (depending on the development scenario) and generate $32 to $118 billion in revenues. (Wright-Mansell, 2007, page 3) British Petroleum, Imperial Oil and ExxonMobil have purchased exploration licenses in the Beaufort Sea for a combined price of $1.8 billion. The interest in these properties is very likely oil rather than natural gas, so their development does not hinge on the fate of the MGP. Yukon could have 5 or 6 mines operating in the coming years. There are two new mines in advanced stages of their environmental assessment in the NWT. And in Nunavut, there are at least two new properties that will be operating five years from now and another 3 with very good chances of being developed by 2020.

Under a full-growth scenario where all of the mineral deposits in advanced stages of exploration and regulatory approval were to open by 2020, one could expect the combined GDP for the territories would double in that time.

Climate change, sovereignty, and other economic opportunities

Other sectors of the economy are smaller but still important.

Tourism is a major component of Yukon's economy, and is growing in Nunavut, especially in areas such as cruise ships due to the decrease in summer sea ice. This decrease in sea ice will also result in more marine traffic through the NW Passage, though it will be sporadic for the next decade or more (Arctic Council, 2009).

Commercial fishing in Nunavut is still small in terms of overall employment and GDP, but is growing through substantial investments in infrastructure and training (Impact Economics, 2010)

National issues related to climate change and sovereignty have increased the territories' exposure across Canada, and with it, increased investment from the federal government. It is not possible to put a dollar value on this heightened exposure, but it does signify a greater awareness of the performance and potential of the North.

Today, thousands of passenger airplanes and dozens of ships pass through Canada's Arctic every year. As climate change makes the North more accessible, it also increases the risk for a major air or shipping disaster. Canada is about to sign an international treaty obliging it to take responsibility for a vast section of the Arctic, and will be responsible for monitoring the region and providing search and rescue services. This is an important sovereignty issue, directly related to the impact of climate change. This activity also increases job opportunities for many northerners, with increased military activity, environmental stewardship, and even Ranger patrols.

Underpinning all three economies is stable financial support from the federal government through the Territorial Formula Financing agreements. The large governments in all three

territories (large relative to the overall economies) provides a lot of security to the economies which would otherwise be vulnerable to the boom-bust cycles experienced by regions where mining is the only major economic contributor.

Labour and the social economy

All of these growth opportunities will create a demand for labour and business that far exceeds what the three territories can supply, thus creating opportunities for increased wealth for people outside the territories as well as those within. But while these opportunities are looming in the near future, there continues to be a serious challenge in bringing the North's social economy along at the same pace of growth.

The divergence in growth paths; that is, the rate at which the economy is growing versus the rate of social progress, is so great that it threatens the long-term sustainability of the North. This is less the case for Yukon which has a vastly different demographic makeup than NWT and Nunavut.

This gap between the social economy and GDP is most evident in Nunavut, where the separation between rich and poor is becoming increasingly pronounced as a result of the new economy creating winners and losers from within the labour market (Impact Economics, 2010). It is a reality that not all northerners are equally ready, willing and able to participate in the types of economic opportunities available. And to date, no clear solution has been found to help these people.

Finding a way to ensure the wealth from resource development benefits all of society is the single greatest economic challenge the North faces.

Failure in this regard will condemn many northerners to a life of poverty and will prolong the financial challenges these communities and individuals represent for northern governments. Simply put, if resource development (notwithstanding the pockets of economic growth in other sectors that can and will occur) is to be the economic driver of the three territories over the next 20 years, then it must be that policies and programs are put in place that allows everyone access to a better quality of life.

It is clear northern economies are very strong and are getting stronger. It is also very clear the challenges the North face are not economic, but social. Broadband-enabled services have a very significant role to play in ensuring a higher quality of life while helping to build and maintain sustainable communities and lessening the digital divide.

There is a strong argument to be made that significant IT investments would do more than any other form of physical investment to assist in developing the social economy and addressing the issues of deruralization, poverty, and sustainability challenges facing many Arctic communities.

8.5 The Market Challenge for Communication Infrastructure in Canada's Territories

Most literature on the subject of the economics of communications infrastructure and broadband services emphasizes the importance of competition. The need for quality Internet services is so great in the context of the world's economy that it is shaping the international flow of investment capital. Money now flows toward regions of the world that offer a quality Internet service. To keep pace with that reality, a region must establish a marketplace where innovation and competition can improve the quality of Internet services while also lowering their cost.

For heavily populated regions of the world including those in Canada, this marketplace is established almost entirely through consumer demand. This is because the demand for Internet services is so great that market forces can be allowed to operate almost freely. A serious challenge arises for less populated areas of the world. For communities, regions or countries that are relatively small, remote or isolated, the demand is insufficient to achieve similar results. As we have discussed in this report, failure to keep pace in the provision of quality Internet services threatens the competitiveness of these regions that in turn will affect their economic viability and long-term sustainability.

But how can these small markets compete with those that have almost perfect competition? The truth is they can't. But a lot can be accomplished in closing the gap through a very competition-oriented and proactive regulatory regime and an aggressive subsidization program. First, regulations are needed to ensure that Internet services exist for all the reasons discussed earlier in Sections 8.2 and 8.3, and to ensure the market operates as efficiently as possible. But second, public investment is a requirement. There is simply no manner under which a small, remote, isolated market can compete in an industry characterized by constantly increasing product quality at an ever decreasing price. Markets in the south achieve this seemingly opposite dynamic through massive investments in innovation, new technologies and costly infrastructure that are made affordable by market demand that is insatiable. Even under a scenario of perfect competition, these conditions will never exist in the smaller markets.

In this chapter, the market challenge for communication infrastructure, broadband and Internet services in Canada's territories is presented. The chapter is organized into four sections, discussing the nature of competition, innovation, regulation and subsidization.

> *"We can't get economies of scale here. Our entire population has this problem. Having a better understanding of mutual challenges is a good idea, but the issue won't be resolved unless we can address the underlying barriers to reducing costs and increasing services such as public investment as a critical infrastructure and regulatory issues that are preventing competition.."* --- Rick Wind, Environment and Natural Resources, Government of the NWT

Competition for broadband

Dynamic and efficient markets contribute to economic growth, innovation, technical development and increased access to services. Markets that function well favour both businesses and consumers as they result in diversity of supply and put pressure on prices. The most important way of achieving efficient markets is functioning competition between the market players (Government of Sweden, 2010, page 18).

Government efforts to stimulate competition

The public sector plays a significant role in the broadband market in Sweden, acting as owners of broadband infrastructure, users of IT and broadband services, and as authorities responsible for regional and local planning and development. The central government there is a large owner of broadband networks, and a significant player in the market. They are directed to act as neutrally as possible to encourage competition, primarily selling unrefined wholesale services such as duct and dark fiber—what we commonly refer to as the Internet backbone in a fiber environment. Government owned broadband networks must aim to contribute to greater competition, to ultimately benefit households and businesses through more and better services and lower prices (Government of Sweden, 2010, page 25).

In Sweden, people believe the principal role of central government is to make the market work efficiently and provide the market players with good conditions in which to operate. Government must take the responsibility for ensuring broadband is available in the remote areas of the country that have poorly functioning markets with too few buyers and sellers of goods and services that would otherwise create competition. They work to identify constructive solutions that contribute to increased collaboration and deployment of infrastructure in areas where there is little prospect of expanding parallel infrastructure to compete on a competitive basis.

Australia has approached the challenge of providing services in its remote regions by first defining broadband levels that every Australian has the right to receive. They define 'genuine broadband' as "Internet access and use that is fast—at least 12 Mb/s with an upgrade path to go faster over time, accessible—always on, affordable, and in widespread use." (National Broadband Network, 2010a, page 2).

The Australian government believes that while investment to build an infrastructure that delivers 'genuine broadband' is high, it is not nearly as high as the 'hidden' costs of maintaining an imperfect market structure and insufficient competition in the provision of broadband services. Australians have calculated that over a period of 20 years, the economic cost of less competition and higher prices that reflect some degree of monopoly power could be 3-4 times more than the initial cost of providing the broadband facility in the first place. (National Broadband Network, 2010a, page 1). They compare competition in broadband services to competition in other types of infrastructure, such as electricity, water, gas, aviation and others that provide evidence (while not perfect) that

competition does ultimately result in sustained investment in the provision of services and sustained growth and employment.

The challenge in the Arctic is determining how to stimulate needed competition, and ensure this competition ultimately leads to more choice and better services for consumers from within government and for the general public.

Governments role in ensuring equitable access for all

Governments also play a pivotal role in ensuring equitable access for all. Most governments have taken a proactive approach to stimulating network roll-out in rural and other underserved areas. A World Bank report examining the role of governments in broadband explains that traditionally, underserved areas were served through internal cross-subsidization by the state-owned monopoly operator. Once markets were liberalized, this was no longer an option. Most underserved areas were then replaced by explicit subsidy mechanisms (infoDev, page 8).

The argument in this World Bank report is that because public and private services are increasingly provided online, the inability for some parts of the population to get access to broadband becomes more of a public policy problem. Data shows that when broadband usage reaches a critical mass in a country (e.g., 25 per cent) it will come to be considered indispensable for everyone if balanced development is to be achieved, without discrimination based on geographical location (infoDev, page 9).

Regulatory requirements

Government's role as regulator is complex as they must understand the interplay between competition, innovation and subsidies in meeting minimum standards. We have identified three issues regulators must grapple with for setting the environment in which operators must function in order to deliver needed services at an affordable price:

1. Regulators should establish a minimum level of service, including definitions of "affordability" in the context of the marketplace;
2. Regulations should allow for the possibility for innovation and therefore should not specify technology but only the level of service required (technology neutral);
3. Regulators must hold a deep understanding of the marketplace. If there is to be open competition for the few profit centres in the North, how does that affect competition and subsidization of small and isolated markets? What impact does competition have on existing network viability? What impact does no competition have on pricing and innovation?

Other countries have broadband implementation plans that include various strategies used by regulators and governments, with the intent of stimulating competition, innovation and investment wherever possible, including:

- Regulators set a minimum level of service to be delivered to all communities, regardless of geographic location;
- Regulators do not direct the market or technical development;
- Regulators' task is to create good conditions for the market, formulate policy targets and clear away obstacles to development;
- The goal is for universal service to be provided by the market at an affordable price. Government should only become involved when it is apparent that the market has failed -- with intervention based on sound economic principles and where the benefits of such intervention outweigh the costs;
- To support the investments it is important to have regulations that are long-term and predictable and that give market players an incentive to invest;
- In the event of market failure, government may request a service provider to provide service, but if cost represents an unfair burden, the government may take more direct position in that market;
- Regional market differences may call for unique solutions. For example some regions may be able to compete with more than one backbone provider, while other regions are only able to compete on the last mile—in this case regulators play a role in ensuring equitable access to backbone interconnectivity that stimulates competition;
- Regulations should promote backbone infrastructure competition wherever possible, with deployment of parallel infrastructure. Where parallel infrastructure is not possible, access by other companies to the dominant infrastructure should take place at as unrefined level as possible. "Unrefined wholesale services impose clear demands on the operators to make their own investments, while control of their own supply of services is greater, making it possible to differentiate the services with regard to content, quality and price. In addition, access at an unrefined level means that the intervention signified by regulation in relation to the dominant company does not become unnecessarily great." (Government Sweden, 2010);
- Where economic conditions for infrastructure competition do not exist, regulation can promote competition within an infrastructure and at higher levels of refinement.

The decisive factor is whether the regulations promote investments in new infrastructure and at the same time ensure effective competition. It is also important to factor in regional market conditions. There may be justification for competition within a backbone infrastructure in some regions while competition elsewhere may only take place at the last mile.

How will competition and incentives for new infrastructure investment be balanced? It can be argued that investment interest will be lower if market access was too easy or access to the backbone infrastructure too cheap. This applies in particular to infrastructure in remote areas where the rate of return is lower than in urban areas. But

liberalization of the market and greater competition has been a crucial factor in driving down costs and promoting innovation. The CRTC will need to understand these points when looking specifically at the Arctic marketplace.

It is a delicate balancing act. If new entrants to the Northern marketplace are not required to invest any of their own money, this does not drive innovation. At the same time, if there is not a great enough rate of return, the companies will eventually stop serving the Arctic, or at least uneconomic parts of it (which is essentially all communities except Yellowknife and Whitehorse).

Territorial and federal government departments concerned with issues of accessibility and affordability for the public have a strong role to play in the regulatory debate. Any group concerned with the long term survival of robust communication companies must also be engaged, including the service providers themselves.

Subsidization/government investment

The challenge of cross-subsidization

One of the challenges of subsidization in rural and remote Canada is the persistent use of cross-subsidy in building and maintaining infrastructure. While reliance on the 'cross-subsidy' model is no longer applicable in much of the world with the introduction of deregulation and liberalization of markets, we are still dependant on explicit and hidden cross-subsidization in the north.

For example, NWTel is expected to use phone service revenue from the larger markets to 'cross-subsidize' the cost of serving smaller markets, which in a northern context, means that the relatively small markets in Yellowknife and Whitehorse are to cross-subsidize over 90 other communities in the NWTel service area—this in itself is rather complicated. But as competition is introduced into these markets, will NWTel be able to continue providing services to unprofitable markets? Should competition be introduced in larger markets at the expense of smaller ones? Under this scenario, NWTel would have no choice but to argue against competition.

In an example of hidden cross-subsidy across services, NWTel competes to win government data service business. This investment is then used to cross subsidize smaller communities phone service access. Competition for the data service could threaten phone services in small communities which is considered part of the telco's "Basic Obligation to Serve".

While it makes sense from a superficial viewpoint to expect a company to internally cross subsidize its services across communities and business divisions, the unintended consequence is that when competition is introduced in a few areas, it threatens the entire communications infrastructure.

Competition for subsidies

In the Arctic, in recent telecommunications development, we have invited service providers to compete for subsidies in order to build new infrastructure that will support services such as broadband networks, cellular services and mobile radio services. (See Section 5.4 for a list of these initiatives.) Then, once the service provider receives the subsidy, they own the infrastructure they build. For each project, there are differing expectations from government investors for service provider investment.

In this 'competition for subsidy' model, it is expected that after competing for, and winning the subsidy for the initial investment, service providers will be able to deliver services at a profit that will allow them to maintain and upgrade their infrastructure through sales to consumers that keeps pace with technological change.

It is evident that this model faces challenges. If the model was working as envisioned, initial subsidies by government combined with private sector investment in 2003 and 2004 would have seen new broadband networks across the North expand and evolve to manage the introduction of services like YouTube, iPhones, Skype with video, movement of large files such as GIS mapping data, and full length movie distribution via the infrastructures with no additional government investment. It is simply not a realistic expectation in the Arctic environment with the high cost of providing service combined with the rapid escalation of use and expectation of increasing capacity from our networks.

Subsidization strategy

A 2009 report entitled 'What Role Should Governments Play in Broadband Development" by the World Bank, a wide range of initiatives for providing broadband services was investigated. An important observation was that countries with coherent national strategies have tended to be more successful in fostering broadband diffusion. (infoDev, 2009, page 5).

With national strategies, government makes investment commitments to build infrastructure, focusing on markets that have failed to produce the necessary services through competition. Depending on the market models used in each country, infrastructure procured by government may be owned by the government or industry, or a combination of both. In Sweden, for example, government owns a great deal of dark fiber, but there is competition built into its system wherever possible.

This chart below contains the relative investment into broadband networks from a number of countries, identifying planned government investment (InfoDev, 2009). While figures of different subsidy amounts vary depending on the publication and the inputs measured, the relative ranking of countries is the important data to note.

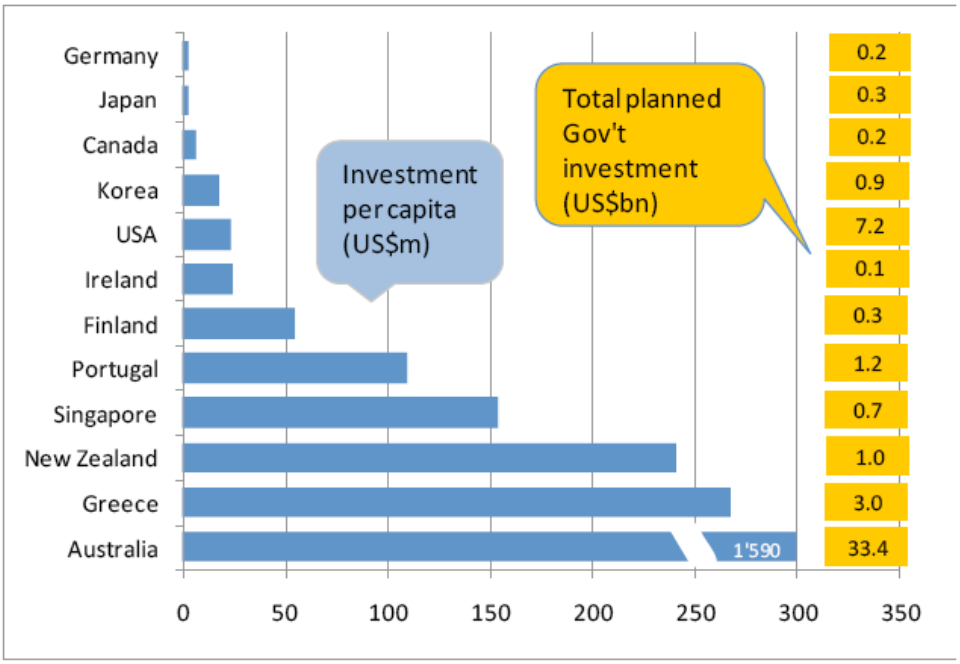


Figure 8: Government planned spending on broadband as a component of economic stimulus packages

Source: World Bank, based on data from ITU, Booz and Co and OECD.

For a country like Australia, for example, with some similar geographic challenges as Canada, the government investment ($33 billion out of 43 billion total investment) is based on a strategy of equal access for all, believing that broadband networks are the key to a robust economy that can attract international business and prosperity for residents.

There is no comprehensive strategy in Canada yet, and no strategy in relation to the Arctic.

The subsidy model used across the territories is difficult to understand. It does not appear to follow a clear strategy. And the results are a rather disorganized market with multiple service challenges. In Yukon, they are faced with one monopoly provider, which causes challenges for innovation and pricing. In NWT, they have two providers, with government investment for its core services provided by the incumbent Telco. In Nunavut, they have selected a new entrant for core government services, and the existing Telco has told the CRTC that its services in satellite-served communities are threatened.

> *To-date, the Government of Nunavut, clearly the 'anchor tenant' for any network in this high cost region, has chosen to move its services to this competing*

network [SSi Micro], resulting in significant revenue losses that Northwestel relied upon to sustain the provision of services to remote high cost communities. Moreover, due to the high fixed cost nature of provisioning local access services to very small remote communities, a net impact will be to increase residential access costs on a per NAS basis. This extensive government funding not only created a very uneven playing field, it has now put at risk the sustainability of providing basic telecommunications services to these high cost satellite communities (NWTel, 2010, page 12).

Whatever subsidy models are determined to be best for the Arctic, it is clear that a one-time investment will not provide the necessary long term stability in the provision of broadband and other communication services, as technology and expectations of service continue to evolve. In most of our Arctic communities, there are requirements for ongoing subsidy for electricity provision, the building and maintenance of physical roads, and other major infrastructure. Communications infrastructure should not be treated differently—except that the pace of change is much faster. Any investment strategy must include provision for current (and increased) rate of change and continuous introduction of new consumer services and devices in the communications industry.

When all levels of government can work to develop a national and northern strategy for improving communications infrastructure, as most OECD countries have done, the question of how to subsidize networks must be front and centre in the debate.

Innovation

Innovation can viewed in the traditional sense with respect to technological innovation, but also refers to innovation in the manner in which the market operates.

Technological Innovation

Innovation is the development and implementation of new concepts, products or services unique to the target market. Technological innovation involves research and development (R & D), and as such, these projects are often eligible for tax credits.

Innovation is something to be hoped for but cannot be mandated, and it is rare.

In an Arctic environment, the small size of the target market means that technological innovation is unlikely without significant investment to entice providers to innovate, as they must eventually obtain a return on investment, and the market is simply too small.

There is certainly some innovation in the Canadian Arctic in communications. Yukon College researchers are doing cold climate innovation, experimenting with green power to repeater stations that may reduce operating costs of microwave backhaul sites. The military is experimenting with rapid response cell phone service that can be delivered via a balloon over a temporary site. Communications Research Centre experiments with improving satellite communications, leading to innovative changes over the years. Cisco's

Internet Routers in Space program is another example of innovation - a program that has the potential to profoundly improve satellite latency for users all over the world.

There is no shortage of innovative solutions to be found for the north. From improvements to satellite services to meet increasing bandwidth demands to the greening of repeater stations, to the development of custom software that support Inuktitut that can be managed through a tablet in the field. The list of innovative services that the North could use is endless.

For the service providers in the Arctic to truly innovate, they will need access to much larger markets who need their innovative products to provide a return on investment. Or, they will need government support to innovate.

Marketplace innovation

There are many reasons broadband markets fail. These include:

- the persistence of monopoly-type structures in the provision of broadband infrastructure, even when no legal monopoly exists;
- lack of economies of scale;
- Difficulties in obtaining legal permission to operate;
- inefficient allocation of radiospectrum; and,
- poor information and limited capital markets (infoDev, 2009, page 6).

Normally, these market failures in the ICT sector are addressed through regulatory policy, such as:

- liberalizing licensing regimes;
- facilitating efficient access to radiospectrum and regulating access to dominant operators' networks;
- provide regulated access to the incumbent operator's network ("unbundling the local loop"); or,
- providing low-cost access to existing infrastructure facilities such as energy and transport networks (infoDev, 2009, page 6).

Some examples of 'innovation in addressing market failure' have been undertaken in various countries.

In France, they have implemented a "ladder of investment" approach:

> *"At the lowest level is resale of the incumbent's capacity, which requires interconnection at only one point in a network.*
>
> *Later, bitstream access was offered at a regional level, whereby the entrant would interconnect at multiple regional points and construct a backbone network between them.*

> *As full unbundling of the local loop was mandated, full-service operators, such as Iliad (www.free.fr), have further generated growth in direct competition to the incumbent, France Télécom, while building their own networks.* (infoDev, 2009, page 5)

The Republic of Korea provides positive financial incentives for operators to invest and compete in a "public/private partnership". The government provides "administrative guidance" to the private sector, and works via public/private institutions to foster national targets and goals (infoDev, 2009, page 8).

8.6 Conclusions on the Economics of Broadband

There isn't a single approach to bringing a great broadband service to a region. In our study of the world leaders in broadband, each has taken a different path. In Sweden, the government has approached the challenge from a view of market demand, but with the caveat that equality is an important value within Swedish society. The first question for that country was "what services do/will the citizens of Sweden want?" Followed by, "how can these services be delivered to rural and remote locations?" Their response has been a mix of regulations on private sector users, public investment, and ownership. Where the market cannot be competitive, Sweden is investing in the backbone and allowing competition for the last mile.

Australia is taking a very different approach. There, the government regards the challenge from the perspective of supply. It has established a minimum standard of service that all Australians must have access to; 12 Mb/s. In setting this standard, it has determined the market would be incapable or too slow in achieving this standard. Its answer is to establish the National Broadband Network, which will invest $43 billion over eight years in a mix of fiber optic cable and satellite infrastructure for the entire country. The competitive market will still exist, but will have equal access to this government backbone.

In the United States, where political ideology tends to favour the free market more so than most other countries around the world, the government is also taking a very active and aggressive role in bringing broadband to its remote communities. The government will not build the infrastructure itself, but will provide large subsidies to ensure broadband services are accessible to all Americans. This includes an $8 billion communications strategy of which $4.3 billion will go into the least populated north western states including North and South Dakota, Wyoming, and Montana.

There are many other examples. The French market for broadband was dominated by the country's national telecommunications company. This is changing by gradually giving the new private sector access to the national backbone. In Korea, the approach to broadband development has been one of private and public partnerships with very high and stringent regulatory standards.

What does this all mean for Canada's north? Countries around the world have been successful by first recognizing the market conditions that exist. One would not automatically think of Australia as the country most likely to have its government hold such a large position in a market that it acknowledges as being highly dependent on competition. But it has done this because it sees the laws of competition also apply internationally. If Australia is to be competitive in the 21st century, it must have this infrastructure in place now. Similarly, one might expect a country like Sweden to view the broadband market from the position of a public good and follow a socialist approach in investing and owning. In their case, the Swedes have determined the role of competition is important in reducing costs and increasing innovation. Where that competition is challenged, the government will invest in and sometimes own the backbone, but otherwise not interfere with the competitive process.

The recent report issued by the Federation of Canadian Municipalities in response to the federal government's Northern Strategy sets out an important recommendation for the future of the North - to benefit both residents and Canada as a whole:

> *"It is always assumed that major infrastructure investments begin with huge ticket items, like roads and railways. Led or supported by the Canadian Forces and local municipalities, the Government of Canada should begin instead by building a world-leading information technology infrastructure for remote regions, focusing in particular on service access and bandwidth improvement. Doing this with Canadian business could help produce a global business opportunity. Creating a next generation information technology network to provide a wide range of services – e-government, e-entertainment/ e-culture, e-health, e-education, remote work, etc. – will improve the quality of life in the North, and connect the region to the country and the world very effectively. The effective provision of IT services across the North should become a hallmark of Canada's 21st century commitment to the country's remote citizens, as well as any military stationed there" (FCM, 2010).*

These are important concepts. In order to meet this important recommendation, we provide some economic recommendations to consider.

Economic recommendations: proposed steps for a way forward

Step 1. Understand the market.

First and foremost, it is imperative that the key stakeholders *understand the market*. Canada's territories share some similarities with Sweden's remote communities and Australia's outback, but there are still many characteristics unique to this marketplace. Any future changes to the industry must be made with full recognition of the unique characteristics that exist in that market.

Step 2. Recognize the importance of competition.

There is probably no other industry where it is so vital in lowering price, adding innovation, and improving what has essentially become a public good. Accepting the role of competition does not translate into a singular, hands-off approach to regulations. We have found that even in the United States, this is not the case. Where vertical or complete competition cannot be achieved (from the infrastructure right to the home), then competition can be made possible at different market segments. For example, competition at the research and development stage, competition for the installation of infrastructure, and/or competition at the community level for household consumers.

Step 3. Establish standards.

There are many strong arguments why fast, reliable, and secure broadband services are needed in the three territories, and not a single strong argument why they are not. It must be understood that as technical standards evolve, minimum standards must evolve as well. There have been numerous studies that indicate the effect broadband investments have on GDP and government costs over the long run. A study of this nature is needed in the three territories. Within that process, regulators must determine what minimum speeds are going to be. It is only after that has been established that regulators can begin to assess the best approach to bringing these services to the market.

Step 4. Develop and articulate a communication infrastructure and broadband strategy that will achieve the minimum standards.

This will include a large public investment. But how that investment is made will be based on Canadian values and ideology. The success of countries like Sweden, Australia, the United States, France, and Korea in becoming world leaders in broadband is largely a result of understanding their own market place, taking a clear position on how the market will evolve, and then following that position closely. Currently, there is no clear strategy or approach across the three territories.

Step 5. Stop relying on cross-subsidization models.

The Canadian telecommunications industry has long relied on cross-subsidization to bring essential services to all citizens. This will no longer work for modern communications infrastructure in the north. There is some competition possibilities in the two largest markets (Whitehorse and Yellowknife), but even there, the population base is not enough to support a lot of innovation on its own. And certainly, there is no room for these markets to subsidize others across the North. It might be more appropriate to think of the current system where Yellowknife and Whitehorse subsidies are supporting deficiencies in the subsidies for remote communities.

Step 6. End market disruption caused by government's muddled approach to the marketplace as owners, regulators, and purchasers of broadband services.

In most governments, the role of regulator and the role of purchaser fall to two separate departments who are not required to meet the other's mandate. It is not reasonable to expect the customer/commercial part of the government (the buyer) to meet the 'consumer right to affordable access' task set out by the economic development department. In another example of complicated mixing of roles, if the same government department that purchases service from the private sector in competitive tendering also owns significant parts of the infrastructure, this will add another level of complexity. For every hidden cross-subsidy, or implementation of mixed models, there are consequences to the market. Once rules are established, government must follow its own rules and regulations and take a transparent approach to its current and long-term purchase requirements. Unraveling this problem starts back at steps one and two and understanding the market and designing a strategy that fully recognizes the market realities.

Objective D: Fit/Gap Analysis & Strategy Forward

Chapter 9: Recommendations: Addressing the Issues

Chapter 10: Strategy Forward

9 Recommendations: Addressing the Issues

9.1 Introduction

It is clear to anyone attempting to use new communication tools in all communities in the Arctic that there is a severe gap between what is needed today and what they can affordably purchase. The gap in the future will only increase if nothing is done.

This chapter details 10 specific recommendations toward closing that gap over the next five years.

This Assessment took a best guess for demand in the next 3-5 years (Chapter 7) based on what we know today. However, the communications industry is evolving rapidly, so this projection will need to be revisited annually as people increase their use of low-latency high-bandwidth applications such as video, telehealth, and use of 'self-service' centralized data. Coupled with an explosion of dependency on mobile devices, communications will play an increasingly important role in the future development of the Arctic.

There are already many extremely difficult challenges in the Arctic; an inadequate communications infrastructure cannot be allowed to cause more important things to fail, like emergency services, health, education, housing, industry, opportunity and sovereignty. It is comparatively easy to fix communications infrastructure.

The recommendations in this chapter are presented as possible solutions to the specific issues raised in Chapter 5. Taken together, they aim to meet the challenges of:

- Achieving service parity
- Meeting bandwidth needs & reducing costs to the end user
- Increasing reliability and quality of service
- Improving geographic coverage between communities
- Improving emergency response
- Keeping pace with technological change
- Increasing choice through innovation and competition (2 recommendations)
- Supporting human resource development

Each section in this chapter presents the overview of the issue, and provides a single recommendation to address each issue (with the exception of 'increasing choice', which has 2 recommendations).

The Arctic must have affordable, robust communication services for the benefit of the residents, and the benefit of all Canadians. These wide-ranging recommendations can help to close the gap in services today and tomorrow. Federal and territorial policy makers, service providers, regulators, procurement officers and NCIS-WG members will need to make a concerted effort to implement them.

9.2 Achieving service parity

As federal and territorial governments implement more and better services that rely on modern communication networks, the gap in access to services and opportunity between well-connected and poorly connected regions and communities will only widen.

Ensuring appropriate communication services may be one of the few truly affordable infrastructure efforts that will help to address some of the challenges facing northern residents, and the sustainability of communities in the long run. There are many strong arguments why fast, reliable, and secure Internet services are needed in the three territories, and not a single strong argument why they are not. Numerous studies in other countries indicate the positive effect broadband investments have on GDP and government costs over the long run.

The decision to ensure or not ensure service parity to all communities within each Territory has many implications to northern development. This decision may be one of the defining decisions in the future of many communities in the Arctic in the 21st century.

Access to modern networks will not necessarily result in increased opportunity in every facet of community life. However, lack of appropriate access will ensure that communities cannot take advantage of what better communications access can help to provide - including improved health care, education, business opportunities, governance, engagement in development, and the hope of a better future.

The consequences of inadequate wealth distribution from resource development are described in Section 8.4. In a comparable way, failure to provide service parity in Arctic communities will eventually put poorly serviced communities at a considerable disadvantage, leading to economic hardship for individuals and communities, and prolonged financial challenges and increased costs to northern governments.

Attempts to reach some level of service parity between the North and South are ongoing, as service providers and governments have worked to connect Whitehorse and Yellowknife to fiber and increase the capacity to the largest communities. But service parity does not stop with the connection of the two largest cities of the Arctic.

If Territorial and federal policy makers do commit to service parity among all Arctic communities, they will need to make decisions at the policy level on minimum connectivity standards for all communities that ensure a level of service parity within and across the North.

Chapter 4 of this Assessment documents the existing bandwidth available to communities. Chapter 7 has provided some community-wide bandwidth targets, based on input from key government departments. These targets form the start of the process required to define an Arctic minimum connectivity standard. It will be important to recognize that minimum standards must evolve as technical standards evolve, so the issue must constantly be revisited.

RECOMMENDATION 1:

To: Federal and territorial policy makers

Commit to service parity among Arctic communities, and set minimum connectivity standards for all Arctic communities that assure service parity to southern urban centres.

9.3 Meeting Bandwidth Needs & Reducing Costs to the End User

Chapter 8 outlines some of the initiatives other countries have taken to meet the challenges of building out a network infrastructure that can provide affordable access to end users. Only after minimum standards have been established can regulators begin to assess the best approach to bringing these services to the market. All the players must understand the unique nature of the market in which the services will operate.

Successful efforts to connect disparate regions in other countries have relied on developing a communication infrastructure and broadband strategy to achieve certain minimum standards, as defined in each jurisdiction. The Arctic will require a similar strategy.

As explained in Section 5.3, delivering affordable bandwidth to Arctic communities is an expensive business, that cannot be borne either by the purchasers of service alone, or by private sector providers that require a return on their investment to stay in business.

The initiatives to date (itemized in Section 5.4) to electronically connect the public and government in the three territories are very important, and have provided minimum levels of connectivity to many communities today. However, today's needs for connectivity are expanding at a much faster rate than what networks are able to provide with the funding models available, and where infrastructure is in place to offer the needed connectivity, the cost is often too prohibitive for users to afford.

Lack of sustained, consistent funds for government initiatives and public access, combined with the need for constant network upgrades to meet expanding demand, make it difficult for service providers or buyers to invest enough to meet future needs for both government and the general public.

In the Arctic, a realistic communication infrastructure and broadband strategy will have a number of important elements.

First, such a strategy will include a requirement for significant public investment. How that investment is made will be based on consistent decisions, and shared values. Currently, there is no cohesive approach across the three territories.

Furthermore, as argued in Chapter 8, the strategy must also set out the rules to deal with market disruption caused by government's contradictory roles in the marketplace as concurrent owners, regulators, and purchasers of Internet services. Unraveling this problem requires a deep understanding of the market and the development of a strategy that fully recognizes the market realities of the Arctic.

Another consideration in developing a strategy for developing Arctic communications infrastructure is in recognizing the impact of cross-subsidization by service providers (as required by regulators) - a process that belonged to another era when large markets subsidized small markets in return for monopoly status in phone service delivery. With convergence, deregulation, and the pace of technological change, cross-subsidization is no longer an effective tool to achieve ubiquitous services.

RECOMMENDATION 2:

To: Infrastructure investors, the CRTC, federal and territorial policy makers

Develop an Arctic-specific strategy with clearly defined rules, that articulates a sustained, multi-year funding commitment for communications network development to meet connectivity standards set by policy makers.

9.4 Increasing Reliability and Quality of Service

As people become more reliant on communications networks to live their daily lives, those networks must become increasingly reliable. Government planners must also have faith that communications networks will work when needed, in order to implement new services enabled by advanced communications networks.

Reliability has become a huge issue in the Arctic, particularly in the regions where investments in new technologies have actually increased dependency on communications for everything from health care delivery and education, to the basics of supporting the economy and providing emergency services. As this dependency increases, so do the negative consequences of system failures. Examples of the inherent fragility of the Arctic networks in all regions are provided in Section 5.5.

The single most important requirement to ensure services are not knocked out in a single communications event, such as fiber cuts, microwave tower and satellite earth station

damage, or even satellite failure, will be to build redundancy into the backbone connectivity. Every satellite-served community will require connectivity to two different satellites. Terrestrially served communities will require a second point of entry - either with a second terrestrial line, or satellite back up that could be brought online immediately as a fail over service.

It is simply not good enough to have a single point of failure when economies, public safety and ultimately lives are at stake. Redundancy should extend beyond the consumer level service and include ground equipment and satellite use.

> RECOMMENDATION 3
>
> To: Policy makers, service providers, and NCIS-WG members
>
> Ensure there is a redundant connection into every Arctic community to avoid gaps in the provision of essential communication services.

9.5 Improving Geographic Coverage Between Communities

As governments assess the need for better geographical coverage, lessons can be learned from one agency to another.

For example, Yukon's MRS system is the newest mobile radio system in the Arctic. The service provider (NWTel), together with Yukon government officials responsible for using the system may be able to offer the NWT, the military and Nunavut some insights into how they deployed the new digital system, made use of repeater station technology in cold weather, and challenges in protocol linking non-military users of mobile radio services.

Emergency responders are experimenting with a wide range of satellite-connected systems as described in the Section 5.6. These systems may be applicable across a wide range of users.

Federally sponsored research by Communications Research Centre (example in Section 3.3) needs to be connected with commercial service providers in the Arctic so they can help develop and commoditize successful services that can then be made available to others across the North.

RECOMMENDATION 4

To: NCIS-WG members and service providers

Create an inventory of Arctic communications technology projects and services that aim to connect people from remote locations outside of communities in order to share experiences, best practices, and lessons learned.

9.6 Emergency Response Improvements

The ability to communicate effectively and efficiently in order to respond to an emergency in the Arctic is, in essence, a question of sovereignty. In extreme emergency scenarios, the existence of adequate communication networks is a question of survival.

Emergency responders arriving in any community in Canada often rely on publicly accessible networks for connectivity - particularly for Internet and mobile device connections. The process of emergency response is outlined in Section 5.7.

The failure of local communication services in an Arctic community during an emergency response exercise in 2009 kick-started this Assessment process. From a southern vantage point, it can be tempting to look at Arctic emergency response in isolation, imagining responders flying into a remote Arctic site with all the communications gear they might need to respond stuffed into their suitcase.

But in reality, if outside responders are required to deal with an emergency, they usually fly into established Arctic communities first, before heading out to the field (in the event of an emergency on the land). Over-all response capability is deeply intertwined with the response capability of the community closest to the emergency - whether the emergency is local, regional, or national in scope. Responders need to initially rely on local communication networks they can access, and they need those networks to be reliable.

It is entirely possible for Arctic service providers to be prepared for emergency events, if in advance, protocols and procedures could be developed that are agreed to by service providers and emergency responders in advance of a wide range of possible emergencies. Issues to be covered include:

- definitive, up-to-date list of what services are actually available, by community; (current list as of February 2011, in Section 4.6).

- a rapid, defined procedure to request surge capacity from the service provider by emergency responders;
- security requirements;
- a system for prioritizing use for first responders, to avoid overloading local networks.

As publicly accessible northern networks improve, emergency access will also improve.

The military typically deploys its own communication sites for its own purposes. But in emergency response, military participants of the Assessment have indicated a willingness to collaborate with civilian agencies in finding communication solutions that help the military and civilian responders as well as community residents with improved communication capacity. Challenges in security are always an issue to be examined, but with planning and foresight certain types of communication services can be shared.

> RECOMMENDATION 5
>
> To: NCIS-WG members and service providers
>
> Identify communication services that will be required in a variety of emergency settings, developing protocols with service providers for surge capacity requests and prioritization of public communications networks for emergency responders within communities. Maintain an inventory of what is commercially available in communities.

9.7 Keeping Pace with Technological Change

The rapid pace of technological evolution combined with rising consumer expectations across the Arctic has left network operators without the necessary resources to meet the needs of both government and the public. Examples of ever-increasing efforts by government to use new communications tools to reach consumers are provided in Section 5.8.

The program-based one-off nature of the investment in new networks (Section 5.4) to date has not enabled service providers to adequately to keep pace with technological change.

Because of the North's small population and large geography, consumers don't drive competition and evolution of service in the same way as southern urban centres. Growth

is therefore at least partially dependant on subsidy frameworks, and regulatory initiatives aimed at ensuring affordable access to consumers.

The CRTC is currently conducting three different hearings, all of which are at different stages. These hearings are dealing with different aspects of the technological pace of change, and how they may affect the ability of networks to respond to, and meet the challenges of the future. They are described in Section 5.8.

In order to keep pace with the rate of change, the reality of the northern marketplace combined with consumer and government needs must be understood by all players, and ongoing subsidy support and regulatory action must be taken in a timely fashion to ensure affordable services can be developed, evolved, and delivered.

> RECOMMENDATION 6
>
> To: CRTC, infrastructure investors, federal and territorial policy makers
>
> Investment strategies for Arctic communication networks must include provisions for the increasing rate of change of technology, and the continuous introduction of new consumer services and devices.

9.8 Increasing Choice through Innovation and Competition

Compared to communications services, there is probably no other industry where competition is so vital in lowering price, adding innovation, and improving what has essentially become a public good. Accepting the role of competition does not translate into a singular, hands-off approach to regulation. Other jurisdictions in the world, as summarized in Section 8.6, attempt to introduce competition, even in markets where logic would dictate that only one provider can survive.

In some jurisdictions such as Sweden, governments own the backbone, and then private companies compete for last mile service delivery. In other jurisdictions, such as southern Canada, private sector companies own the backbone, and are forced through regulation to provide open access to competitors to compete to provide last mile services.

If vertical or complete competition cannot be achieved (from the infrastructure backbone all the way to the home), then competition should be made possible at different market segments. Examples include competition at the research and development stage, competition for the installation of infrastructure, and/or competition at the community level (or last mile) for household consumers.

RECOMMENDATION 7

To: Policy makers, CRTC, service providers

Investment models should allow for, and encourage competing services in as many market segments as possible, thereby promoting consumer and government choice, and innovation and improved services.

In southern markets, consumers drive innovation and choice through their buying power.

In the North, governments are expected to drive innovation through their buying power. But most government buyers are required to be risk-averse and make long term decisions that do not typically allow for rapid technological evolution of networks to meet their evolving needs. Section 5.9 looks at some of the challenges in innovation and competition in an Arctic context.

It is unrealistic to expect that government procurement will drive innovation and expansion of networks. However, procurement processes could help improve innovation with some steps, including:

- pan-Arctic efforts to share best-practices in procurement;
- focusing on outcomes-based RFPs that are technologically neutral;
- consider innovative procurement strategies such as Joint Solution Procurement;
- allow flexibility in federal procurement within the Arctic, recognizing the unique infrastructure challenges that are different than the South.

Public demand for more services fuel innovation faster than government buying. Real innovation will occur if financial incentives are put in place for delivering services to the public through competition for subsidies that lead to better, more ubiquitous services to the Arctic public. The public will benefit, and ultimately so will government procurement processes, as the existence of multiple providers may be made possible, leading to more competition and innovation to meet governments' needs in the long run.

RECOMMENDATION 8

To: Procurement officers, service providers

Government procurement officers are to encourage innovation through RFPs that focus on business outcomes requirements and technology neutral RFPs to stimulate innovative solutions from service providers.

9.9 Human Resource Development

Issues in human resources are summarized in Section 5.10. Communication networks hold the promise of being able to actually solve some human resource challenges in communities to improve training and education opportunities for local staff..

In addition, linking specialists from other communities or the South to provide expertise will continue to evolve, as governments invest more heavily in connectivity in order to solve some human resource challenges in smaller communities particularly in education and health.

When designing and building communication networks, it is important to recognize the existing capacity of the people who are already living in communities, and ensure systems can be maintained with local support.

Designing systems whereby local people can learn the basic maintenance and support roles will allow local people to grow into the jobs, and evolve their skill levels over time. Corresponding training for network support people in communities can be delivered as needed, even using communication tools for distance training.

RECOMMENDATION 9

To: NCIS-WG members, IT developers, all government departments

Recognize the reality of community capacity, and design applications and networks that will allow for effective remote service delivery.

RECOMMENDATION 10

To: NCIS-WG members, IT developers, all government departments

Take advantage of robust networks to deliver training to government workers using new communication tools.

10 Strategy Forward

10.1 Introduction

Clearly, the 10 recommendations in Chapter 9 of this Assessment represent a far bigger set if tasks than members of the Northern Communications Infrastructure and Information Systems Working Group can achieve alone.

However, NCIS-WG's role is to provide a forum for discussion and development in the field of communications in the Arctic. the NCIS-WG members can play a key role in assisting many other players within government and the private sector to move the agenda forward, as follows:

- Section 10.2 looks at the role of NCIS-WG members in moving the issues forward, suggesting which recommendations may be influenced or managed directly by members of the NCIS-WG.
- Section 10.3 looks at the need for political and industry support in the development of an Arctic Communications Infrastructure Strategy, and the corresponding recommendations in this report. NCIS-WG members may play a role to move this agenda forward within their own spheres of influence.
- Section 10.4 examines investment issues to be considered by policy makers, investors, regulators, procurement officers and service providers who grapple with the question of the economics of building an Arctic infrastructure that can actually meet the needs of users. Failure in developing an appropriate economic model for the Arctic is at the root of the problems faced by everyone. The related recommendations must be addressed urgently by all those concerned with ensuring a strong communications infrastructure is developed.
- Section 10.5 highlights some examples of future developments in technology, and
- Section 10.6 summarizes some possible next steps for NCIS-WG members as they ultimately work toward developing a better communication infrastructure for the Arctic.

10.2 Role of NCIS-WG Members

The purpose of the NCIS-WG is to develop an understanding of communication capabilities in the North, assets that are available, identification of communications deficiencies and redundancies, and development of a timeline to address concerns/issues.

The NCIS-WG also aims to provide a forum for mutual discussion and

> *"Close collaboration with other government departments will be the key to success in ensuring communications pathways, and shared applications will permit sharing of key information in the interests of pursuing our respective missions and mandates."*
> --- Major Michael O'Donnell, Department of National Defence, Canada Command

development in the field of communications in the Arctic.

The research, meetings, and collaboration required between governments and service providers in order to produce this Assessment has been an important first step in working toward addressing communications infrastructure concerns and issues.

Strategy suggestions

Ideas presented during the visioning sessions for consideration and discussion at future NCIS-WG meetings include:

- Obtain a mandate from the political level to collaborate across governments on solving the communication concerns/issues raised;
- Identify champions within each department to move the issue forward within their own department;
- Continue semi-annual NCIS-WG meetings, casting a wider net to include more departments across the North for collaboration;
- Invite service providers to present technical solutions to the group at formal meetings so members can see what the future may hold.

Some of the recommendations in Chapter 9 could be led by the NCIS-WG as concrete goals to work toward in the coming years. Specific recommendations for consideration by NCIS-WG include recommendations 3, 4, 5 and 9.

10.3 Who Develops an Arctic Communications Infrastructure Strategy?

The decision to solve the communications challenges in the Arctic is a political decision outside of the scope of the NCIS-WG mandate. Sharing the findings of this report may help to move the agenda forward at the political level.

If territorial and federal policy makers decide that modern communications infrastructure is a fundamental requirement for the survival of communities across the Arctic, the next step is determining how to make it happen.

Other countries have taken these steps in the development of their strategies to connect their populations, and the Arctic would benefit in having a well-thought out strategy, distinct from a national strategy. Key steps (as outlined in Chapter 8) include:

Understand the market - Recognize the economic reality of the North as a high-cost, low population region where public funds will be an ongoing requirement for communication networks;

Establish standards - Determine the minimum standards of connectivity for northern communities based on user needs, that enables communities to access services and participate fully in health, education, business, social and safety related activities for the long term survival of communities;

Develop an Arctic Communications Infrastructure Strategy - Develop and articulate a communication infrastructure and broadband strategy that will achieve the minimum standards as defined by policy makers.

This strategy would have to involve policy makers, regulators, and service providers in attempting to map out the rules and regulations for stimulating the development of a service that meets the needs of users at an affordable price, and can evolve over time.

Recommendations 1, 2, and 3 as described in Chapter 9 are issues to be considered by federal and territorial policy makers and service providers in developing a comprehensive Arctic communications infrastructure strategy.

10.4 Investment Plan

It is clear that communications infrastructure in the Arctic will require more public money to support its development and evolution.

An investment plan will need to be developed, making the rules and regulations for public support clear for service providers, public investors and government procurement officers to avoid a haphazard approach to communications development. The CRTC's National Contribution Fund, Infrastructure Canada's National Satellite Initiative, and Industry Canada's BRAND program are all important initiatives, but these types of programs need to work together to ensure public investment results in affordable, reliable infrastructure.

Competition also plays a key role in providing innovative solutions, particularly in the rapidly evolving communications sector, as outlined in Section 8.5. Other countries with comprehensive plans use public funds to help stimulate competition in otherwise uneconomic markets. Investment plans should recognize these issues in determining how investment will be made in Canada's Arctic communications infrastructure.

Canada's public investment in broadband infrastructure pales in comparison to the $33 billion public investment pledge made by the Government of Australia (plus another $10 billion of private investment) to link all of its citizens to adequate communication services. With a geography and population distribution similar to Australia's, it should be of great interest to Arctic stakeholders to watch to how Australia's efforts unfold in delivering affordable access to its remote regions.

It is entirely possible to allocate the necessary public funds to support communications infrastructure development in the Arctic if the political will is in place. The cost of developing a robust communications infrastructure is an inexpensive infrastructure investment in the Arctic, when compared with other infrastructure initiatives like roads and ports. And communications infrastructure investment stands to provide the biggest payback for all citizens in all 75 communities if implemented to a standard that ensures parity.

A sovereign Canadian Arctic requires Canadian citizens to live in it. Resource exploration and extraction is made affordable in part because of the presence of communities with

airstrips, hotels, and local workers. The military relies on a network of Rangers to patrol much of the Arctic. These national efforts require national support.

Arctic residents are key players in the future of Arctic sovereignty and resource wealth generation that will benefit all Canadians. Much of the wealth generated from resource extraction is collected by the federal government. There is a corresponding responsibility to ensure federal support goes back into communications infrastructure that results in opportunities for all people who live in the Arctic.

Relevant recommendations from Chapter 9 for consideration by policy makers, government investors, regulators, procurement officers and service providers include recommendations 6 through 8.

10.5 Backbone Infrastructure Options Evolving Too

Just as recent innovations in consumer products like the iPad or BlackBerry Playbook, or services like Facebook have changed the way consumers connect, recent improvements in backbone infrastructure products also offer new and better ways to connect communities, and people on the land.

As vendors pitch technologies to link a handful of communities, or sell a service to one single government department, government money is sometimes spent to solve a single isolated problem when collaboration may provide better results in the long term.

By developing a strong Arctic communications infrastructure strategy that includes a well-articulated investment plan, it will ensure that public money is not used to purchase services in isolation, that might not meet the needs of the Arctic.

As recommended in this Assessment, it will be important to define the business requirements and outcomes, not the specific technical solution when determining public investment.

Establishing minimum standards, developing a strategy to meet those standards, and developing an investment plan, will set the stage for all vendors to propose innovative solutions for Arctic connectivity that can benefit everyone.

There are many examples of current and potential future initiatives in backbone development of relevance to the Arctic. Some of these are included here for reference. This is not intended to be an exhaustive list - it is only provided to indicate the wide range of possibilities that exist technically.

- NWTel and SSi are both able to upgrade their networks, ground station infrastructure, and terrestrial networks to handle more bandwidth, and are continually evolving their networks as funds permit.
- Telesat plans to launch two new satellites, and still has unused capacity footprinting Arctic communities.

- Arctic Cable Company LLC based in Alaska is planning to install a submarine fiber optic telecommunications system providing a direct low latency route (89 milliseconds) from Tokyo to London, traversing the Canadian Arctic. Their initial estimates to provide fiber links into 15 Arctic communities is $250,000,000.
- Cisco estimates it can effectively link all 75 northern communities with a new 'space-to-ground' IP network that features 'IRIS' (Internet Router in Space) technology that provides high-bandwidth low latency connections via satellite, at a much lower cost/community than fiber solutions.
- The Government of the NWT has commissioned a study to determine the costs and viability of linking communities along the Mackenzie Valley to a fiber connection linking Tuktoyaktuk to Inuvik, and down the Mackenzie Valley to southern NWT. Initial estimates put the price tag at $60,000,000.
- Hughes is launching a new satellite in 2012, with a 100 Gb/s throughput on Ka band.
- TELUS holds a number of federal contracts with responsibility for delivering services to various federal departments in northern communities, and are partnering with local service providers. They too are able to build on their national expertise to access new technologies.
- Communications Research Canada is experimenting with KA-Band dishes for remote connectivity.
- DND is experimenting with a wide range of communication devices in many different Arctic settings, particularly in the field.
- Nunavut Broadband Development Corporation will be investigating the cost of landing fiber into Nunavut communities in an upcoming study this year.

10.6 NCIS-WG Next Steps

The NCIS-WG members may consider these steps:

- review the recommendations in this Assessment;
- determine the NCIS-WG members' tasks in relation to the recommendations and the NCIS-WG mandate;
- discuss strategy suggestions made by NCIS-WG members in the Assessment process;
- determine who should be part of the NCIS-WG going forward;
- determine the group's specific tasks (if any) in relation to the recommendations and strategy suggestions;
- define who will be responsible for carrying out the defined tasks as a result of this Assessment;

Whatever actions the NCIS-WG takes, there is significant momentum built from the production of this Assessment. It is hoped that resolutions to the issue of communications infrastructure can continue to move forward with the vision and efforts of the people involved in the NCIS-WG, and the many stakeholders who want to be part of the solution.

This Arctic Communications infrastructure Assessment report is published online at www.aciareport.ca in an effort to make the data and findings widely available to all Arctic stakeholders.

Appendices

Appendix A: Participants in Workshops

Appendix B: Online Survey

Appendix C: Applications

Appendix D: Literature Search

Please see www.aciareport.ca to download appendices separately