Fire, Ice, and Politics: The Evolution of Domestic Satellite Communications in Canada

Name of Author: Louise St.Germain
School: University of Victoria

IEEE Region: 7

Current email address: lsg@uvic.ca

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Abstract

When Anik A1 was first launched, the future of Canadian satellite communications was bleak. However, in the last 35 years, Canada has learned many lessons on technical, political, economic, and social levels. At present, the system is still not perfect, but by considering the needs of all its people, Canada is rising to the challenge of providing a network which empowers its residents and supports the variety of rich cultures. This essay follows the evolution of the Canadian satellite network from its birth in the raging political environment of the 1960s to the present era of community and global partnerships.

Table of Contents

Introduction

Canada has long been recognized as a leader in communication systems worldwide, but this experience has not come without its problems and learning experiences. There have been technical problems and social considerations that have been overlooked, and there has certainly been no immunity to politics and financial difficulties. This essay is an account of the birth and survival of the Canadian domestic satellite communication system, and its evolution into an integral part of the communication infrastructure. Beginning with a description of the challenge facing the prospective builders of a satellite system, this essay retraces Canada's steps along the path from satellite's humble beginnings in the 1960s to its current success, ending with a look along the path to continuing success in the future.

The History of Domestic Satellite Communication in Canada

The Scene – A Brief Description of Canada

Canada is the second largest country in the world, with a total area of nearly 10 million square kilometres. There is a broad range of climates, ranging from temperate in the south to arctic in the north. Similarly, there is a wide range of terrain, ranging from the Rocky and Coastal mountain ranges in the west, to the relatively flat prairie land in the southern parts of the central provinces.

The Players in the Development of Satellite in Canada

The Government of Canada

When talk began in the late 1960s of satellite communication in Canada, there was considerable turmoil both within and outside Canadian borders. The Vietnam War was raging, the space race between The United States and the former USSR was escalating, and within Canada there were at least three political parties and activist groups attempting to secure sovereignty for the province of Québec. In 1968, leadership of Canada switched hands from Lester B. Pearson to Pierre Elliot Trudeau, the latter being particularly famous for his charisma and fiery conviction.

Canadian Telecommunications Carriers

Terrestrial communications and broadcasting in Canada were, and are, controlled by regional telecommunications carriers rather than a single national carrier. As commercial entities, these carriers' interests lie, justifiably, in turning a profit and expanding their business segments.

Telesat Canada

Telesat Canada was formed in 1969 through an Act of Parliament, with the goal of providing domestic satellite communication coverage to Canada. Until 1998, it was owned jointly by the Government of Canada, and by a consortium of telecommunications carriers in Canada. [1] Since 1998, it has been a wholly-owned subsidiary of Bell Canada Enterprises (BCE), Inc. [2]

Canadian Radio-television and Telecommunications Commission (CRTC)

Since its inception in 1968, the CRTC has been the regulating body of the Canadian broadcasting system, and through the federal government, has the authority to regulate and supervise all aspects of it. The CRTC's authority also covers telecommunications common carriers and service providers operating in Canada. [3]

Broadcasting Corporations

The most influential and pervasive broadcasting network in Canada is the Canadian Broadcasting Corporation (CBC). The CBC came into existence in 1936, though it replaced the Canadian Radio Broadcasting Corporation (CRBC), which was formed in 1932. [4] The other major Canadian broadcaster is Canadian Television (CTV).

The Canadian People

In 1968, the population of Canada was approaching 21 million; currently, there are approximately 32 million residents. [5, 6] The majority of the population speaks either English or French as a mother tongue. However, there is also a small proportion of aboriginal Canadians, which currently make up approximately 2.8% of the Canadian population. While this may seem insignificant, when the numbers are computed by province and territory, the percentage of aboriginals in the Northern regions of Canada is dramatically higher, reaching 85% for the territory of Nunavut. These aboriginals, mostly Inuit, do not have English as a mother tongue, but rather one of the Inuit dialects. [7]

In 1971, a year prior to the launch of Canada's first domestic communications satellite Anik A1, the population distribution was as shown in Figure 1. Today's population is distributed in a

similar fashion, as there has been little geographic spread – only an increase in population density. Both in the past and present, the majority of Canada's population is concentrated in the arable lands of the south.

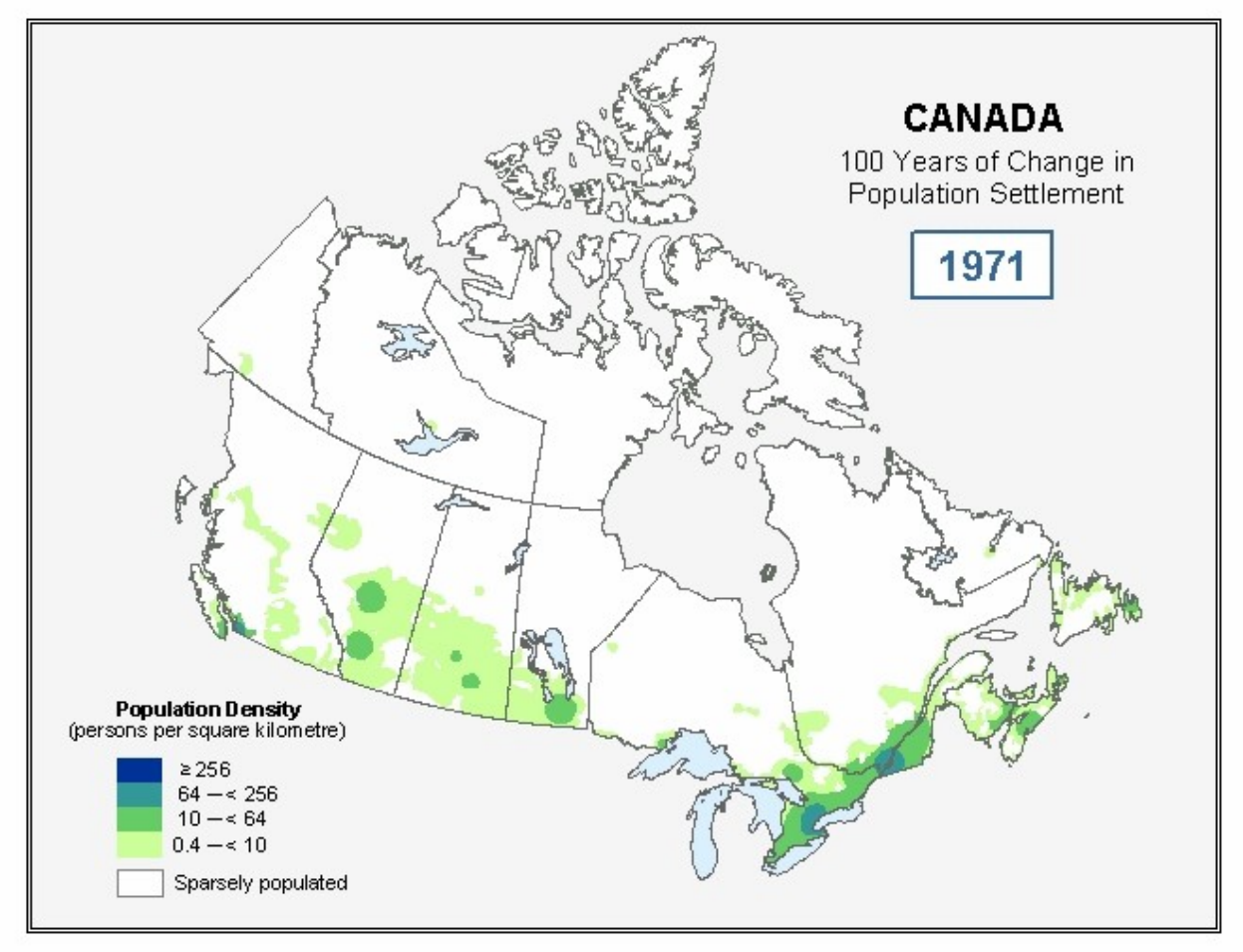

Figure 1 - Canadian population distribution, 1971 [8]

Linking Canada – Historical Background

The vast distances and highly uneven population distribution has always been a challenge to developers of communication systems in Canada. Traditionally, the focus has been East-West

connectivity, beginning with the Canadian Pacific Railway that was completed in 1885. [9] Since then, technologies have improved and telephone, microwave, and fibre optic networks have all spread East-West in Southern Canada.

While the coverage of the Canadian communication infrastructure in the South was quite good, the Canadian government recognized that to extend the same quality of coverage to every community in Canada would be prohibitively expensive. Prior to the launch of Anik A1, Canada's first domestic communications satellite, television coverage was achieved through terrestrial microwave transmission systems. These systems were concentrated in the southern regions of Canada with the higher population densities. [10] Communities in Northern Canada were therefore left with little to no coverage.

The solution to the problem is not necessarily simple. While it is often said that Canada is a nation which exists in its present form because of its extensive communication network, one point of view is that Canada exists despite this network, not because of it. [11] Attempts to simply expand the Southern network into Northern Canada has been the source of criticism and failures at the social level, as the culture is primarily aboriginal in the Northern areas, and due care has not historically been taken to respect the culture of the inhabitants. The example often cited in these cases is the Inuit community, which occupies most of the Canadian territories.

The Inuit Communities in the Canadian North

Until the 1970s, the Inuit were poorly represented in the political affairs of Canada, with the Canadian government assuming that it had full responsibility for the decisions made concerning

policy and programs for the Arctic region. [12] The control of the government over the communications services it planned to extend to the North was no exception. In the historic white paper describing the plan for domestic satellite communications in Canada, published by the government in 1968, there was constant emphasis on the planned availability of television and radio programming in both English and French; however, no plans were mentioned of programming to be made available in the indigenous languages of the people to be served in the remote communities. [10]

This mentality had its roots in history. In 1931, an advertisement by Burgess batteries for radio batteries aimed at Arctic inhabitants had the headline “Burgess aids the northward course of civilization”, and the text in the advertisement makes several statements indicating how the batteries will aid in updating the standard of living in the North to that enjoyed by the South. [13] This attitude was not significantly changed until the early 1970s, with the formation of vocal interest groups representing the Inuit and aboriginal people. [12] The introduction of satellite communications had an important impact on these communities, which will be described later in the discussion on the human impacts of the established Canadian satellite communications system.

An Overview of Satellite technology

Frequency bands

The International Telecommunication Union (ITU) has designated a range of frequencies within the electromagnetic frequency spectrum for use in satellite communication. This frequency range

is between 1 and 30 GHz, and is divided into smaller ‘bands’, each designated by a letter. Within each band different frequencies are usually used for uplink (Earth to satellite) and downlink (satellite to Earth) connections. Two of these bands are popular for communications satellites:

- C-band (6 GHz uplink, 4 GHz downlink)
- Ku-band (14 GHz uplink, 12 GHz downlink, though there are regional variations)

For satellite communications, C-band has two main advantages over Ku-band. One advantage is the size of the signal footprint – while one beam in C-band is enough to cover all of Canada, one bean in Ku-band can only cover around a quarter of the country. Another advantage of C-band is that less power is required to transmit a C-band signal than a Ku-band signal of similar strength. This is a particularly important issue for satellites due to the limited power resources available on-board. Despite these advantages, C-band has a distinct disadvantage that is not shared by Ku-band, which is that C-band frequencies are also used by terrestrial microwave communication systems, while Ku-band frequencies are not. Thus, Ku-band signals can be used regardless of the terrestrial microwave traffic that may be happening in the area around any earth stations in communication with the satellite. [14]

The frequency bands available to the satellites can be further subdivided into channels. Each channel aboard the Anik satellites can accommodate either 1 television channel, or 960 voice conversations.

Geostationary Orbit

Another important concept is that of the geostationary orbit – if the satellite is positioned over the equator at an altitude of 35,786 km, the period of rotation of the satellite is equal to that of the Earth, and thus the satellite appears stationary to Earth systems. The main advantage of

having communication satellites in geostationary orbit is that the antennas at the earth stations do not require mechanisms to track the satellite as it moves through the sky. This greatly reduces the cost of an earth station, which is especially beneficial for earth stations in remote areas that do not have large population bases to support the cost of such a station. With that in mind, all the Anik and Nimiq satellites are geostationary, as opposed to the Alouette and ISIS experimental satellites, which had periodic orbits. [15]

Telesat's Satellites

Telesat's satellites fall into two main categories: the group of Anik satellites, and the group of Nimiq satellites. The Anik satellites were generally designed for point-to-point satellite transmissions, where transmissions are received by one earth station and distributed to individual customers by terrestrial means. In contrast, the Nimiq satellites were built especially for direct broadcast, or point-to-multipoint. In this case, individual customers each have their own satellite receiver and receive their signals directly from the Nimiq satellites with no intervention of a community earth station. Table 1 summarizes the satellites in the Telesat fleet that have served as part of the Canadian domestic satellite communication system.

Table 1 - Summary of Telesat Canada's Satellites [16]

Series	Number of Satellites in Series	Operation Dates	Number of C-Band Channels	Number of Ku-Band Channels
Anik A	3	1972-1984	12	-
Anik B	1	1978-1986	12	6

Anik C	3	1982-2003	-	16
Anik D	2	1982-1995	24	-
Anik E	2	1991-present	24	16
Anik F	2	2000-present	36	48
Nimiq	2	1999-present	-	32

Satellite Development in Canada

Pre-Anik – Alouette I and II, and ISIS I and II

Before launching Anik A1 in 1972, Canada was involved in four research satellite projects, many in conjunction with the United States. Canada's space presence began in September of 1962 with the launch of the research satellite Alouette I, making Canada the third country in space (behind the former USSR and the United States). [17] Alouette I was used to study ionospheric disturbances, particularly in the area above Northern Canada, where such disturbances are particularly common. The objective of the research was to improve scientific understanding of the ionosphere, as the charged ions and electrons in these disturbances can make long-distance radio communication difficult or even impossible. Alouette II, launched in 1965, was also a research satellite for the study of the ionosphere and communication, though focused on the effects of sunspot activity. Both of the Alouette satellites had expected life spans of one year, but Alouette I lasted nearly 11 years, while Alouette II lasted just under ten years. [1]

Canada, along with the U.S. several other countries, formed the International Satellites for Ionospheric Studies (ISIS) group, which collectively launched two satellites: ISIS I (1969) and ISIS II (1971). Both of these satellites were designed and constructed in Canada.

The Battle for Canadian Communications Satellites

Despite the success of the first four satellites launched for research purposes, the commercialization of such an enterprise for consumer communications services was another story entirely, and in fact the satellite program suffered several near-fatal blows both before and after the launch of the first Anik satellite. When the first proposal for a national programming distribution via satellite was put forth to the Canadian Government's Department of Transportation (DOT) in 1967, the Canadian telecommunications carriers quickly rallied to oppose such an endeavour, claiming that the existing terrestrial facilities were already more than adequate to meet demand in the foreseeable future. This stalled the DOT's approval of a satellite project until a report later that year from the federal science secretariat claimed that unless Canada took action, it may lose control of any space segment it could have had. It further stated that contrary to the claims made by the carriers, the need for satellite communication in Canada was clearly established, and action should be taken as quickly as possible if Canada was to remain competitive. Upon the release of this report, the telecommunications carriers quickly joined again, this time in support of satellite communication, urging the government to proceed as quickly as possible.

Fearing that the public would not look favourably on a satellite program because of the unfavourable economics, the federal government kept most information regarding a potential

satellite project under wraps. Meanwhile, the Quebec government was forming an agreement with France to receive satellite communications with the SYMPHONIE satellite being developed in Europe. When the federal government was made aware of this, the ensuing uproar resulted in the prompt publication of the historic 1968 *White Paper on a Domestic Satellite Communication System for Canada.* For the next year, the federal government and the consortium of telecommunications carriers were engaged in a power struggle over control and rights to the satellite services. The government intended to allow fair competition for the satellite services, while the carriers demanding exclusive rights to the satellite channels. When the carriers threatened to boycott the satellite project if their demands were not met, the federal government finally gave in. In 1969, Telesat Canada came into existence through an Act of Parliament. The planning for Telesat's first satellite began, though Telesat was as well as doomed due to the economic restrictions imposed on it by the carriers. [11]

Anik A

When Anik A1 was launched on November 9, 1972, and put in service in early 1973, it was the first geostationary domestic communications satellite in the world. It provided a total of 12 C-band channels, where one channel could accommodate either a television channel or 960 voice circuits. [1] The inaugural telephone call performed through Anik A1 was made on January 11, 1973, between Ottawa and Resolute Bay, a community well above the Arctic Circle and near the North magnetic pole. [18]

Two more identical satellites, Aniks A2 and A3, were launched in April 1973 and May 1975 respectively. Aniks A2 and A3 were used not only as backups to Anik A1, but were also built to

accommodate potential increases in demand for satellite services. [1] The area of coverage of the Anik A series included all of Canada and was thus the first source of reliable communication for many Northern communities. Prior to the launch of Anik A1, radio and telephone service in the North came from mobile short-wave radio, which was expensive and unreliable. [19] The following account by Dr. Colin Franklin about a visit to a community dependent on this type of radio demonstrates the situation: “We tried to make a telephone call to southern Canada, and failed miserably both because the circuits that were available were continually tied up, and on the one or two occasions when a call did go through, the conversations were so garbled that you couldn’t get any message across.” [20]

By 1976, all three Anik A satellites were in operation, but only eight of the 36 available channels had been leased by the carriers, and no market could be found for the remaining channels due to the restrictions placed on Telesat by the Canadian carriers. To make matters worse, Telesat was faced with a decision on whether to build a new satellite to replace the aging Anik A fleet, and around that time Telesat had also been given an ultimatum to either join the consortium of telephone companies, or the largest carriers would not renew their contracts for their current satellite services. Further, to join the consortium, Telesat would have to yield to further restrictions on potential customers for the satellite services. It was at this point, in 1977, that the CRTC stepped in and requested a hearing on the fairness of such an arrangement, which was indeed concluded to be against public interest. However, this decision was later annulled and Telesat was bound by the carriers’ arrangement. [11]

Anik B

Despite the storm of politics surrounding Telesat in the late ‘70s, Anik B was launched on December 15, 1978. It was the first hybrid satellite in the world, carrying 12 C-band channels and six Ku-band channels. Once it was launched, Anik B provided commercial bandwidth on its C-band channels, while the Ku-band channels were used in numerous successful pilot projects, including tele-education, telemedicine, direct-to-home broadcasting, and advanced technology. [21] The success of these projects led to the development of the Anik C series of satellites, all of which operated in Ku-band frequencies.

Technicalities for Communities Dependent on Service by Aniks A and B

For communities served only by satellite, and with only one earth station, a technical problem emerged, which was that the desirable television channels were not all carried on a single satellite. Since a satellite dish can only be aligned with one satellite at a time, and must be physically turned to receive a signal from a different satellite, an earth station can only see the channels on one satellite at a time. At one point, Anik A3 carried the CBC national service, while the CBC House of Commons channel was carried on Anik B. It was therefore impossible to receive both channels with only one dish. This led to a 1980 recommendation by the Committee on Extension of Service to Northern and Remote Communities that as much as possible, similar channels should be carried on a single satellite. [22]

Telesat Continues its Struggle to Survive

By 1980, all three Anik A satellites and the one Anik B satellite were in service. At that time, the Anik C and D series satellites were in the planning stages. The federal government was tentatively attempting to loosen the binds the carriers had placed on Telesat's ability to sell its services, and in 1981 the CRTC once again intervened. Though ultimately the CRTC's order to open Telesat services to all potential clients was overturned, a partial victory was gained that allowed broadcasters, previously excluded from leasing Telesat channels, to join Telesat's circle of clients. Despite this new breathing room, Telesat remained in financial trouble. [11]

Anik C

After the successful launch and operation of Anik B, Telesat began planning five new satellites – three satellites in the Anik C series and two Anik Ds. The Anik C series was unique in being Telesat's only satellites that did not have any C-band capabilities. Instead, they were outfitted with Ku-band transponders, each satellite capable of handling 16 Ku-band channels. These satellites were aimed at the southern Canadian market, with its dense population and lucrative market. [15]

Anik C – The White Elephant

A report of the Committee on Extension of Service to Northern and Remote Communities describes the successes of the satellite services available through the existing Anik satellites, but emphasizes the problems with the plan for Anik C satellites. The root of the problem was that the Ku-band transmissions have a smaller footprint than that of C-band. The Anik C satellites

covered the width of Canada with four separate spot beams, but these were planned for southern Canadian coverage, meaning that none of the additional bandwidth provided by the Anik C satellites would be useful to communities north of the 63˚ parallel. The committee also criticized Telesat for not consulting the CBC before designing the satellites.

Telesat's reply was that if necessary, the antenna on one of the Anik C satellites could be tilted such that coverage would include more of the Canadian North, at the expense of some coverage of southern Canada. The committee was sceptical that such a solution would ever work, mainly because of their conviction that Telesat was more concerned with making a profit, leading to the conclusion that there would never be a decision to make any modifications to the coverage area that would negatively impact the more lucrative business in southern Canada. [22]

Adding to Telesat's problems was the under-utilization of the satellites by the Canadian carriers, and because of this and the resulting financial difficulties, Telesat twice attempted to sell one of the Anik Cs to other countries, to no avail. [11] It was only much later, in 1993 that Aniks C1 and C2 were sold to Paracom S.A. to become part of the Argentinean satellite communications system. [23]

Anik D

Anik D, another C-band series of satellites, was intended as a replacement for the aging Anik A and B satellites. The launch of the first Anik D satellite was scheduled for late 1982, but this in itself caused a perceived bottleneck to occur in the growth of satellite services. Anik A1 was to reach the end of its life in early 1981, and while the traffic from A1 could be switched to A2,

Anik B was already at full capacity and there were not enough free channels left on Aniks A2 and A3 to accommodate the expected demand increase of 12 channels by January 1982. [22] While this demand is not obvious given the account of the power struggles in [11], it shows the contrasting realities of the carrier constraints and those of the broadcasters attempting to expand the services requested by the Canadian public. In August of 1982, Anik D1 was launched, followed by Anik D2 in November 1984. [23]

Starting in 1984, and through to 1986, the CRTC intervened a third time in Telesat's situation with the Canadian telecommunications carrier, and this time, with the support of the DOT, many of the restrictions placed on availability of Telesat's satellite capacity were lifted. For the first time, Telesat had a wide variety of potential customers and was tasked to make itself financially viable, with the flow of subsidies gradually decreasing until ending completely in 1988. [11] It was in this new light that planning began for the Anik E series of satellites.

Anik E – A Generation Fraught with Misfortune

The two Anik E satellites were the first to make channels in both C-band and Ku-band commercially available, each having 24 C-band and 16 Ku-band channels. Anik E2 was launched in April 1991, followed by Anik E1 in September 1991. The first technical difficulty was encountered almost immediately after the launch of Anik E2, when its antennas jammed in the stowed position. One of the antennas popped free in April after some testing had been done on it, but it was not until July that the second antenna was freed. This was accomplished by rotating the satellite such that the side with the antenna faced away from the sun, cooling it until

the dampers holding the antenna contracted enough for the antenna to pop out. Finally, after three months in space, Anik E2 was operational. [24]

Disaster struck again on January 20-21, 1994 when a geomagnetic storm caused a loss of attitude control on both Anik E1 and E2. While control of Anik E1 was re-established a few hours later by switching to backup attitude control circuitry, it wasn't until June 21, 1994 that Telesat regained control of Anik E2, as both the primary and backup attitude control circuits were damaged. [25, 26]

Two years later, in March 1996, Anik E1 suffered a major failure in power systems, involving the loss of the use of one of its solar panels. While Telesat maintained control with the satellite, the reduced power input meant that Anik E1 could no longer maintain its full capacity of channels. The lost channels included several leased to the United States, but which were contractually about to be vacated, and some leased by Bell ExpressVu Direct Broadcasting, which were not yet in service. The capacity of Anik E1 was permanently reduced to nine C-band and ten Ku-band channels, down from 24 C-band and 16 Ku-band channels. [27]

Anik F and the Nimiq Satellites – Telesat's Newest Satellites

By the year 2000, the development of plans for Anik F satellites were under way. At the time, three of Telesat's Anik satellites were still in operation – Aniks C1, E1, and E2. Additionally, Nimiq 1 had been launched in 1999 to provide direct-broadcast service to individual customers. In the light of Telesat's expanding services, Anik F1's design needed to meet several design criteria, including:

- Cost-effectiveness
- Having the capacity to replace and expand on the services provided by the existing satellites
- Operating in both C-band and Ku-band
- Having capability of direct-to-home broadcast services, complementing the Nimiq 1 satellite

Additionally, Anik F1 was designed to extend coverage to both North and South America. [28] Nimiq 1's footprint extends through most of Canada and the entire continental U.S., as shown in Figure 2. Anik F1 was launched in November 2000, followed by a second Nimiq satellite in December 2002. [23]

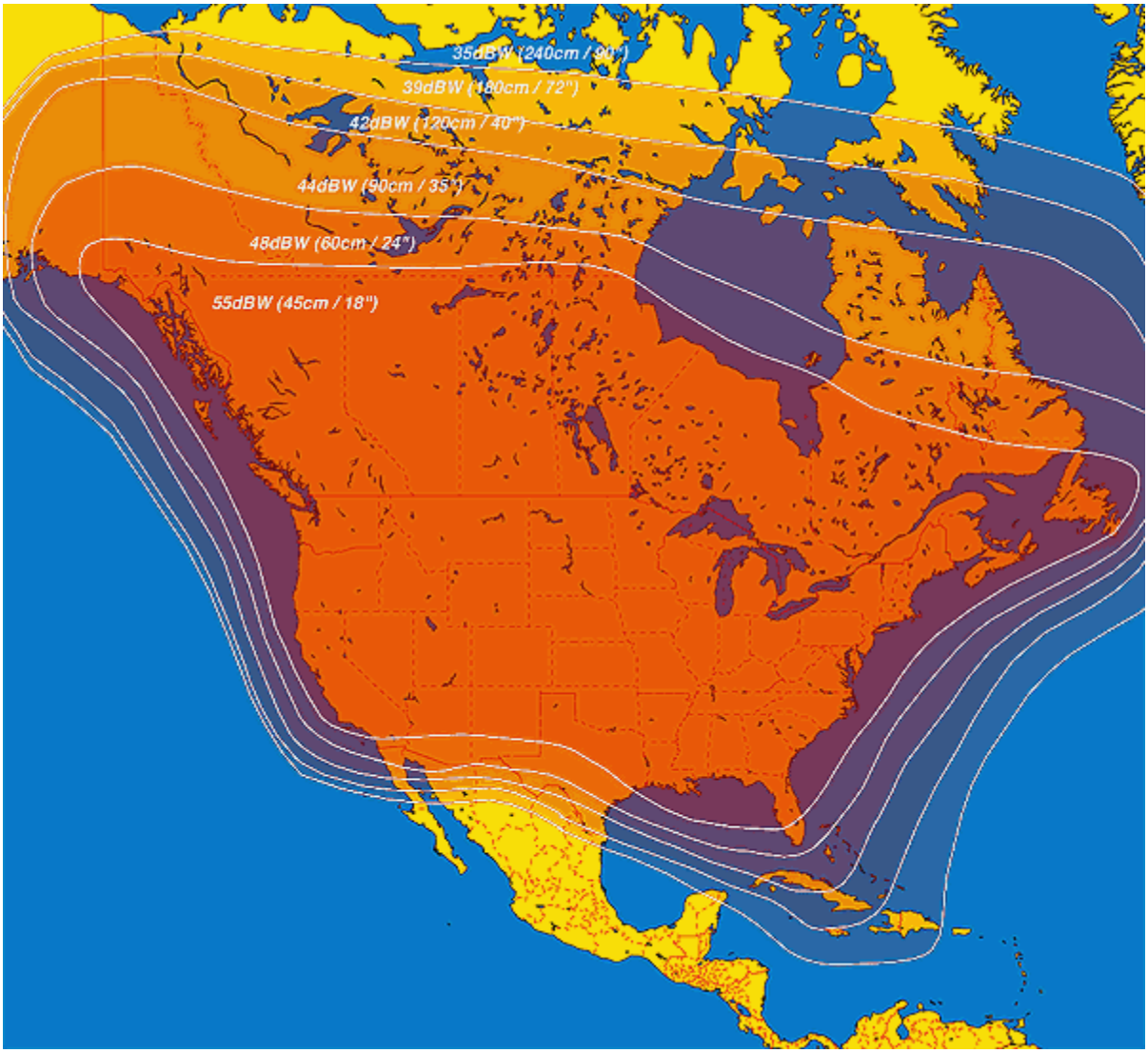

Figure 2 - Footprint of Nimiq Direct Broadcast Coverage [29]

The Social Impact of the Introduction of Satellite Communications

Through Telesat's domestic satellite communication system, more information is available to Canadians than ever before. While for those residing in the South of Canada, this can be seen

only as a good thing, complications arise when considering remote and aboriginal communities. When satellite service first became available in the North, few Inuit spoke English, and the programming available was of little relevance to the inhabitants. As time progressed, and the younger Inuit became more adept in English, a more important problem developed. As stated in a report on aboriginal peoples, “this is television in which the tradition, the skills, the culture, the language count for nothing. The pressure, especially on our children, to join the invading culture and language and leave behind a language and culture that count for nothing is explosively powerful.” [30]

Fortunately, the federal government and the telecommunications carriers have placed an emphasis on maintaining a minimum standard of Canadian content in the satellite communication services available to Canadians. In addition, a growing awareness of the needs of aboriginal and Inuit people has led to an empowerment of these people to form their own broadcasting organizations and communications services, though there is currently some concern about cuts to funding. [30]

The fact that the CRTC and Canadian service providers can enforce anticompetitive measures to favour Canadian content in domestic broadcasts has even been deemed a foreign trade barrier by the U.S. Trade Representative. [31] This places Canada in an uncomfortable situation regarding Canada-U.S. relations, but shows the government’s unswaying commitment to the maintenance of a distinct Canadian culture and communications network.

Future Directions for Canadian Satellite Services

While the introduction of a domestic satellite communication infrastructure in Canada has been successful in providing broadband services to certain remote communities in Canada, there is still progress to be made. Currently, while approximately 75% of the Canadian population has access to broadband communication, 75% of Canadian communities still have no broadband access. [32] As stated in a document by the Nunavut task force, “right now, someone in Ottawa sitting in his basement with an Internet connection provided by the local cable company has access to more bandwidth than all users in a single Nunavut community.” [33] Currently, several initiatives such as Smart Communities, led by Industry Canada, are working to bring connectivity to all areas of Canada, with the requirements defined by the community itself. [34]

Conclusion

Canada’s experience in developing a domestic satellite communications system and integrating it into its existing infrastructure has certainly not been a smooth process. However, lessons learned in this experience can be beneficial to those countries who have yet to employ satellite networks, or to those who are currently facing similar challenges. While technological innovation is important in maintaining an ability to meet the physical demands placed on the system, it is as important, if not more so, to first recognize the needs of the people and to empower the right groups to make decisions for the benefit of the system. Working together, with checks and

balances in place, Canada may eventually reach the goal it had so long ago, to develop a unifying and empowering communications network for all its people, regardless of their location.

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