Redundancy, Reliability and Disruption: Broadband Competition in Rural and Indigenous Regions

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1. Introduction

In the past, major telecom operators argued that high costs and low revenues meant that service to rural and remote regions should be considered a *de facto* monopoly. This "PTT mentality" seemed to have been discredited decades ago with the widespread introduction of competition. For example, competitive mobile operators in the developing world demonstrated that making communications more affordable could unlock enormous pent-up demand in rural and low-income communities.

Yet in the broadband era, this monopoly mentality has resurfaced, as incumbent providers seeking infrastructure funding to serve rural, remote and Indigenous regions build business cases based on an assumption of monopoly service provision. However, technology disruption has once again occurred, this time in the form of LEO satellites. The need for resiliency and redundancy in these regions has also gained prominence in the wake of service outages caused by wildfires, floods, and earthquakes.

This paper discusses the current adoption of LEO satellite services, particularly Starlink, in rural and Indigenous regions of North America and funding strategies by government agencies to extend and upgrade broadband in an era of technological disruption, as well as options to improve redundancy and resilience. It also suggests lessons from this experience that are relevant to other isolated regions, particularly the Pacific islands.

2. The Context in the Remote North

Alaska and northern Canada both have isolated Indigenous villages or communities, many without road access, and similar demographics in terms of Indigenous population, low and/or seasonal incomes, and numerous multigenerational households. Alaska Natives constitute more than 18 percent of Alaska's total population; most Alaska villages are predominantly Alaska Native. Alaska's Native population increased 10.9 percent to more than 133,300, between

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2010 and 2020.[1] The percentages of Indigenous peoples living in Canada's Northern territories range from 25 percent in Yukon, to 52 percent in the NWT, to 86 percent in Nunavut.[2]

In the past few years, several U.S. federal programs, plus some state and other initiatives, have allocated billions of dollars for rural broadband. While federal funding is more limited in Canada, funding for rural and Indigenous broadband is available from the Canadian Radio-Television and Telecommunications Commission (CRTC) and the Department of Innovation, Science and Economic Development (ISED) as well as some other government agencies. (For a comparison of U.S. and Canadian funding programs see Hudson, 2024.[3])

Agencies charged with allocating funds have recently faced new challenges in terms of competitive providers and technologies:

- The increased demand for broadband, accelerated by the COVID pandemic;
- The emergence of new technologies, especially LEO satellites, that can provide services more quickly than terrestrial or submarine fiber;
- The need for redundancy to back up networks prone to damage from natural disasters.

Of course, these circumstances also offer new opportunities:

- Availability for consumers of more reliable and less expensive broadband;
- The chance to compete for small and local ISPs;
- Opportunities for broadband users to improve delivery of social services; expand or start new ecommerce and other businesses, etc.

3. Competition and Disruption

Facilities-based competition is based on the provision of equipment for multiple networks, such as more than one mobile network, or different technologies such as satellites or wireless to complement fiber optic networks. Services-based competition requires access to an existing provider's equipment.

Facilities-based Competition

Facilities-based competition has existed in Alaska since the 1970s, when a new entrant (GCI) was established to compete with the incumbent long-distance carrier (at that time, RCA).[4] GCI is now the dominant incumbent. A major incumbent provides most services in northern Canada, with limited competition from a GEO satellite-based provider.

Facilities-based competition can also take the form of technological disruption. The most recent facilities-based competitor is SpaceX's Starlink; its LEO satellite

terminals have proliferated in Alaska and northern Canada, as residents seek access to reliable and affordable broadband. Purchase prices of approximately $500 have been subsidized by some Native organizations in Alaska, while initial discounts by Starlink reduced equipment prices for some residents in northern Canada. Purchasers then pay monthly usage fees of approximately $120. There are now thousands of Starlink terminals installed across Alaska and northern Canada on homes, small businesses, schools, health care facilities, fishing boats, ferries, and construction sites.[5] There were an estimated 400,000 Starlink terminals in Canada in July, 2024, including installations in southern rural regions as well as the remote North. A Facebook Alaska Starlink users group had 15,000 members in 2024.

Services Based Competition

Community and Indigenous service providers need access to transport networks provided by incumbent carriers where the cost of installing their own networks is prohibitively expensive. Small providers in Alaska have complained that they cannot provide competitive service packages in their communities because of the high charges they must pay for backhaul on an incumbent network installed with federal funding.[6]

In northern Canada, Indigenous ISPs have testified that high transport charges make it difficult for them to meet the CRTC's connectivity targets at affordable prices.[7] Lease charges can be very expensive, as regulation of wholesale fiber transport services has generally been forborne by the CRTC since 2011.[8] This forbearance is based on the assumption that all wholesale fiber facilities are potentially competitive. However, in most rural and remote regions, regulatory forbearance has not resulted in facilities-based competition but rather has perpetuated difficulties in access to wholesale transport monopolies.[9]

Responses to Competition

It is unclear whether LEO connectivity is primarily a temporary solution until terrestrial service is provided or upgraded with government funding from the broadband programs discussed above. Although incumbents view Starlink (and other LEO systems) as a threat, their response has also been to view them as an opportunity to add a cheap alternative or backup.

In Alaska, while GCI has successfully avoided most services-based competition, it now faces facilities competition, most recently from Starlink. GCI has responded by entering into an enterprise reseller agreement enabling it to integrate Starlink into its suite of connectivity solutions for business customers. It states: "…the addition of Starlink's LEO technology …ensures GCI is better positioned than ever before to deliver fast, reliable managed connectivity to healthcare, education and business customers throughout the state regardless of location."[10]

Bell Canada, however, sees threats from both facilities-based and services-based competition in the North: "The launch by Canadian and international competitors of low earth orbit (LEO) satellites to provide connectivity, primarily in rural areas and the North, intensifies competition, which could adversely affect our network deployment strategy in such areas and negatively impact demand for our connectivity services. The ability of our subsidiary Northwestel, operating in Canada's North, to respond to the competitive threat from these providers is further hampered by CRTC retail Internet regulations."[11]

4. Sustainability

Internationally, bilateral and multilateral agencies typically fund only for equipment and installation (Capex). They do not provide ongoing operating support (Opex). However, in the U.S. various programs subsidize service to high cost and low-income customers, as well as to schools, libraries, and rural health facilities to pay for connectivity.[12]

Operational subsidies can be a key component of financial stability for providers in Alaska. For example, GCI, Alaska's largest carrier, receives support from each of the various Universal Service Fund (USF) programs: Rural Health Care, E-rate (schools and libraries), High Cost, and Lifeline. These payments contributed 39 percent, 35 percent and 32 percent of GCI Holdings' total revenue for fiscal years 2023, 2022 and 2021, respectively.[13]

In Canada, there is a modest high-cost fund, but Indigenous and other small ISPs are not eligible for this subsidy, which is intended to maintain affordable primary exchange residential service in high-cost serving areas, i.e. local telephone service. There are no other operating subsidies. Some Indigenous ISPs generate revenue through contracts with government education and health agencies to deliver connectivity for education and telemedicine.

5. Strategies to increase Local Ownership and Participation

Local participation through partnerships with providers or local ownership may increase local engagement and employment while either fostering competition or strengthening incumbent dominance

Participation Models: Partnerships and Ownership

In Alaska, Indigenous ownership of telecommunications facilities and services originated in telephone co-operatives, several of which were initiated with support from the federal Rural Utilities Service (RUS -- formerly the Rural Electrification Administration. The co-ops were formed to provide local telephone service in several

Alaska villages.[14] Today these co-ops also provide local broadband, although other carriers may also offer internet services.

In Canada, Indigenous ISPs are typically nonprofit organizations that provide internet services to remote Indigenous communities in the northern regions of the provinces and the northern territories[15]. Some of these ISPs have received federal funding to expand or upgrade their networks.

Besides ownership, Indigenous participation may also take the form of partnership of an indigenous organization with a provider. In Alaska, such ventures may be useful to qualify for federal funding that requires Indigenous participation. For example, Alaska has received federal Tribal Broadband funding for 17 projects totaling $385 million for infrastructure deployment. The successful applicants are Alaska Native villages, Tribes, Native Corporations and Native nonprofit organizations (plus one community electric utility).[16] Major partners are telecommunications companies that will then operate the networks. The Indigenous entities have no equity in these companies. It appears that the TBCP program may function primarily as a pass-through to these providers or other contractors.

In northern Canada, a majority of the CRTC's broadband funding has gone directly to major Canadian telecommunications providers, with no guarantee of local or Indigenous jobs and no equity in the providers' companies.

Also, in northern Canada, the major incumbent has introduced two Indigenous ownership models. In 2022, Northwestel, a subsidiary of Bell Canada, announced the sale of its Yukon fiber-to-the-home (FTTH) assets to a group of 13 Yukon First Nation development corporations. Northwestel will make regular payments for the fiber network's use for 20 years, and will operate and maintain the network at its own cost for that period.[17] The financial details on how usage payments will be calculated have not been made public, nor has what amount or percentage will be retained for operations and maintenance.

In June 2024, BCE (Bell Canada Enterprises) announced that it would sell Northwestel to a consortium on northern Indigenous development organizations for C$1 billion. Bell claims that Northwestel will be the largest telecommunications company worldwide with full Indigenous ownership. Many questions remain unanswered about this proposed sale, such as how the valuation was calculated, whether Northwestel is sustainable as a standalone entity, and what control, if any, the Indigenous organizations will have. [18]

Local Procurement

Procurement guidelines from funding agencies or incumbents can be a barrier to hiring local residents or contractors. However, procurement guidelines can also be designed to contribute to local/Indigenous skills and jobs. A Canadian Indigenous ISP pointed out that a necessary

component of any broadband development funding mechanism "is supporting opportunities for development and growth of First Nations and Aboriginal businesses" and noted that a federal mechanism known as a Procurement Strategy for Aboriginal Businesses (PAB) is used in other sectors.[19]

6. Resilience and Redundancy

Alaska has faced at least three outages in the past two years caused by breaks in submarine and terrestrial fiber. In 2023, a submarine fiber severed by sea ice off the Arctic coast was not repaired for more than three months. Satellite service provided backup, but capacity was limited, and emergency response, business and health services in several communities were disrupted.[20] Another fiber optic break occurred in the Alaska Arctic in April 2024.[21]

Earlier, in 2021, a submarine fiber break near Juneau knocked out 911 service in Alaska's capital, as well as some internet and mobile phone services.[22] In January 2020, a fiber break occurred in Alaska's Cook Inlet. Although service was rerouted, full functionality was not restored until March 2020 due to the challenging environmental conditions in the location of the fiber break.[23]

Also, financial risks may impede repair or replacement of damaged facilities. For example, Alaska carrier GCI states that it does not have insurance to cover some risks; GCI is self-insured for damage or loss to certain transmission facilities, including its buried, undersea, and above-ground fiber optic cable systems.[24]

In northern Canada, terrestrial fiber in the Northwest Territories has been cut by freezing and thawing of muskeg. Also, wildfires damaged fiber networks in 2023 and 2024. While satellites are typically used for backup, a terrestrial solution for resilience is to install fiber in a ringed configuration so that traffic can be routed in either direction to avoid a breakage point. The CRTC is currently examining whether its Broadband Fund should prioritize such resiliency investments over expanding and upgrading broadband.[25]

Concerning future proofing, Northern Canadian ISPs have found that some incumbent fiber and microwave backbone (or middle mile) networks have no additional capacity available. During the pandemic, northern residents complained that networks could not meet demands for broadband for learning from home and telework; some Indigenous providers could not obtain sufficient capacity needed for increased use of telemedicine from remote communities. For example, in northern Ontario, an incumbent's engineering of a fiber backbone did not anticipate residential and anchor institution demand. Accordingly, five years after lighting up the backbone, its electronics reached end-of-life.[26] Some local providers have also faced unforeseen costs to upgrade switching equipment such as for mandated 988 access.[27]

Project requirements for inclusion of dark fiber and upgradeable switching can extend useable project life. Installing extra dark fiber during construction is much cheaper that adding fiber in later upgrades and overbuilds. In addition, surplus optical fiber capacity owned by electric utilities could be used to extend or back up facilities in rural regions.

Government funding agencies in the U.S. and Canada have not yet determined whether they will fund redundant rural broadband networks, nor what priority they would consider for redundancy funding vs. expanding and upgrading existing rural networks. In Canada, the CRTC is currently whether to implement a new resiliency focused project category under its Broadband Fund.[28]

7. Training and Hiring: Improving Reliability, Increasing Demand

Mandating training and hiring of local/Indigenous residents in broadband projects could provide local jobs that can contribute to local economies, which in turn can create additional demand for providers' services. Use of local employees and contractors can also reduce costs. Reliance on urban contractors typically results in higher installation and maintenance costs (including travel and lodging as well as wages for outside crews) and results in no transfer of skills or income to rural communities.

In the U.S., NTIA specifically refers to training in the Tribal Broadband Connectivity Program's (TBCP's) Notice of Funidng Opportunity (NOFO): "NTIA encourages infrastructure projects that enhance economic development and provide a clear plan to build technological knowledge and capacity in their Tribal employee base by training existing employees and/or creating new jobs for Tribal members." Project proposals must include a plan for workforce training and development.[29]

NTIA's Broadband Equity, Access, and Deployment (BEAD funding guidelines also refer to development of a skilled workforce, with examples of apprenticeships, partnerships with training institutions, etc. [30] BEAD further states: "Entities must coordinate with local stakeholders—such as entities that carry out workforce development programs and labor unions …."[31]

The Rural Utility Service (RUS) ReConnect Program application requires "a plan to recruit and support an appropriately skilled, trained and credentialed workforce" but does not specify whether the workforce should include local and/or Indigenous residents.[32]

Indigenous participants in Canadian regulatory proceedings have urged that commercial recipients of federal broadband funding be required to hire and train local residents to install and maintain their equipment.[33] In December 2024, the CRTC issued a decision on Indigenous funding under its Broadband Plan concerning training:

> "To support the development of technical skills for Indigenous people and promote more resilient Indigenous-owned networks, the Commission is providing funding for up to two years of technical training for local Indigenous staff in communities that Indigenous applicants propose to serve as part of funded capital projects."[34]

Of course, funding requirements should be accompanied by adequate oversight to ensure that they are implemented. Concerning hiring and training, evaluation will be important to determine whether trainees were hired, and remained employed in permanent jobs.

8. Implications for the Pacific Islands

The Pacific Islands are also physically remote, with small populations on over numerous islands. Their total population is estimated at 2.3 million, spread over 15 percent of the earth's surface. Population ranges from 900,000 in Fiji to 12,000 in Kiribati.[35] They face similar challenges to the remote regions of North America in terms of isolation and small populations that make them unattractive to commercial operators.

GEO satellite service has been the major means of connecting the capitals throughout the region to each other and to global networks. Some regional GEO satellites such as Kacific now provide service through local incumbents. While submarine cables are being extended throughout the region with funding from bilateral and multilateral agencies and some platform operators, capacity remains limited on major islands and nonexistent in many outlying islands.

SpaceX's Starlink LEO satellites now cover the Pacific; other LEO systems may soon be available, bringing similar opportunities and challenges of facilities-based competition to those discussed above. These islands also need redundant capacity to maintain or restore services disrupted by natural disasters such as earthquakes and tsunamis. Yet some have been slow to authorize LEO services for island households and institutions.

Tonga has experienced prolonged communications outages including a break in the Tonga-Fiji submarine cable as a result of the underwater volcano eruption in January 2022. At that time, there were significant delays by the Tongan government in authorizing GEO and LEO satellite use. The Tonga-Fiji Submarine Cable System is owned and operated by majority state-owned Tonga Cable Limited (TCL).

Two and a half years later, in June/July 2024 the Tongan islands of Vava'u and Ha'apai were without internet service for more than two weeks after an undersea cable linking them to the capital was damaged in an earthquake. The government ordered all Starlink terminals to be disabled on July 10 because Starlink did not have a license. After

numerous complaints from residents and businesses, the government issued a temporary permit for six months to Starlink in July 2024, stating:

> "This temporary permit follows recent events where the government instructed Starlink to cease its services in Tonga due to illegal use of satellite terminals and disruptions caused by the undersea fibre cable outage to Vava'u and Ha'apai Islands since June 29th. The issuance of this permit aims to address public concerns while ensuring that operations are conducted in accordance with regulatory requirements, resorting to the connectivity outages in the outer islands, while the application for a full license is finalising."[36]

In December, 2024, the Tongan government announced that the license had been approved and that Starlink services could now be accessed through authorized resellers, including majority government-owned Tonga Communication Corporation (TCC).[37]

Vanuatu's submarine cable service was disrupted by an earthquake on December 17, 2024. Kacific was one of only a few systems that remained live after the earthquake; Vodafone took a large amount of emergency capacity on Kacific's K1 satellite.[38] Starlink had applied for a license in 2021, but it was not approved until August 2024, and its operations in Vanuatu were fully legalized only after the Department of Customs and Inland Revenue (DCIR) issued its business license on October 7, 2024.

The regulator stated: "Ordering directly from Starlink will take a few weeks for the equipment to arrive in Vanuatu, and the equipment you order online for personal use or business must have a type approval import permit, approved by TRBR." Further: "If you are purchasing for personal use then it's free but if it's business related then one has to pay VT1,000 [about 8 USD] fee for each model regardless of the quantity."[39]

Thus, at least some Pacific Island nations appear intent on protecting incumbents from LEO competition, even when facing communications outages from natural disasters. Evidence from remote North America indicates that LEO backup can be beneficial when terrestrial or submarine networks are disrupted.

The evidence to date is less clear on whether Starlink or perhaps other LEO systems offer a long-term alternative or interim solution for remote regions. Some operators predict that LEOs will be a short-term option until terrestrial facilities are installed or upgraded, and then serve primarily as backup.

Also unclear is the impact of Starlink on use of existing networks. In most cases to date, it appears that Starlink is being adopted by those without broadband or outside coverage of terrestrial broadband, or where the existing connectivity is too limited for their needs. Whether

these users will transition to terrestrial technologies when they are extended or upgraded may depend on pricing as well as evidence of reliability.

Also unclear is the potential impact of expanded mobile connectivity, particularly 5G or future mobile generations that offer broadband capacity. These mobile wireless networks may also expand their coverage through connectivity with LEOs, as is currently being rolled out in some regions, although with very limited bandwidth so far.[40]

However, strategies to increase internet/broadband usage and jobs being adopted in remote North America appear promising for the Pacific Islands. Requiring local training and hiring by licensees and providing for digital literacy training may reduce costs and also expand economic benefits of broadband access. Public sector benefits may require additional budget allocations for broadband use, or discounts negotiated with providers may be required.

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