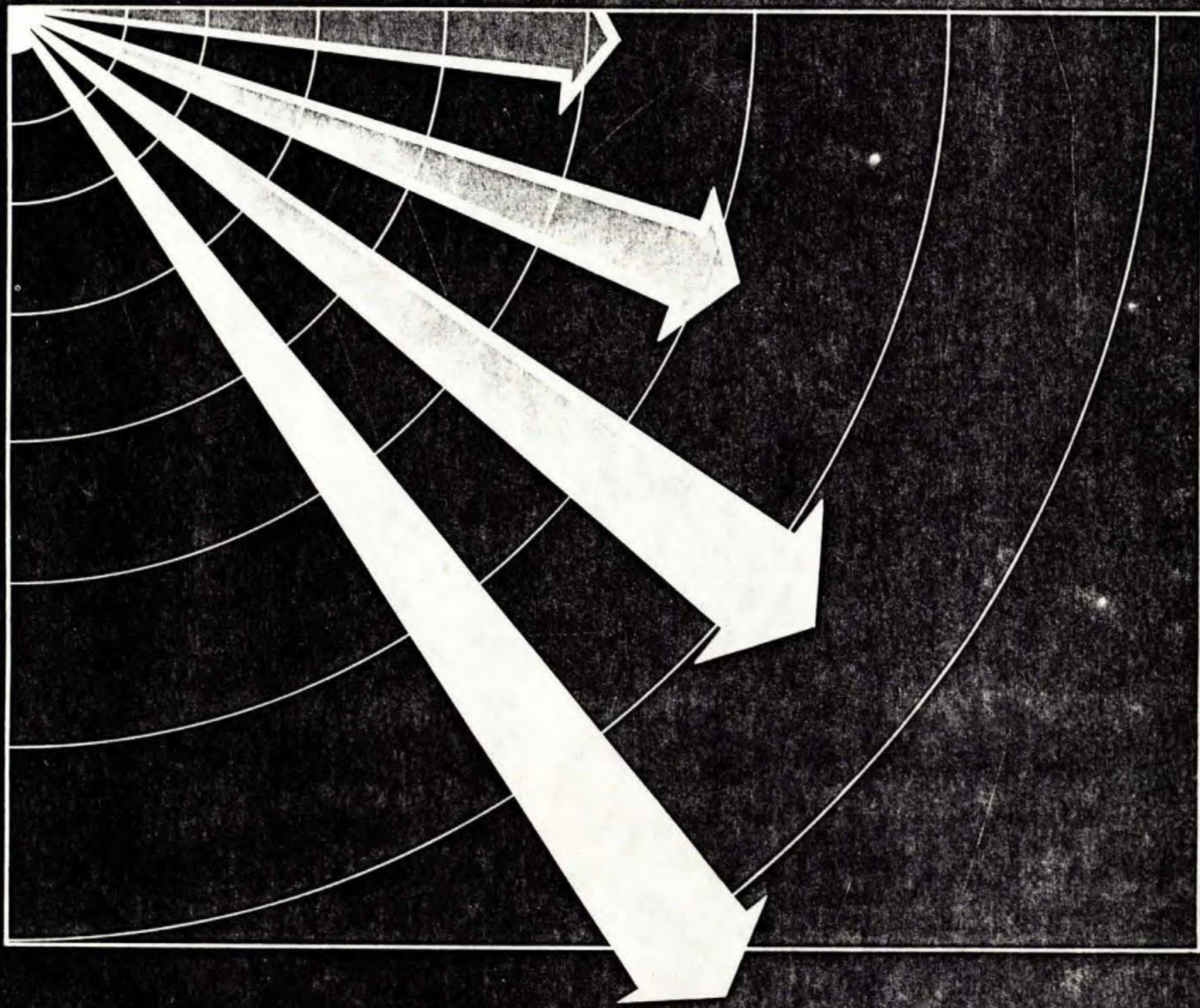
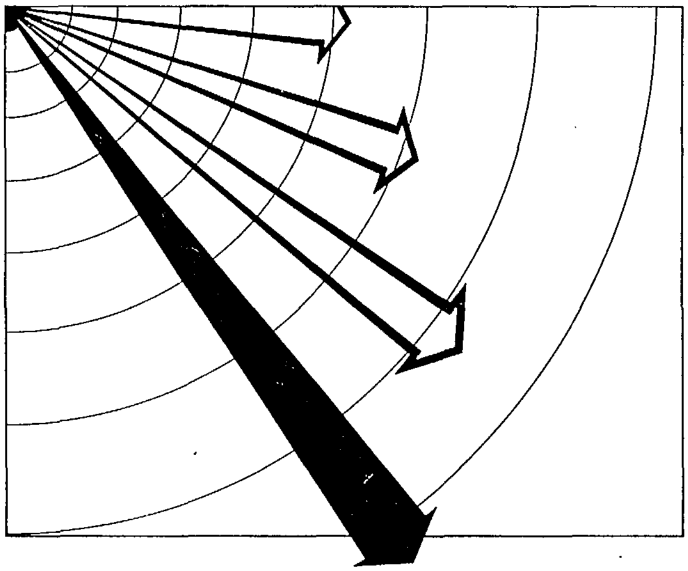
Telesat

Telesat Canada

Study of the Use of Anik C for Direct-to-Home and Community Television Distribution Services



The Use of Anik C for Direct-to-Home and Community Television Distribution Services



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NOTE:

This document is intended to stimulate the discussion of future options and policies. Due to the speculative nature of the material treated, no commitment for future action should be inferred from the statements contained herein. This report presents the views of the authors. Publication of this report does not constitute DOC approval of the report's findings or conclusions.

September 1981

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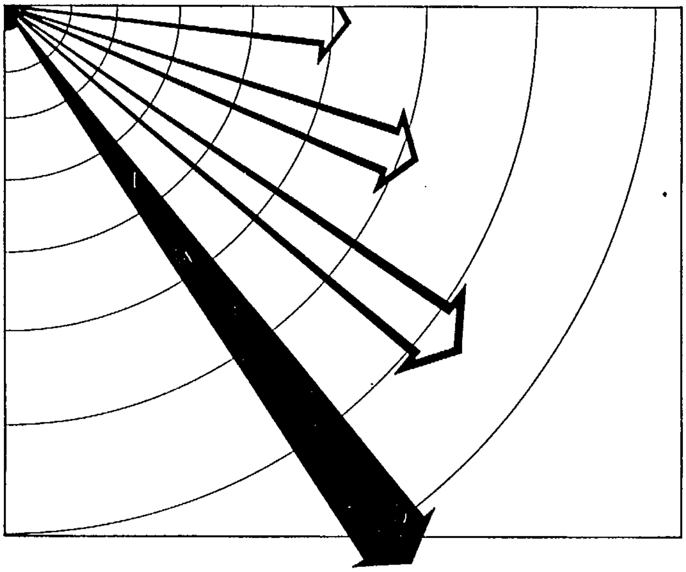
Introduction and Executive Summary



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ES.0 Preface

In August 1980, Telesat Canada began work on a study of the use of Anik C for direct-to-home and community television distribution services, under contract to the Government of Canada, Department of Communications, but with Telesat providing roughly half the resources without cost to DOC. The work undertaken was divided into five major activities:

1. Market Analysis and Modelling;
2. Technical Analysis;
3. Economic Analysis;
4. Social, Political, Regulatory, Rates and Service Offering Analysis; and
5. Future Integration Considerations.

Some of the above activities fall outside Telesat's normal operational focus. For example, Telesat's interest in the end-user market (treated in Section 1) is indirect since, under its present corporate policies, Telesat sells services only to Regulated Canadian Telecommunications Common Carriers who, in turn, serve the needs of the broadcast industry by distributing radio and television programming to the Canadian public.[1] In addition, Telesat believes that the DOC is better equipped than Telesat itself to treat the social and political questions raised by direct-to-home satellite broadcasting services. However, the DOC has stressed that it seeks simply a "satellite carrier's viewpoint" to supplement information being provided under other contracts. Under these circumstances, Telesat has agreed to pursue the topics requested, and has benefited from the breadth of the investigations, while retaining some trepidation at venturing outside the more-traditional areas of concern.

ES.1 Introduction

ES.1.1 Canadian Institutional Factors

Traditionally, Canadian policy makers have viewed broadcasting as of special significance in its ability to build or alter the national sense of a Canadian identity. For example, the Broadcasting Act states that broadcasting should help "... safeguard, enrich and strengthen the cultural, political, social and economic fabric of Canada ...". Broadcasters and their regulator have, for several years, been expressing concern as to how direct-to-home satellite delivery of television programming may best be effected without undermining the viability of existing networks and local stations. Cable operators were also concerned at the possibility that direct reception of television programming from satellites would "cream off" some of their most lucrative business in urban areas. The very fact that the evolution of new services (e.g., pay TV) receives such detailed and exhaustive study and consideration by government and by the industry prior to any introduction being permitted, is sufficient to differentiate strongly between Canadian telecommunications and that found in the United States. In the Canadian environment, it is highly desirable that the initial market targeted for Anik C direct-to-home delivery of television and radio programming be non-disruptive. A violently competitive and disruptive entry into the Canadian broadcasting system would likely not be favoured by government planners and regulators, let alone the other participants in the Canadian broadcasting industry. For this reason, it is anticipated that Anik C signals would be delivered in the direct-to-home mode, primarily where other forms of local distribution do not exist and are not particularly viable. Signals carried on Anik C destined for this market could also be made available in Canada's smaller communities and urban centres through cable systems and/or local rebroadcast transmitters receiving feeds from, amongst other sources, a simple, low cost Anik C TVRO earth station. Such local distribution would, of course, be expected to remain subject to existing regulatory procedures designed, in part, to preserve the viability of local broadcasters and the overall rationality of the Canadian broadcasting system. Cable operators' markets in urban areas will be maintained by their natural ability to provide superior choice in programming, combined with high technical quality, not to mention the desirable esthetic factor of receiving signals through a coax cable. Beyond that, cable is probably the more economically effective medium in the densely-populated cities. When asked about the viability of high-powered DBS in the United States, Clay Whitehead of Galaxy is quoted as responding (Satellite Week, May 25, 1981):

> "It's pretty clear that cable is a much more cost-effective way of distributing programs. However, the major markets are not yet wired. So until they are wired, there is some potential there for direct broadcast. Once the major markets become wired, then the economics of DBS don't seem to make a lot of sense."

Since, in Canada, the major population centers *are* wired, Whitehead's remarks take on a different significance north of the Canada-U.S. border.

The Broadcasting Act states that "all Canadians are entitled to broadcasting service in English and French as public funds become available." It further states that "the national broadcasting service should be extended to all parts of Canada, as public funds become available." Clearly, there is a policy objective that all Canadians receive service regardless of their location. Anik C satellite distribution provides the means to achieve this objective, while fitting naturally within the existing broadcasting infrastructure in Canada.

ES.1.2 The Anik C Satellite System

The initial DBS concept as defined by WARC '77 envisaged relatively high satellite radiated powers (about 63 dBW) and extremely small receive station antennas (about 0.6 m). The viability of such a design seems, in the Canadian context, dubious at this time. Since the total available power is a critical design

[1] This policy is presently under review as a result of CRTC Decision 81-13 and the subsequent appeal to the Governor in Council

limitation, a satellite can have many low power channels or a small number of high power channels. Providing a small number of channels leads to a higher cost per channel, requiring an extremely large supporting population density within the service area. But it also means a smaller capacity to carry the diversity of programming that is absolutely essential to cater to the spectrum of Canadian regional, cultural and linguistic interests. A three-channel DBS satellite, as proposed by Comsat in the U.S., is simply not realistic in the Canadian context. In a speech delivered to the International Institute of Communications, Mr. Alex Curran, Assistant Deputy Minister, Space Program, Department of Communications, added that:

"The satellites with such large transponders and correspondingly large power supplies are expensive to build, costly to launch and are less reliable than moderate power satellites ... it is equally interesting that cost studies also support the use of lower power levels ... thus there are advantages to the use of lower powers in the broadcast satellites ... the very high power satellites proposed at 1977 WARC have not yet been demonstrated to have the reliability normally associated with operational systems. It has been shown, however, that acceptable quality of reception can be achieved with much lower powered satellites, while maintaining the advantages of low cost, small earth stations. Both the satellite and the earth stations are available for these power levels."

Anik C is extremely well suited for direct-to-home television broadcasting in the Canadian context, because:

a) Anik C's four-spot-beam footprint covers all Canadians in rural and remote regions;

b) The system has flexibility for providing regionalized programming to cater to regional needs;

c) The four spot-beams can accommodate the different time zones;

d) Earth stations can be located wherever there is an unobstructed signal line with the satellite, without concern for mutual interference with terrestrial radio systems; and

e) Earth stations will be relatively small and inexpensive.

Despite the desirability of Anik C as a direct-to-home television delivery vehicle, the CRTC has not established firm regulatory policies and procedures related to a direct-to-home broadcast satellite service. In the view of some observers this approach maintains flexibility in the determination of the Canadian position for the upcoming Region 2 Regional Administrative Radio Conference on this subject, to be held in 1983. The desirability of an undeclared Canadian position on DBS must certainly be questioned in light of several American direct broadcasting satellite proposals. The FCC decision of April 21, 1981 gives credibility to these proposals albeit on an "interim" basis, and they appear to have the support of the U.S. administration. In any event, the CRTC has stated in its April 14, 1981 Information Bulletin that Anik C "will be of specific interest for broadcasting purposes in future because of its capacity, through the use of ¼-Canada and ½-Canada coverage beams, to respond to scheduling problems created by time zones, and allowing for the reception of a different service package in each region of the country", but the extent to which this interest includes direct-to-home delivery of television programming remains to be tested.

ES.1.3 Market Analysis

Telesat Canada is not a broadcaster. Therefore the final determination of the signals to be carried on Anik C for distribution throughout the country will not be Telesat's decision. For purposes of analysis, however, Telesat has broken the possible signals to be carried into three categories:

1. *Basic.* Regional services provided by the CBC and provincial educational authorities (2-3 TV signals).
2. *Extended.* Advertiser supported regional broadcasting services (3-6 TV signals).
3. *Pay-Television.* Subscriber-supported services of a diverse nature (1-2 TV signals).

From the above, it can be seen that the total potential service (Pay-TV plus Extended plus Basic) could consist of eight television signals. Depending on the desired regional coverage, this could require a full Anik C satellite assuming that two TV signals are carried by each travelling wave tube amplifier.

Telesat's analysis has determined the potential number of households making up the *target* market for direct-to-home reception for each class of services as follows:

1. Basic Services would be of interest to households which presently do not receive any television signals.
2. Extended Services would be of interest to households receiving less than 3 TV signals.
3. Pay-TV plus Extended Services would be of interest to all rural households unlikely to be served by local distribution methods.[2]

ES.1.4 Technical Analysis

The overall application of Anik C to direct-to-home television program delivery has been analysed technically with respect to the establishment of performance objectives, consideration of propagation effects, overall system concept, link analysis, earth station parameters and the resulting coverage in terms of different sizes of TVRO earth station. Much of the relevant material has been presented to interested parties during the CRTC hearing on Extension of Services.

As indicated in the preceding sections, a combination of Pay-TV, Extended and Basic services has the *potential* to use the entire capacity of one Anik C satellite, if each

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[2] CRTC Decision 81–252 has authorized CANCOM to distribute programming to community distribution systems. Communities which have a total population of more than 300 households are not included in the direct-to-home market identified in this study

signal is restricted to a ¼-Canada spot beam. However, it is expected that while the Basic and Extended elements of this service (CBC regional, regional educational TV, plus other regional broadcasters) would be carried on a ¼-Canada spot beam basis because of its regional focus, the Pay-TV services could be carried on a ½-Canada basis to improve the economics through taking account of their more-universal nature, leading to a fill of, perhaps, thirteen or fourteen travelling wave tube amplifiers out of the possible sixteen. Interestingly enough, there is little penalty with respect to the TVRO antenna size requirements, for a high proportion of subscribers, when using the ½-Canada coverage beam configuration. In this configuration, it may be worth considering the use of the 1 TV program per RF channel for the Pay-TV services. The superior performance obtained in this manner would be consistent with the "premium" nature of this service.

As a basis for total system design, Telesat has adopted a signal-to-noise performance objective of 42 dB at an unfaded carrier-to-noise ratio of 12 dB.

Using this performance objective, and a careful analysis of the coverage provided by the Anik C satellite transmit footprint, the required TVRO earth station antenna sizes are calculated for all Canada. This is repeated with the Anik C satellite antenna tilted northward by 0.25° to provide improved northern coverage.

ES.1.5 Economic Analysis

One of the objectives of the economic analysis is to determine the TVRO supply-demand relationship resulting from both the demand for TVRO earth stations and their cost of production. Demand has been calculated through a somewhat-complex and subjective model discussed in the text. The supply curves have been computed making use of Telesat's experience in procurement of TVRO earth stations, together with information supplied by manufacturers. The results are used to determine which classes of programming would attract sufficient demand for earth stations to bring the unit cost to an acceptable level and what the maximum achievable level of market penetration is likely to be. The service demand curves should be able to quantify the previous subjective opinions on whether or not the provision of a limited variety of television signals would produce sufficient demand for receive stations to guarantee the viability of manufacturing those terminals. It should be noted that this approach deals only with the direct-to-home market and the acceptability of receive terminal costs.

The second objective of the economic analysis is to assess the economic viability of the distribution of the various program packages. This viability is determined by establishing a figure of merit for each package and identifying the optimum configuration. The figure of merit used in the study is the total distribution cost expressed as a monthly cost per subscriber.

ES.1.6 Rates and Service Offering

Telesat's rates are based on the following principles:

(a) Recognition of costs. The rate structure should result in charges sufficient on a per-segment basis (space and earth) to generate revenues that cover total operating and administrative costs, and provide a fair rate of return to shareholders.

(b) Value of service. Where there is more than one class of service, the relative rate to be charged for each is based on the value of the service to the customer, with the *total* return still calculated to cover costs as in (a) above.

The discounted cash flow method is used to determine the rates to be charged for particular services, so that the rates for a satellite channel, for example, are given by the net present value of costs divided by the net present value of forecast utilization. In calculating the rates, it is assumed that one RF channel will provide two Television Channel Services. The Anik C annual rate per Television Channel Service is subject to future revisions to costs and forecasts and, of course, to future regulatory approval. These results together with projected rates for television uplink service, are presented in detail in the text.

ES.1.7 Future Integration Considerations

Concern has been expressed with respect to the obsolescence of equipment should an interim DBS service on Anik C ultimately evolve into a higher powered version, possibly utilizing a different frequency band. In Section 5 an attempt is made to forecast the characteristics of a future DBS system for Canada, in order to determine its compatibility with an Anik C direct-to-home television delivery system.

Forecasting the future is always hazardous, particularly since so many uncertainties must be resolved before a dedicated or pure DBS system could become operational in the latter half of the eighties. The Future Integration Considerations section investigates the necessary TVRO modifications and whether replacement or retrofit of the outdoor unit should be considered. Uplink earth station modifications and other planning-oriented implications are also dealt with.

ES.2 Summary of Study Results

ES.2.1 Market Analysis

For direct-to-home reception the total potential market consists of 1,278,000 households, assuming that totally new services are provided. The rest of the Canadian audience would be best served by some form of community distribution system.

For the extension of existing services to households presently receiving less than 3 TV programs, the total potential direct-to-home market is 720,000 households.

The total potential market for extension of Basic services, such as CBC national or regional programming, consists of 72,000 households which presently do not receive any TV signals.

ES.2.2 Technical Analysis

A signal to noise ratio of 42 dB as the unfaded system performance objective at a carrier to total noise ratio of 12dB was chosen as an acceptable quality for home viewing on a regular basis. This is in accordance with CCIR recommendations.

Propagation effects at 12 GHz indicate, that on an average basis across Canada, an unfaded C/N of 12 dB will mean that a C/N of 11 dB can be met 99% of the time and C/N of 9dB can be met 99.9% of the time.

This performance can be achieved over almost all populated areas of Canada using direct-to-home terminals with 1.2 to 1.8 m antennas. In some cases 2.5 to 3.0 m antennas may be required. In the worst case of extreme northern locations receiving 2 TV programs in one RF channel a 4.5 m antenna will be required.

ES.2.3 Economic Analysis

The total demand for direct-to-home terminals for the reception of solely Basic services, such as CBC regional or national programming, would not be sufficiently high to reduce the unit cost of the direct-to-home terminal to an acceptable level.

The addition of one or two private advertiser-supported-networks to the Basic services would increase the demand for direct-to-home terminals to a level which could result in a per unit cost which would be acceptable to a significant portion of the potential market.

The addition of Pay-TV to the Basic and Extended services would increase the demand for terminals to a level where the price would approach $700. At this price a market penetration of 250,000 households is projected. It is assumed that the demand for direct-to-home terminals would be minimal in areas where these services could be more economically provided by community distribution systems.

The cost of distribution of an 8 TV program package is made up of RF channel and TV uplink charges and amounts to $11.00 per month per subscriber. For services such as Pay-TV, the number of households served by community distribution would far exceed the 250,000 households expected to use direct-to-home terminals. Including these subscribers in the calculations could significantly reduce the per-subscriber distribution cost for the total 8 program package.

It is believed that market saturation will not be achieved with Basic, Extended and Pay-TV services and that a greater proportion of the potential direct-to-home market would buy a terminal if additional services were included.

ES.2.4 Social, Political and Regulatory Analysis

Studies done by Arthur D. Little in the United States, for the Comsat DBS proposal, indicate that audience fragmentation as a result of DBS services would not be sufficient to result in undue economic harm to local broadcasters. This would indicate that direct-to-home satellite services appears not to threaten the survival of local broadcasters particularly if the satellite services are supported by customer subscriptions rather than advertising revenues.

It is important that new program services be equally available to all Canadians whether reception is through direct-to-home terminals or community distribution systems.

Some method must be found to give Canadians a desirable alternative to imminent American direct broadcast satellite programming. This programming is very likely to be available for reception in at least southern Canada, and the early use of Anik C as a Canadian alternative is an attractive opportunity.

There is some uncertainty about the acceptability, under present I.T.U. regulations, of the use of Anik C for direct-to-home TV distribution. Telesat believes that the interim nature of such usage should be sufficient to overcome any objections. This belief could be significantly strengthened if the same programs were also received by community distribution systems in the major population centers. The size of this urban market is so much greater than the potential direct-to-home market that the DBS portion could quite justifiably be considered incidental to what would be essentially a fixed satellite service.

ES.2.5 Rates

Assuming that the full 8 program package is distributed in a 2-TV-programs-per-channel mode, the rate per Television Channel Service is expected to range from $1,050,000 to $1,160,000 per year. This does not include rates for Television Transmit Services.

ES.2.6 Future Integration Considerations

Canadian needs could be met with a DBS system with beam-edge EIRP levels of 48 to 52 dBW. This would be sufficient to provide a 42 dB signal-to-noise ratio for 99% of the worst fading month using a terminal with an antenna no larger than 1 meter.

The conversion of terminals designed to receive programs directly from Anik C into true DBS terminals will require replacement of the outdoor unit and optional replacement of the antenna. The cost of this conversion would be approximately ⅓ to ½ of the then-prevailing terminal price. This approach was judged technically and economically superior to pre-designing Anik C terminals for eventual conversion.

ES.3 Study Conclusions

This study has shown that for the distribution of television programs, an Anik C satellite can be used very effectively for direct-to-home services outside the major population centers. With a 0.25° northern tilt of the satellite antenna. Anik C can also be used to distribute these same TV programs to the extreme north without sacrificing the ability to serve the south. This study concludes that the direct-to-home distribution of Basic, Extended and Pay-TV services has a sufficient potential market to make the provision of those services economically viable. The addition of the total Canadian market located in urban areas potentially reduces the distribution cost per subscriber to a level which is sufficient to justify the inauguration of these services.

Based on the results of American studies, it appears that audience fragmentation and the associated economic harm to local broadcasters is unlikely to materialize. The operators of cable TV distribution systems welcome the concept of direct broadcast satellites, claiming that, given the right to distribute the same programs, they will compete favourably with the cost of direct-to-home reception. Such a mode of operation has the additional advantage of eliminating any concern over the possible violation of I.T.U. regulations for DBS systems.

In total, this study concludes that the use of an Anik C satellite for the regional and national distribution of television and radio programming to the major population centers is economically justifiable and has the added advantage of permitting the reception of those same programs by the 1,278,000 households that would not normally be served by community distribution systems. Within this potential market of direct-to-home terminal users, the provision of even a minimal number of new and innovative services will create sufficient demand for terminals to make the price of those terminals affordable.

Appendix A
To

Introduction and Executive Summary
Statement of Work

Activities and Tasks

Activity 1.0 – Market Analysis & Modelling

1.1 Market literature search (general)

1.2 Obtain and assess DOC TV-related demographic studies and more-general DBS studies

1.3 Examine Anik B direct-to-home TV pilot projects

1.4 With DOC assistance, determine boundaries for the number of TV channels to be transmitted (including specialized TV services such as pay TV, and the possible development of regional services), and prepare scenario

1.5 Define functional specifications of user and broadcaster requirements

- user terminal requirements
- projection of minimum, maximum, and most probable number of users
- proportion of users served by individual reception and community reception

1.6 Develop conceptual market model

- maximum/minimum market projection
- penetration rate
- price elasticity
- cross elasticity with 6/4 GHz and terrestrial distribution

Activity 2.0 – Technical Analysis

2.1 Review propagation data

2.2 Establish service parameters (quality, reliability and service availability)

2.3 Determine overall system concepts, including uplink regional locations

2.4 Link budget calculations

2.5 Determine available and required satellite capacity, and utilization plan

2.6 Determine uplink earth station design parameters

2.7 Determine TVRO earth station design parameters to serve different coverage configurations

2.8 Develop suitable earth station design concepts for uplink and TVRO stations, including discussions with suppliers

2.9 Identify coordination and licensing constraints

2.10 Examine the impact of Anik C antenna tilt on the Interim DBS service coverage area identified in the Market Analysis and Modelling Activity

2.11 Determine the optimum spot beam configuration for the Interim DBS service area(s) to be covered identified in the Market Analysis and Modelling Activity

Activity 3.0 – Economic Analysis

3.1 Develop projected uplink and downlink earth stations capital and operating costs based on Task 2.8

3.2 Derive a system model for direct-to-home and local distribution systems

3.3 Derive equations for costs as a function of:

3.3.1 costs of program reception both on a regional and national basis, including:

(i) use of direct-to-home; and

(ii) use of local distribution systems

3.3.2 costs of program distribution on a regional and national basis, including:

(i) use of direct-to-home techniques

(ii) use of local distribution; and

(iii) collection of programs at uplink sites

3.4 Iterate variables using a computer simulation of the system model, including:

(i) variations in the number of programs transmitted:

(ii) variations in the number of transmit stations;

(iii) variations in the number of direct-to-home receivers;

(iv) variations in the number of national and regional channels transmitted; and

(v) variations in the number of community distribution systems

3.5 **Determine where direct-to-home service is economically more feasible than alternate means such as cable distribution**

3.6 **Repeat 3.3 and 3.4 for hybrid local distribution systems (e.g., direct-to-home and cable distribution combined as determined in 3.5) and determine optimum alternative**

3.7 **Compile results to demonstrate the most effective role for Anik C as an Interim DBS in the Canadian Telecommunications environment.**

Activity 4.0 – Social, Political, Regulatory, Rates and Service Offering Analysis*

4.1 **DBS literature - Canadian, U.S., others (theory element)**

4.2 **Canadian, U.S., and foreign experience, commercial or experimental, associated with DBS - a historical review (practical element)**

4.3 **Research the potential impact of telecommunication regulations on existing institutional programming frameworks (production, distribution and exhibition) for a broadcaster planning to operate an Anik C and, later, a DBS service**

4.4 **Development of illustrative strawman rates and service offerings for program delivery and receive service, on a regional and national basis**

* DOC personnel will be available to discuss political and social factors but will not provide an input per se to this topic. DOC is more interested in a Telesat viewpoint in this area.

Activity 5.0 – Future Integration Considerations

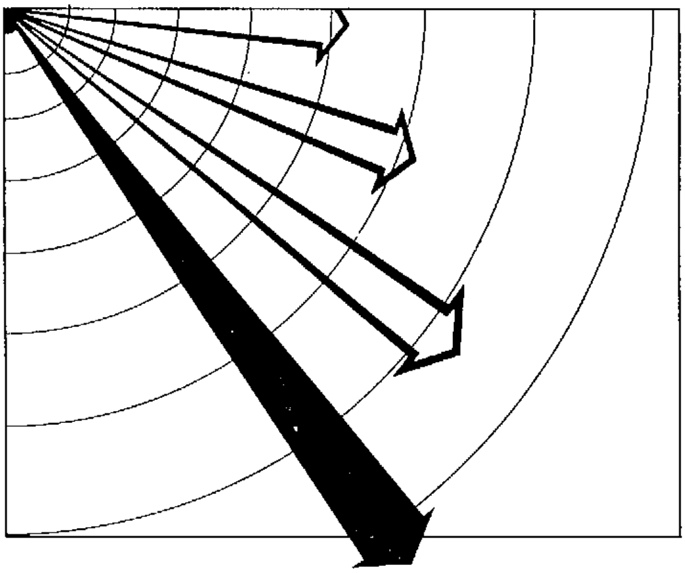
5.1 **Assess shortcomings of the Interim DBS system (coverage, quality, reliability, variety, cost)**

5.2 **Assess the difficulty of modification to the Anik C baseline system**

5.3 **Forecast satellite and earth station parameters of a future pure DBS system, if required**

5.4 **Demonstrate the compatibility of the Interim DBS with a pure DBS system.**

Section 1 –
Market Analysis



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1.0 Introduction

(1) Background

The objective of the contracted study is to examine the feasibility of using Anik C as a vehicle for providing interim Direct Broadcast Satellite (DBS) services. This section of the report discusses a market study of Direct-to-Home services, and constitutes the input upon which the technical and economic studies are based.

In the study, the term "interim DBS service" is used to refer specifically to Direct-to-Home and Direct-to-Community television distribution services provided by Anik C which is presently to be licensed in the Fixed Satellite Service. The term "DBS service" alone is used more generally to refer to Direct-to-Home and Direct-to-Community television distribution services, whether delivered by Anik C or by a future satellite licensed in the Broadcasting Satellite Service.

The reader should note that, as required by contract, this section is based on input from a concentrated assessment of studies and analysis carried out in previous DOC studies.

(2) Methodology

The contract with DOC defined the following paraphrased methodology for sections 1.1 through 1.6 inclusive:

(a) Search market literature for present plans for Direct-to-Home satellite services and TV services in general.

(b) Analyze and assess DOC demographic studies as they relate to TV services and Direct-to-Home services.

(c) Examine Anik B Direct-to-Home TV pilot projects to determine their applicability to this study.

(d) Prepare a scenario of the TV and radio signals to be transmitted by Anik C, and determine generally who the program suppliers might be.

(e) Define potential users and the proportion of them that would be served by individual and community reception; define the functional specifications of user and broadcaster governing user terminal characteristics.

(3) Study Approach

The present research relies heavily upon secondary sources obtained from the Department of Communications and the open literature. The study approach was as follows:

(a) Determine the motives for DBS implementation in other areas of the world and relate them to Canada's situation.

(b) Establish market size for traditional and new services via a Direct Broadcast Satellite.*

(c) Determine market demand based on cost of terminals and program variety that could be offered as a DBS service.

(d) Quantify the effect of community reception systems on DBS market potential.

* *New Services* – refers to introduction of premium programming.

(4) Study Inputs

The following is a list of information sources used as a basis for this study:

(a) Secondary research from published sources and the Department of Communications.

(b) Some interim results of ongoing DOC studies (e.g. Anik B Pilot Project).

(c) Informal interviews and surveys of a primary research nature.

1.1 Foreign Plans for DBS Services

Many countries are now examining the possibility of DBS service, but from different perspectives. In the U.S., such services are left to private enterprise to implement, whereas in most other countries they are the responsibility of Postal, Telephone and Telegraph (PTT) or other government agencies. The former is primarily interested in the prospect of a profitable venture, while the latter may be more concerned with extending basic communications services at a cost that can be justified. Countries with plans for implementing DBS are listed in Table 1-1 which provides the launch date and status of each system.

The following sections describe the Western Europe and U.S. approaches to DBS.

1.1.1 Western Europe

Any analysis of the potential development of the DBS systems in Western Europe must start with the special World Administrative Radio Conference (WARC) on Broadcasting Via Satellite held in Geneva in January-February 1977. A detailed plan was established for Europe, Africa, Asia, Australia and the Pacific region (Region I and III), while planning for the Americas (Region II) was postponed until 1983. The WARC identified two factors which have become important to international debate on the topic of DBS – individual reception and national coverage.[3]

(a) Individual reception was interpreted to mean the reception of satellite signals by individual antennas without the intervention of a centrally-located earth station. It was agreed that frequency and orbital positions should be assigned with this possibility in mind.

(b) National coverage was interpreted to mean the reception of a broadcast signal within the borders of a country.

Table 1-1 Status of DBS Development Worldwide[4]

Country	Launch Date	Status
Australia	1984	RFP issued
China	1985	Planning multi-purpose satellite with potential capability to handle DBS, although the primary use will be community reception.
ESA	1984	Multi-operational service approved.
France	1984	Pre-operational service approved.
Germany	1984	Pre-operational service approved.
Japan	1984	Second generation experimental satellite approved for development.
Luxembourg	1983–85	Decision pending
Scandinavia	—	Future in doubt due to limited support.
Switzerland	—	Swiss-British consortium has proposed advertiser-supported system.
United States	1983–85	STC-COMSAT — A premium subscription TV distribution system proposed.
		DBS Corp. — Proposed to operate as a DBS carrier.
USSR	1976	UHF downlink system, 5 spacecraft reportedly in use.

Source: A. Curran, DOC.

In most cases five television channels (each television channel also useable for about 16 monaural or 8 stereo radio channels) have been allocated to European countries. But viewers in many of these countries will be able to receive more than five channels owing to "spillover", where the signal spreads beyond the national boundaries of a country.

The question arises: Why should countries with already developed television networks be interested in satellite broadcasting? In most countries, satellite broadcasting would be able to take over the broadcasting of national television programs, thus freeing terrestrial transmitters for local, regional or special broadcasting – if the cost of a satellite television network is comparable to that of a terrestrial television system. These costs are difficult to evaluate and vary according to country.

In Western Europe, satellite communications ventures are undertaken by individual nations as well as by cooperative international interests. Different views prevail, depending on each national situation.

Great Britain has examined the use of DBS and is considering a limited service DBS satellite with 2 channels. This proposal was part of a report done by the Home Office, the government ministry that regulates communications in the U.K.. Programmers may include the BBC and the Independent Television Authority. This DBS system is now contingent on Government approval.

The *West Germans* analyzed both the cost of replacing their present distribution facilities and the costs that would be incurred by extending services to remote locations. The analysis included the cost of distribution to future cable and rebroadcast systems as well as Direct-to-Home service. Not measured in their analysis was the ability of their market to support the manufacturing of their own equipment. They concluded that DBS distribution is the most cost-effective solution to their needs.

The *French Government* has been active in forming DBS systems, for technical reasons. It has the goal of extending coverage to 100% of the population. To reach this goal without the aid of satellite transmission, it would require 3,250 additional TV relay stations in addition to the 5,300 now in-service. The additional facilities would help service only 1% of the population not served by any signals. The French conclude that DBS is the most cost effective solution to their needs.

The *Nordic countries*; Denmark, Finland, Norway and Sweden, have formed a venture to provide a satellite beam containing eight channels. Their aim is to increase understanding and closeness between the countries.

1.1.2 U.S.A.

The F.C.C. has agreed to receive applications for DBS services. The Communications Satellite Corporation (Comsat) has made application to the F.C.C. for a license to offer DBS Pay TV services to U.S. households. Some highlights of the Comsat approach are as follows:

(a) Four (4) operational satellites are planned, one for each coverage zone shown in Figure 1-1.

(b) Three (3) channels of diversified premium programming are planned.

(c) The system is suitable for transmission to 0.75 M antennas. The configuration of household equipment is shown in Figure 1-2.

(d) The proposed monthly rate is $14-18 per subscriber. This does not include the terminal costs of which the subscriber will have the option to lease or buy.

(e) The signals will be scrambled and decoders will be required for each subscriber.

(f) The cost of the earth terminal is not expected to exceed $300. This includes an allowance of $100 for the decoder.

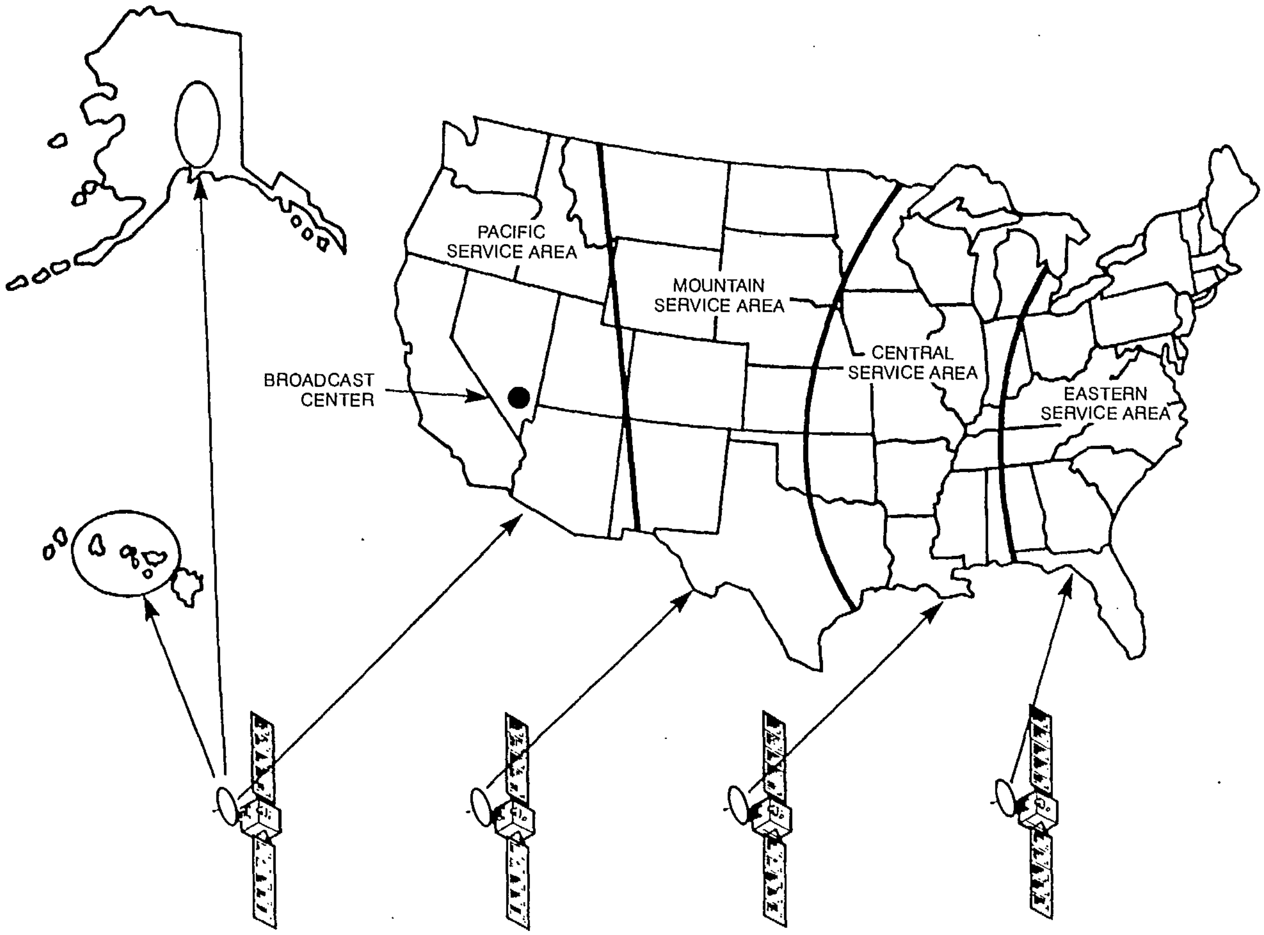


Figure 1.1 Service areas

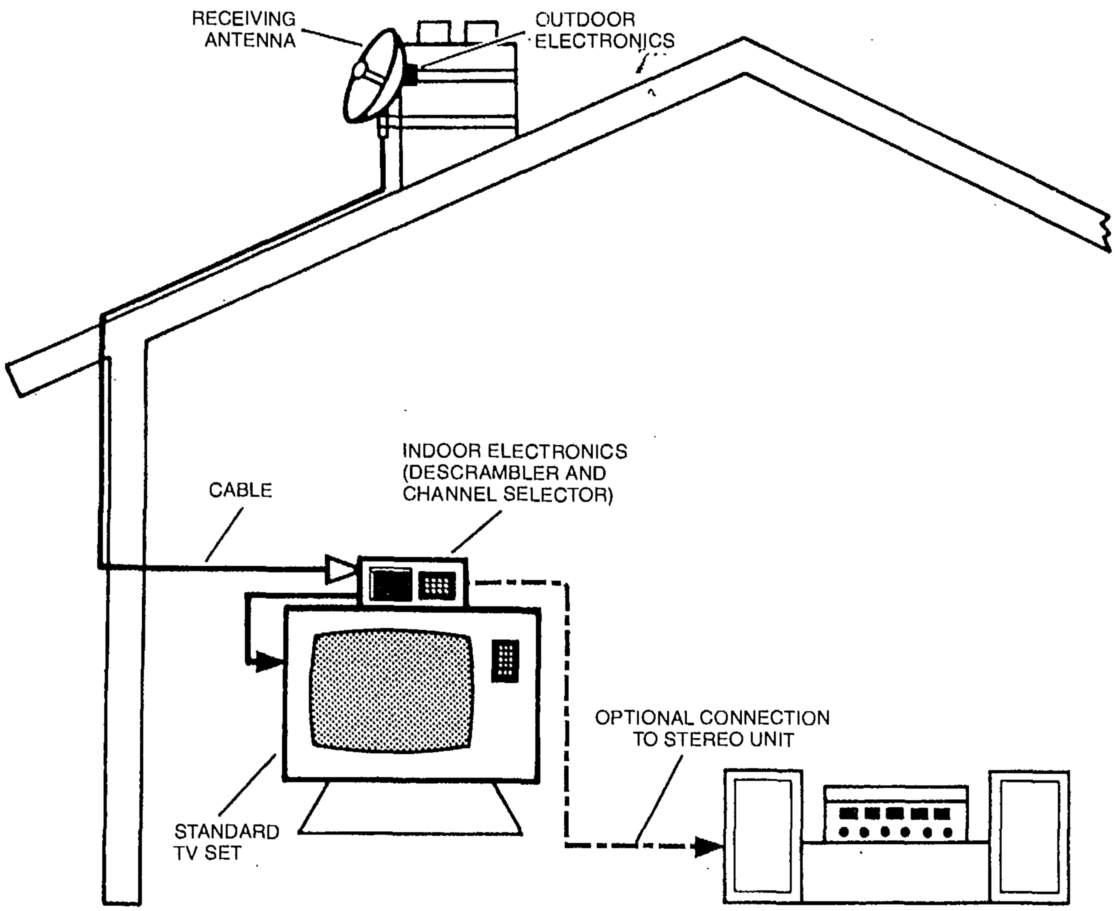


Figure 1.2 Typical residential installation

Two major points of the Comsat proposal are: a terminal cost less than $300; and the need for unique premium TV signals. This proposal aims to make DBS a commercially viable venture that will appeal to the well-served urban areas as well as to the underserved markets. Thus Comsat sees a potential market comprising all the 80 million U.S. households. A 12.5% market penetration (10 million households) will make this venture profitable.

Comparing the Canadian situation with that of the U.S., we find:

(a) Canada has a larger penetration of cabled areas (78%) than the U.S. (25%).

(b) The number of households in Canada is approximately 10% of that in the U.S.

(c) Comsat signals will spill over into the highly populated areas of Canada. Although Comsat signals will be coded for security, a tendency toward piracy can be expected owing to the potentially-attractive program content.

Table 1-2 compares the size and nature of Canadian and U.S. Television markets. This data indicates that the "high power" approach of the Comsat proposal is contingent on serving a very large market. The Canadian market is not sufficient to support such a system,

Table 1-2 Comparative Analysis, Television Statistics in U.S. and Canada

	U.S.	Canada
Households population	80 million	7 million
Households receiving no TV signals	1.6 million	72,000
Number of cable systems	4,100	467
Percent of cabled areas	25%	78%
Number of communities served by cable	9,600	1,082
Number of cable households	14.5 million	3.7 million
Penetration by cable of all households in cabled areas	18%	52%

Source: Canadian Cable Television Association Cablestats however, the Anik C system may be able to provide an economic alternative. Consider the Comsat system which requires four satellites to deliver three programs as compared to one Anik C satellite which is capable of providing 8 programs in each of four spot beams. The Anik C system requires somewhat large receive antennas, however, the savings in space segment may make it economic for the Canadian environment.

The Direct Broadcast Satellite Corporation (DBS Corp.) intends to file for an experimental common carrier license in September 1981.

The following is a summary of their proposed operation as outlined in their Letter of Intent to the FCC April 20, 1981.

(a) DBS Corporation do not intend to generate program material.

(b) If the FCC authorizes application on experimental basis, DBS Corporation intends to later apply for a permanent license.

(c) Service is *free* to home viewers. Viewers will provide their own home terminals.

DBS Corporation expects that the home terminal mass-production cost will be comparable to the cost of a TV set. Also, their home terminal cost will be less expensive than for those systems on monthly subscription basis (e.g. COMSAT proposal) since no specialized decoding equipment (descramblers) are required for the former system. In addition, by offering a "free to user" system, DBS Corporation feels reduced consumer costs can be realized from the elimination of administrative costs for billing monthly subscribers.

(d) More television channels will be offered for video use than the proposed COMSAT system.

(e) DBS Corporation is proposing to sell time on transponders covering various time zones and high density spots on first-come basis. Approximate cost $500-$1,000 on a TV beam per hour (non-prime time).

(f) Services will be provided via one satellite that will have spot beams of various configurations covering 1/2 or 2/3 of the U.S. geographically.

1.2 DBS in the Canadian Environment

The Rural Communications Program was created to study the problems of the rural areas of Canada in achieving a satisfactory level of communication services. These "rural areas" include both farm and nonfarm areas of low density population, where telecommunications services are extensions of urban services. It was found that many communities surrounding the metropolitan areas were greatly under-serviced compared to those more closely located to urban centers. This imbalance in services was the first concern of the Department of Communications. It sought to determine the best, most cost effective methods to supply better communications services to these outlying areas.

A 1976 DOC study established the size of the underserved areas. It was found that 24% of the population of Canada, comprising 6 million people, live in rural areas. The rising importance of resource industries may serve to increase this amount. Communications technology, they said, had reached a point where cost effective methods could be found to provide communication services on a single infrastructure as opposed to the fragmented approach to servicing rural Canada.[5]

1.2.1 Summary of Population Trends

The market for Anik C interim DBS service is affected by changes in Canadian population distribution. The following presents an overview of demographic changes to be expected over the next decade, which is the Anik C service life. Assuming that trends from previous years can be projected into the future, we obtain the extrapolations depicted in Figures E-1 through E-8,[6] as contained in Appendix E.

(a) The declining youth population growth affecting the overall population in the future can be seen in the declining percentage distribution of youth in the forecasted years 1986 and 2001. (Figure E-1)

(b) An increase of older-age Canadians is expected in both urban and rural areas. (Figure E-2)

(c) A continuation of migratory trends between provinces of high rural concentration (Saskatchewan, Manitoba) and provinces with larger urban areas (Ontario, British Columbia). (Figure E-3)

(d) A continued increase in the number of people in the work force, especially younger women. (Figure E-4)

(e) Leisure time continuing to increase in both rural and urban areas with the decrease in the number of working hours expected for all workers. (Figure E-5)

(f) A number of households will continue to increase, with more non-family households (elderly and young singles), and with less people per household. (Figures E-6, E-7 & E-8).

These trends will have their effect on demand for variety and content of TV and radio services, and modify viewer watching habits. Programming will appeal to more targetted audiences demanding specialized channels of entertainment and information services.

The following are some of the effects expected of these population trends:

(a) an increase in sedentary population wanting more in-home entertainment

(b) increase of specialized TV entertainment owing to increasing number of non-family households (less general variety content)

(c) increase of time-convenient entertainment facilities (TV) for larger work force

(d) increase of entertainment services to both rural and urban areas owing to increase in leisure time

Another DOC study relating to mobile communications concluded that; owing to "the ever present substitution of capital for labor, the rural areas are being depopulated."[7] Those living in rural areas have become

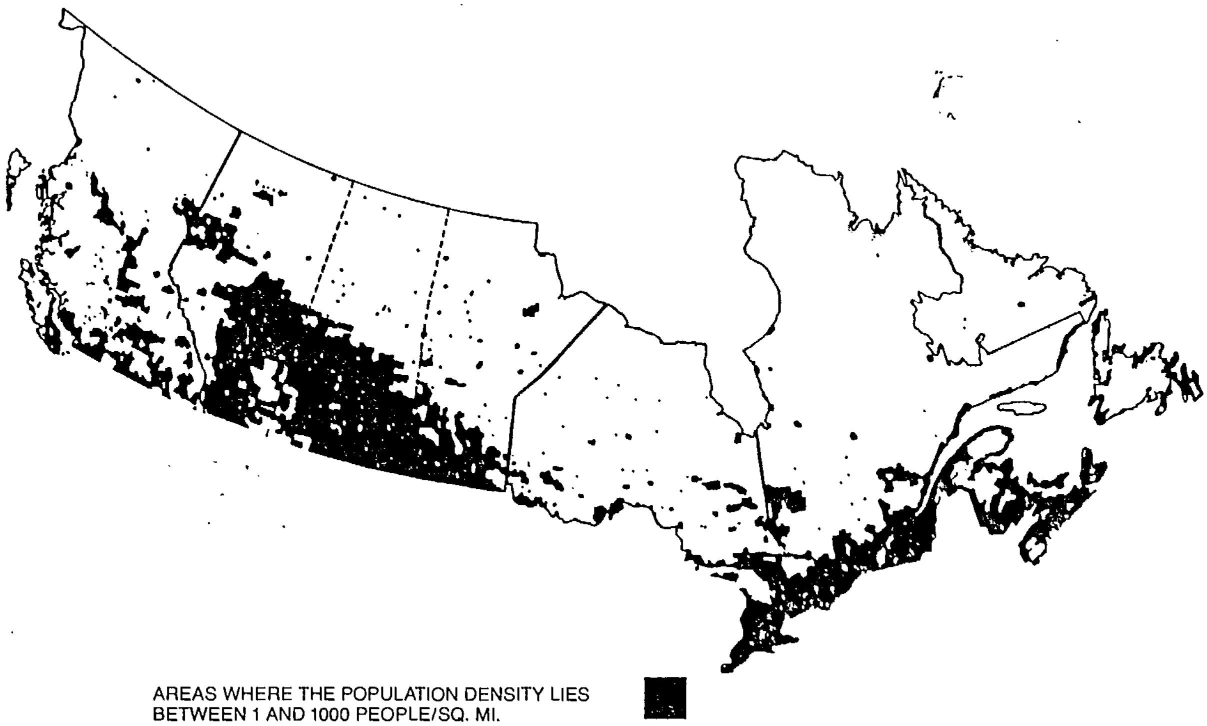


Figure 1.3 RURAL AREAS (1976 DATA)

Table 1-3 Area of Ecumene and Real Population Density

Province	Land Area in sq. miles	Ecumene* in sq. miles	%	Pop.** '000	Density of Population: p. sq. m. of total area	Density of Population: p. sq. m. of ecumene
Newfoundland	143,045	9,360	6.5	543	3.7	58.0
P.E.I.	2,184	2,184	100.0	117	53.6	53.6
Nova Scotia	20,743	10,320	49.7	813	39.2	78.7
New Brunswick	27,473	16,835	61.3	662	24.1	39.3
Quebec	523,860	60,900	11.6	6134	11.7	100.7
Ontario	333,835	65,507	19.6	8094	24.2	123.5
Manitoba	211,755	35,739	17.3	1011	4.7	27.5
Saskatchewan	220.182	104,610	47.5	907	4.1	8.6
Alberta	248,800	74,722	30.0	1914	7.7	25.6
British Columbia	359,279	31,600	14.4	2395	6.6	75.7
Canada, Excl. of Territories	2.091,176	432.777	20.7	22389	10.7	51.7
Yukon Territory	205,346	1,979	0.9			
Northwest Territories	1,253,438	4,144	0.3	57	0.03	9.3
Canada	3,549,960	438,900	12,4	22446	6.3	51.1

* Source: Gajda, R.T. (1960) "The Canadian Ecumene – Inhabited and Uninhabited Areas, *GEOGRAPHICAL BULLETIN*, No. 15.

** *Canada*: 1976 Statistics Canada.

'mentally urbanized' owing to increased personal mobility and mass media techniques. Thus rural communities now expect to obtain the same level of services enjoyed by urban communities.

Most Canadians live along the American border, while the North remains largely uninhabited. With an area of 3,549,960 square miles, Canada enjoys a population of just over 24,000,000 people. Population density is 6.3 persons per square mile, increasing to 10.7 if one excludes the territories. The latter figure is misleading, since it still includes vast empty areas. Figure 1-3 shows pictorially the rural Canadian population distribution.

Table 1-3 provides more detailed population data of the provinces and the territories. In southern Canada the ecumene or inhabited areas of the country is a strip of land coinciding with the agricultural areas and the dense populous zones. The northern ecumene differs from the south in that no appreciable amount of land is used for agriculture. The people in this area tend to live in communities. The Prairie Provinces form 19.1% of the total land area of Canada, and represent 49.2% of the total ecumene.

In 1978 the DOC set out to identify the various types of communities and determine the spatial distribution of households throughout the various regions in Canada. Very distinct topographical, population density and economic characteristics were identified within the four regions of southern Canada:

(a) The mountainous and ocean-bound region of British Columbia consists of dispersed settlement[8] patterns comprising 75% of that Province's rural population.[9]

(b) The Prairie provinces of Alberta, Saskatchewan and Manitoba displayed a high level (75%) of 'areal and dispersed households.' These communities are the most difficult to service because it is uneconomical to cable households or to establish rebroadcast facilities there.[10]

(c) Ontario and Quebec contain more than 50% of the rural Canadian population. These areas are evenly split between 'settlement' communities and 'areal and dispersed' communities. In these two provinces there is a large rural population surrounding the urban and large metropolitan areas.

(d) The provinces of New Brunswick, Nova Scotia, Prince Edward Island and Newfoundland concentrate their populations in community settlements or according to a linear pattern. Few, if any, areal and dispersed household patterns could be identified in this region.

Some areas are suitable for cabling (East Coast), owing to the density and linear strucutre of their communities. Other areas, notably in Saskatchewan, Ontario and Quebec are more widely dispersed and may be better serviced by Direct-to-Home satellite reception.

1.2.2 Availability of Television In Canada

About 25% of the small town and rural population have had programming extended to them by the CBC.[11] Larger cities receive, on average, 3.3 times more distinct and different TV channels than does rural Canada[12]. The rural dweller receives on average, 3.85 distinct TV channels, whereas his city cousin receives 12.6 distinct TV channels, as detailed in Figure 1-4. Cable TV systems serve to accentuate these differences.

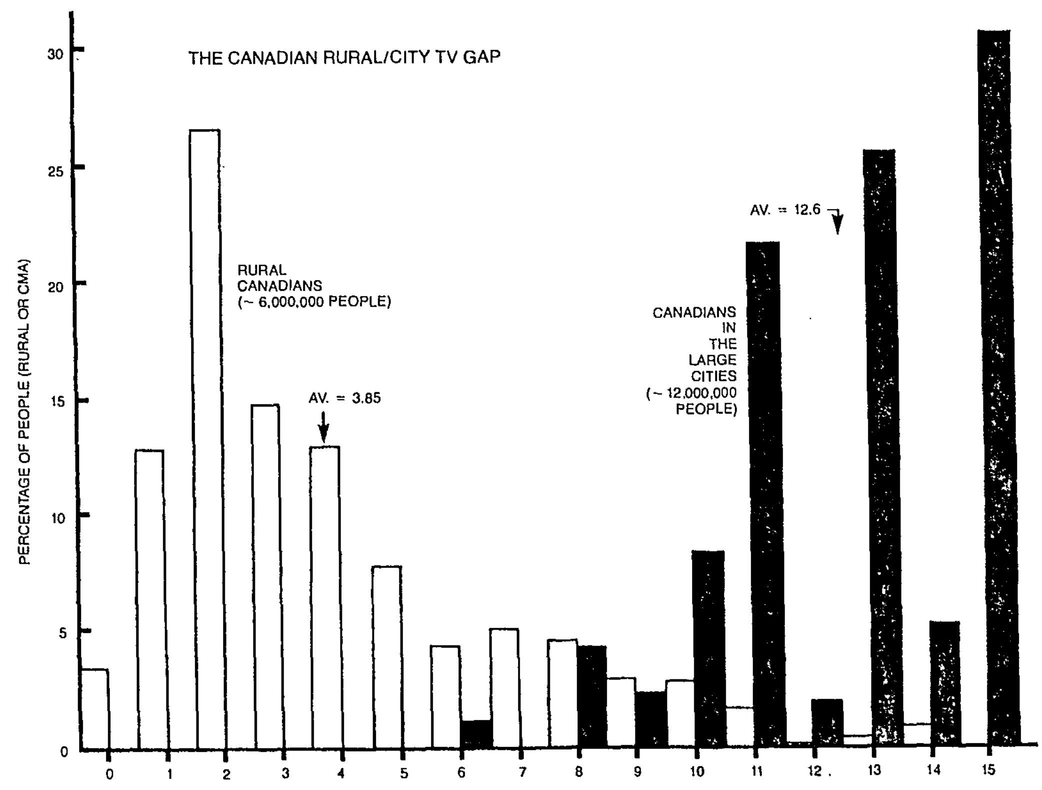


Figure 1.4 The Canadian rural/city TV gap

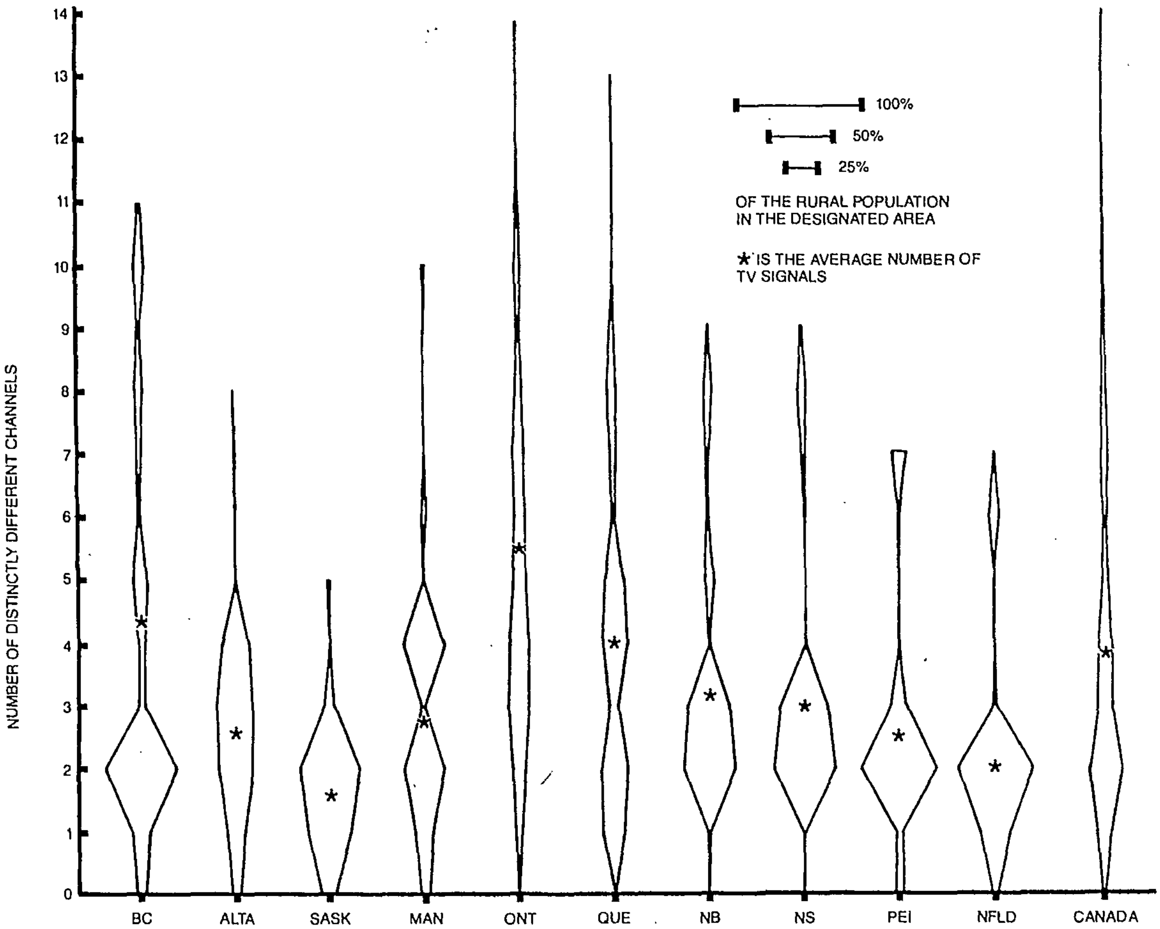


Figure 1.5 Availability of TV in rural Canada

There are more cable systems operating in large metropolitan areas, owing to the accessibility of large numbers of potential subscribers.

The present reception patterns for TV signals in Canada (see Fig. 1-5) show how common the reception is of 2 to 4 distinctly different TV channels in most of the provinces. CBC programs reach 98.5% of Canadians. CTV covers 95% of Canadians. Other signals include those of local broadcast stations or signals received from the U.S.

1.2.3 Market Reaction to DBS

DOC plans to survey rural Canadians in the future to seek opinions and interests for improved communication services. In preparation for this new study, focus groups[13] were formed to test the survey questionnaire. Many divergent opinioins were revealed by this exercise. These survey results cannot be blindly accepted owing to lack of scientific sampling.

Ten focus groups were surveyed in various rural areas across Canada. Beginning with a general quality of life inquiry, the questioning moved to communication services, levels of satisfaction, and improvements needed. A summary of the comments received follows:[14]

(a) "Quality of life is much better in a rural environment".

(b) "Telecommunications would seem to play a less important role as a disadvantage of living in a rural environment".

(c) "Programming seemed to be a major source of disappointment while reception was perceived to be unsatisfactory. Typically, reception is good on one channel, mediocre or unacceptable on the others."

(d) "Rural residents' needs seem to center on obtaining more local news and better programming."

(e) "Most of them were also reluctant to acquire any new TV reception equipment owing to cost factors, no perceived change in programming, and a certain mistrust in such a system actually delivering the promised service."

(f) In reference to FM radio programming, many of the participants said, "they enjoyed it and would appreciate getting more of it."

(g) "The available selection of radio stations was not seen as a problem."

(h) "The radio fills, or should fill, the need for: local, regional and national news (with perhaps more local content)."

(i) "The most relevant attributes of a radio broadcasting service are: 1) quality of reception, 2) number of stations received, and 3) amount of local vs. regional vs. national programming."

These comments are not based on any proper sampling method and the survey results should be better indicators of the extent of these attitudes. Should these comments be confirmed by the survey, it would seem to indicate a soft rural demand for DBS, owing to the following:

(a) DBS reception would entail additional terminal costs.
(b) DBS would probably carry either national or regional programming, but not local programming.
(c) DBS would be limited in the number of channels being offered and may deliver channels that are already being received by the viewer.

1.2.4 Industry Reaction to DBS

(1) Cable TV Industry[15]

The cable operators do not see an interim DBS service on Anik C, with the carriage of public broadcast signals and some private broadcasting, as a threat or competition to cable.

The cable operator will use satellite distribution to cable head-ends as a means of increasing the number and variety of programming channels carried by cable. As increased satellite distribution is authorized and TVRO terminals come down in cost, new markets may become economical for cable in communities not presently cabled. Also, in the eyes of the cable industry, satisfaction of the extension of services requirements will make possible a more permissive government attitude toward new-service development (e.g., Pay TV).

(2) CBC

The extension of coverage to complete the CBC mandate to provide service to all Canadians will require some DBS capability.[16] Anik C could be used to provide regional distribution of radio and TV signals with the added bonus of Direct-to-Home capability, particularly if cost is competitive with existing terrestrial distribution.

(3) Canadian Association of Broadcasters[17]

Some of the members of CAB are concerned about the plans for a lower powered DBS system as compared to systems being planned in the U.S. and other countries. The lower powered DBS would require larger, more expensive earth stations, making it less attractive to both the broadcast industry and the public.[17]

Their concerns are in reference to future U.S. higher-powered DBS signals which will have considerable spillover into Canada. The Canadian viewer would be able to purchase a smaller, less expensive terminal to receive U.S. programming.

CAB feels that the Canadian DBS system should be designed to serve both the urban areas as well as the rural, remote and poorly-served areas of the country.

They are opposed to the concept of superstations for the following reasons:

(a) It may fragment the viewing audience.
(b) The programming will not meet the needs of the northern and remote areas.
(c) Since there is limited satellite capacity (6/4 GHz satellites) now, it is unfair to other private broadcasters if one station were able to broadcast as a superstation.

At a Telesat/DOC briefing to the CAB on this study, some broadcasters said that Telesat should be exploring systems for the delivery of Canadian programming to U.S. Markets.[18]

1.3 Examination of Anik B Direct-to-Home TV Pilot Projects

Full time use of the Anik B 14/12 GHz channels by DOC began in March, 1979. The Ontario Educational Communications Authority's Program Delivery Pilot Project, to broadcast its TVO programming to various locations in Northern Ontario, commenced on September 25, 1979.

In December 1979, Vancouver affiliates of both the CBC (CBUT) and CTV (CHAN) began distributing their programming via Anik B. They used 1/2 transponder each to serve a number of receive terminals distributed across B.C., the Yukon, and the Mackenzie Valley area of the N.W.T.. An Educational TV project was implemented by the B.C. Ministry of Education. Project coordination was the responsibility of the B.C. Institute of Technology. The Alberta Educational Communications Authority and the Quebec Ministry of Education also carried out ETV projects. These programs were largely concerned with institutional or instructional TV, which is different from the OECA concept of enrichment programs, offering an entertainment element in the material.

Project descriptions and interim reports used are listed in the attached References 19-27 in Appendix B.

Table 1-4 presents a summary of broadcast and ETV projects and the results obtained from interim reports or private discussions with experimenters.

Other projects, including three relating to native programming, and another to put three video carriers on one satellite transponder in the West beam, are being investigated by the DOC.

Table 1-4 Anik B Program Delivery Pilot Projects

	Broadcasters	Provincial Governments and ETV
Project Description	**CBC/CTV** (B.C.) Each feeding standard broadcast day of approximately 22 hrs. and sharing power of one TWTA in west beam **OECA** (Ont.) Feeding approx. 87 hrs./week of TVO programming using the full power of one TWTA in the central east beam. Main purpose was to demonstrate feasibility and to gain experience/user feedback of direct-to-home and community television.	**B.C.** An interactive ETV project coordinated and uplinked by BCIT into an RF channel of the west beam. **Alberta** ETV programming, taped and uplinked with BCIT signal for 10 hrs./week. **Quebec** An ETV project linking a school in Radisson with Quebec Dept. of Education studios in Montreal using the east beam. **Ontario** ETV (Tele-Academies) uplinked by TVO into east central beam. Main purpose was to test effectiveness and create awareness of ETV potential delivered to remote locations.
Test Market	**CBC/CTV** Approx. 20 terminals in individual homes, cable headends and institutions. Terminals located in B.C., Yukon and N.W.T. **OECA** Over 40 terminals at individual homes, cable headends, schools, motels, a prison and one low power rebroadcast transmitter in Northern Ontario.	**B.C.** Terminals located in colleges and training centres in B.C., Yukon and the Mackenzie Valley area of N.W.T. **Alberta** A number of terminals located in remote communities of the province. **Ontario** Four of the 40 plus Ontario locations were used for the ETV courses via local cable distribution. **Quebec** The initial project used video for teleconferencing link to the one school with the ministry studios.
General Results To Date	In all cases, the projects have met a very positive response from both the communities and the user groups conducting the projects. The broadcasting projects especially have been very well received. The users are now requesting the 'experimental' service not be terminated.	
Signal Quality	In all projects to date, the video and audio signal quality has been perceived as ranging from very acceptable to good or excellent compared to existing off-air signal reception. This viewer judgement has been achieved with the DOC system parameters of 40-42 dB S/N and a C/N 2 to 4 dB above threshold. The west beam carries two video signals in one TWTA and 1.8 M antennas are used. The east central beam carries the TVO signal using full power of one TWTA to 1.2 M antennas in the primary coverage area. 1.8 M terminals in secondary converage areas and 3 M terminals in fringe areas or to cable headends.	

Table 1-4 (cont'd)

	Broadcasters	Provincial Governments and ETV
Operation and Maintenance of Terminals	Operation and maintenance evaluation of the terminals has been hampered owing to numerous initial equipment failures. These should be overcome with time to give a better assessment of O&M performance. To date, the users report operating problems have been less than expected. There have been interface problems mainly with MATV and rebroadcast locations rather than with cable systems. This could be a continuing problem unless the interface is standardized for community systems. Some users are concerned about equipment reliability and the time it might take to get repairs done in remote areas.	
Users Future Satellite Plans	**CBC** CBC are interested in using Anik C for regional distribution if satellite rates are competitive with existing terrestrial distribution costs.	**B.C.** Government has publicly stated it wants to use Anik C for ETV and for other government applications but rates are too high.
	CTV CTV have stated they cannot afford satellite distribution costs.	**Alberta** Planning to use Anik C for provincial ETV, including radio and other multiplexed services such as slow scan video, Telidon, etc.
	CHAN (CTV affiliate) They would like to use satellite distribution both to improve rural coverage and to greatly improve signal quality by replacing cascaded rebroadcast transmitters, but say they cannot afford it. They can see no additional revenue accruing from increased coverage to remote areas.	**Ontario** No definite plans other than the OECA service. They are still looking at tele-health and tele-conference use for various departments and branches in the province.
	OECA They have definite plans to go on Anik C in 1983. They feel DBS satellite is the only practical method of reaching all Ontario population.	**Quebec** No firm plans for satellite use. Their ETV system is regionalized with local sub-area programming and distribution which would be difficult for satellite to replace. The provinces have committed themselves to provide better communication and broadcast services to underserved areas.
Perceived Role or Need for DBS	Public and private broadcasters are opposed to DBS unless tightly regulated. They feel it would further fragment their markets. If the use of DBS could be regulated to have minimum negative impact and if it could generate additional revenue then they would certainly use DBS to increase coverage and improve signal quality.	Provincial governments like the regional coverage of Anik C and plan to use DBS to provide ETV coverage to all residents. Feel generally that satellite facilities to date have been underutilized and overpriced. They state more services and extension of services would be put on the satellite if satellite rates were more reasonable.

1.3.1 Concluding Observations on Program Delivery Pilot Projects

As most projects are still ongoing, only interim conclusions can be drawn at this time.

The projects are largely funded by the DOC, therefore no hard market data is available as to what the pilot project program suppliers would pay to use a DBS delivery system, or what the home viewer would pay for a receive terminal and what program content he would expect or want to be delivered.

Surveys now completed by the DOC and pilot project users have provided considerable data on received signal quality, terminal reliability, operation, maintenance, etc. Initial results in these areas are detailed in the preceding Table.

In the areas where broadcast signals are being received, the desire for additional TV and radio channels has certainly been confirmed, with users requesting that the existing service not be terminated.

The quality of the signal received by the home viewer has been found to be very acceptable and would indicate that an interim DBS service using Anik C could also provide acceptable quality signals via a low cost receive terminal.

Of the various pilot project users, only the Provincial ETV's have indicated firm plans to use Anik C if the satellite channel costs are "reasonable". OECA has stated that they will use Anik C to distribute their TVO programming to provide coverage over the entire province.

As detailed in a DOC Focus Group study[14] the cost of a home terminal may not be as critical to the user as the number of channels received, the quality of the programming, the quality of the signal received and the assurance that the system will deliver the promised service. People in the remote/rural areas will spend money for entertainment and leisure activities if they feel they are getting their money's worth.

1.4 DBS Services

The DBS system must satisfy the needs of two basic user groups or markets.

(a) An intermediate market – program provider

(b) An end-user market – the viewing audience

To meet the program providers' needs, the DBS system must enable him to attain the largest possible viewing audience at the lowest possible distribution cost. The DBS system costs will be partially offset by the replacement of some existing terrestrial distribution facilities.

To meet the viewers' needs, the DBS must provide a variety of broadcast signals sufficient to satisfy his entertainment and information needs. In so doing, a large enough market may be created to offer economies of scale and a competitively-priced home/community terminal.

Telesat will be primarily involved in the intermediate market, through its selling effort to the program providers. To be viable, the DBS service must offer a mix of programming which combines public and educational services with commercial entertainment programming. The success of the interim DBS end-user market relies heavily on Telesat meeting the various broadcaster and program supplier needs and, again, in the quality of programming available.

1.4.1 Service Groups

For purposes of this study, TV and radio signals have been grouped into three categories to reflect the different market demands associated with each type of programming. This grouping is to aid the analysis. Operational services will, of course, be provided in the form most responsive to customer requirements.

Basic Services: publicly funded services provided by the CBC and the provincial educational authorities;

Extended Services: the advertiser-supported regional broadcasters;

Pay Services: subscriber-supported services.

The following factors are seen as prime requisites in the viability of these services using the Anik C satellite:

(a) The content wil be regional in its origination and the market it is to serve.

(b) The program delivery will be time zone sensitive.

(c) The TV and radio signals making up the Basic and Extended services must provide a solid base of entertainment and information programming sufficient to create a substantial demand for Direct-to-Home receive terminals.

(d) The distribution of Pay TV signals in addition to the Basic and Extended services is required to increase the penetration into the Direct-to-Home market by providing a more diverse program content.

In a press release accompanying its April 14, 1981 "Extension of Services" decisions, the CRTC made the following statements:

"These decisions are only the beginning of what will undoubtedly be a more extensive use of satellites to meet Canada's future communications needs which are, in part, a reflection of our geography and scattered population. The potential of future broadcast satellites to provide services to Direct-to-Home has particular merit in this regard."

"The Anik C satellite, not yet launched, will operate using the 14/12 GHz band. This will be of specific interest for broadcasting purposes in future because of its capacity, through the use of 1/4 Canada and 1/2 Canada coverage beams, to respond to scheduling problems created by time zones, and allowing for reception of a different service package in each region of the country."

The regional content proposed in this study, for Anik C distribution, would certainly seem to meet the future regional and geographical broadcasting needs as seen by the Commission.

Public broadcasting services have government mandates to effectively serve the entire population in their region of interest. The DBS can uniquely fill this need but the distribution cost must still be judged cost-effective. A recent consideration of the distribution of CBC Regional TV and Radio (carried out by Telesat) showed that demand for satellite RF channels was price sensitive to other competitive forms of distribution.

There are indications at this time that private broadcasters and Pay TV entrepreneurs have an interest in using Anik C. A higher level of interest is shown by the public broadcasting services. Demand is expected to increase as the Anik C in-service date approaches.

If only Basic services are offered on a DBS system, indications are that it will not be able to attract the number of users required to make it a viable service. Extended services must therefore be included and they must provide the private broadcaster with a larger viewing audience at a competitive distribution cost. New Pay TV services, in addition to what may already be existing, may be offered to both a cable subscriber and home/community terminal market.

Past submissions to the CRTC on broadcasting services, particularly from native people's groups have stressed the need for improved radio services. Both public and private radio broadcasting signals have been assumed to be included with the TV signals to be carried by the interim DBS system. A detailed description of Basic, Extended and Pay services is provided in the following section.

1.4.2 Description of Basic, Extended and Pay Services

(1) Basic Services

The distribution of CBC regional French and English television programming and provincial education television signals will likely be provided on a 1/4 Canada coverage basis. The Anik C satellite will provide a regional or provincial distribution of these broadcast signals from the main studio or regional networking point to the broadcast transmitter locations within each province or region. As such, the Anik C distribution will be an integral part of the CBC and provincial educational regional delivery system and the satellite distribution cost will be a part of their overall broadcast distribution network cost.

The Anik C satellite can thus provide a regional point to multi-point distribution system for the CBC and ETV signals to existing and future broadcast transmitter locations and in addition, the signals could be made available to all Direct-to-Home and community reception terminals. This would enable the CBC and the provincial educational authorities to fulfil their mandates in providing these basic public supported services, free of charge, to all homes within a CBC region or provincial boundary.

In the study, we have assumed the regional distribution of these basic services would start with the distribution of one CBC regional signal and one educational TV signal in each of the 4 Anik C beams.

(2) Extended Services

The TV and radio signals to be provided by regional independent broadcasters will also likely be distributed on a 1/4 Canada coverage basis for the following reasons:

(a) The programming content should be as local in origination as possible so that the news, special events and other locally-produced programming will be of maximum interest to the users in that region.
(b) The various time zones in Canada will be best served by using the 1/4 Canada coverage beam.
(c) The coverage area of any one broadcaster would be limited and the impact on local broadcasters in other areas of the country will be kept to a minimum.

In the east beam, the programming of La Sette, presently available to the cable operators in Quebec via the Anik B satellite, could be made available to all cable systems, communities and homes and the predominantly francophone areas of the Maritimes. The service of the Atlantic television system (ATV/2) has already been approved by the CRTC to provide a new regional television service in Atlantic Canada.

The CTV programming of station CJON/TV in St. John's, Newfoundland, which was approved on an experimental basis by the CRTC could become a permanent, regional service using Anik C.

In the east central beam, the broadcast signals of Global TV and CITY TV, both of Toronto, would be potential program content, as well as a French language broadcast station.

In the west central beam, the broadcast signals of stations such as CKCK in Regina and CKND or CKNP in Winnipeg could be part of the content package. A broadcast signal from the city of Saskatoon would also be desirable, but of the total of 3 extended broadcast services being recommended, one should be in the French language, or at least have a significant component of French language programming.

In the west beam, broadcast signals from stations in Calgary, Edmonton and Vancouver would be desirable content.

In addition, new broadcast services, tailored to regional audiences, could be distributed by the Anik C satellite. These signals could be similar in content to Atlantic television ATV/2 service which will concentrate on program content of most interest to the region being served, i.e. regional news, sports, etc. These signals may be partially subscriber-supported, with possibly some regional advertising being carried, and would have both a Direct-to-Home/community and CATV systems market.

(3) Pay TV Services

An English and French Pay TV channel has been proposed. The basic concept with these Pay services is that they will be regional in their origination, in addition to first-run movies. It is assumed the content will be sufficiently different from other existing Pay TV services that a market will exist in the smaller CATV systems and in the Direct-to-Home and community households.

The approach we have taken in the carriage of a regional Pay TV service is detailed below:

(a) Larger cable systems may or may not carry regional Pay TV as proposed for an Anik C DBS. This would depend on the availability of national Pay TV services and to what extent the regulators would allow these services to co-exist.

(b) The Pay TV channels would be a tiered pay-per-channel service which would not be tied directly to the package of extended broadcaster and basic services intended primarily for the rural/remote homes and communities.

(c) The pay channel services are, however, viewed as an important part of the Anik C regional broadcasting service as they will increase the potential market to all rural households by providing new entertainment services not previously available and also increasing the number and variety of signals available in total from the Anik C satellite. By having both a rural home/community and CATV market, sufficient revenues should be generated to fund Canadian program production.

(d) The French Language Pay TV channel is proposed as a regional service in both eastern and western Canada. However, as 97% of the French speaking population resides in eastern Canada (85% in the province of Quebec). A market base obviously does not exist to support a western Canada French language pay channel. There are 5.9 million Canadians whose first language is French, which is certainly a large enough base to support one or more French language Pay TV services. It may evolve that most of these services are supplied to the large francophone market in eastern Canada and the 166,000 francophones living in western Canada may have to be served by distributing the same programming supplied to eastern Canada.

(e) Even though a large number of the rural/remote communities may be receiving some television broadcast signals, and possibly Pay TV signals, via the 6/4 GHz satellite, the relatively modest cost of 12 GHz TVRO equipment suggests that community distribution systems will want both 4 and 12 GHz capability to maximize the variety of their service offering.

1.4.3 Maximum/Minimum Program Scenarios

As part of the study objectives, we have set out two bounding scenarios as to the number of TV and radio signals to be transmitted over an interim DBS system. One scenario details the minimum number of signals which we feel are required in order to attract an end-user market. The second scenario details the maximum number of signals which can be realistically expected, based upon Telesat's knowledge of the market place.

Table 1-5 postulates a regional DBS system with 4 TV and radio signals as a minimum content in each of four regional spot beams.

Table 1-5 Minimum Number of Signals Transmitted per Beam

Service	TV/Radio Signals
A) BASIC	
1) Regional CBC – (English or French)	1 TV + 1 FM Radio
2) Provincial Ed.	1 TV + 1 FM Radio
B) EXTENDED	
1) Advertiser-supported Regional Broadcaster	1 TV + 1 AM Radio
C) PAY	
1) English or French channel	1 TV + 1 FM Radio
TOTAL	4 TV + 4 Radio

Note (1) For Extended and Pay services, it is assumed that Private Broadcasters would provide the radio signal originating from the same source as the TV signal.

(2) The Regional CBC service must provide both French and English signals in the East Beam.

(3) The Extended service of a private network must provide a French affiliated station service in the East Beam.

Table 1-6 presents the alternative extreme case, where a maximum number of 8 TV and radio signals are carried. The CBC service is shown to expand to provide one English and French signal in each beam. The number of ETV signals remains the same as for the minimum signal configuration. Extended services are expanded to include additional English and French regional broadcasters. Pay services are also expanded to include an English and French Pay TV signal.

Table 1-6 Maximum Number of Signals Transmitted per Beam

Service	TV/Radio Signals
A) BASIC	
1) Regional CBC – English	1 TV + 1 FM Radio
2) Regional CBC – French	1 TV + 1 FM Radio
3) Provincial Educational	1 TV + 1 FM Radio
B) EXTENDED	
1) Advertiser-supported Regional Broadcasters	3 TV + 3 FM Radio
C) PAY	
1) English Channel	1 TV + 1 FM Radio
2) French Channel	1 TV + 1 FM Radio
TOTAL	8 TV + 8 Radio

Table 1-7 Estimate of Potential Market

Service Offering	Potential Market
Basic Services CBC national or regional	Households not receiving TV signals (72,000)
Extended Services Basic services plus one or two private networks up to 4 or 5 TV signals	Households receiving less than 3 TV signals (720,700)
Pay TV & Extended Services	All non-cabled households, less households in areas able to distribute on a community basis (1,278,000)

1.5 The Demand for an Interim DBS Service

1.5.1 Potential Market

Factors considered in analyzing DBS service demand are detailed below:

(a) TV signals now available to underserved areas of Canada and the different types of programming that would be provided by an interim DBS is most significant. Table 1-7 details the potential market for each of the three categories described in Section 1.4; i.e. Basic, Extended and Pay services. A maximum of three signals are available with the Basic services; the Extended services add one to three private or public broadcaster signals to the Basic services to a maximum of six TV signals. The last combination adds one or two Pay services for a maximum content of eight TV signals. For each combination, a potential market is identified, based on the number of TV signals already available.

(b) The cost of the DBS terminal equipment has been related in a general way to the cost of colour TV receiving equipment.

(c) The number of TV signals available with an interim DBS service will affect demand. We have estimated a demand curve as shown in Figure 1-8, for an Anik C supplied service. The demand would be low for one or two TV signals, and would increase quite rapidly as more signals are added, until a saturation point is reached where demand slackens off. For the Direct-to-Home service we have estimated this point to be at 6 or 7 signals.

(d) Household distribution was obtained from the 'Clustering of Households'[8] study to locate the potential community reception vs Direct-to-Home terminal markets.

Demand tables have been developed for both the maximum and minimum scenarios. Tables 1-8A and 1-8B detail the market for Direct-to-Home terminals for each of the combinations of service offerings for a range of terminal prices. Appendix C provides the details of the calculations and assumptions used in developing these tables.

Table 1-9 assumes a community size of 300 or more households as the criteria for a Direct-to-Community market. It provides the number of communities and total households involved for each of the Anik C beams. This table further identifies the number of communities of 21 to 300 households.

These households form part of the potential market for Direct-to-Home terminals detailed in Tables 1-8A and 1-8B. They offer a potential shared-use or small community reception market where a number of homes might share a common distribution system from one satellite terminal.

Figures 1-6A and 1-6B depict the potential markets for Direct-to-Home terminals, detailed in Tables 1-8A and 1-8B.

A set of demand curves for the different service combinations, using the market penetration figures from Tables 1-8A and 1-8B, are shown in Figure 1-7.

Table 1-8A Direct-to-Home Terminal Market Penetration Minimum Content Scenario

Program Content		Basic Services (2 T.V. & Radio Signals)	Basic & Extended Services (3 T.V. & Radio Signals)	Basic & Extended & Pay (4 T.V. & Radio Signals)
Potential Mkt		72,000 H.H.[1]	260,700 H.H.[2]	1,278,000 H.H.[3]
Probable Mkt		61,200 H.H.	170,540 H.H.	392,000 H.H.
Terminal Price	**% Penetration**	**Market**	**Market**	**Market**
100	79	48230	134400	309000
200	73	44220	124070	285200
300	66	40111	111770	256940
400	58	35450	98795	227100
500	50	30600	85270	196016
600	42	25750	71745	164930
700	34	21100	58770	135100
800	27	16790	46780	107535
900	21	13000	36140	83070
1000	16	9700	27065	62215
1100	12	7050	19610	45085
1200	8	4950	13780	31676

See Appendix C for full explanations and calculations.

1 From "Statistics of Television Broadcast Covered in Rural and Remote Canada", *Telecommunications Research Group* , Burnaby. British Columbia, Simon Fraser, Univ, 1979 p. 21. This figure represents those households receiving no T.V. signals based on an average of 3.6 persons per household.

2 Ibid p. 21. This figure represents those households receiving less than 2 T.V. signals.

3 The total rural market comprised of 1.7 million households less the households in the likely community reception market.

Table 1-8B Direct-to-Home Terminal Market Penetration Maximum Content Scenario

Program Content		Basic Services (3 T.V. & Radio Signals)	Basic & Extended Services (6 T.V. & Radio Signals)	Basic & Extended & Pay (8 T.V. & Radio Signals)
Potential Mkt		72,000 H.H.[1]	720,700 H.H.[2]	1,278,000 H.H.[3]
Probable Mkt		68,400 H.H.	558,000 H.H.	774,000 H.H.
Terminal Price	**% Penetration**	**Market**	**Market**	**Market**
100	79	53400	439465	609785
200	73	49760	405670	562895
300	66	44830	365470	507110
400	58	39624	323030	448230
500	50	34200	278815	386870
600	42	28776	234590	325510
700	34	23570	192160	266630
800	27	18762	152956	212240
900	10	14494	118160	163955
1000	21	10855	88500	122790
1100	16	7872	64127	88980
1200	12	5527	45056	62520

See Appendix C for full explanations and calculations.

1 From "Statistics of Television Broadcast Covered in Rural and Remote Canada", *Telecommunications Research Group* . Burnaby. British Columbia, Simon Fraser, Univ, 1979 p. 21. This figure represents those households receiving no T.V. signals based on an average of 3 6 persons per household.

2 Ibid p 21 This figure represents those households receiving less than 3 T.V signals

3 The total rural market comprised of 1.7 million households less the households in the likely community reception market

Table 1-9 All Canada

Prospective Households for Community Reception

Community Reception
Households that are within communities that are highly capable of being served on a community reception basis.

	West Beam	West Central Beam	East Central Beam	East	All Canada
Size of Community					
300 or more hh					
# of communities	88	250	102	310	250
# of hhs	73,374	134,325	72,076	166,940	446,715

Clustered Household Reception

The households in these communities can be served in a variety of ways. The use of a small community reception system with distribution among households done privately as opposed to being cabled commercially. These households were not used to separate the potential market for community reception and are still included in the market potential for an Interim DBS service.

	West Beam	West Central Beam	East Central Beam	East	All Canada
21 hh – 300					
# of communities	2,469	1,152	1,070	3,621	8,312
# of hhs	172,696	78,103	71,049	244,628	566,476

This is the area where CANCOM, which was not taken into account, would have the greatest impact.

Note: Estimated from the CRTC Statistics on Service Availability to communities in Remote and Rural Areas.

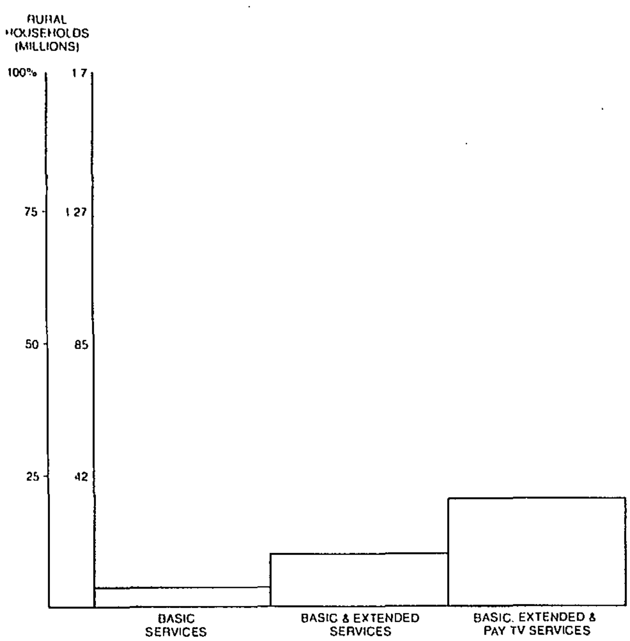


Figure 1-6A Potential market direct-to-home terminal minimum scenario

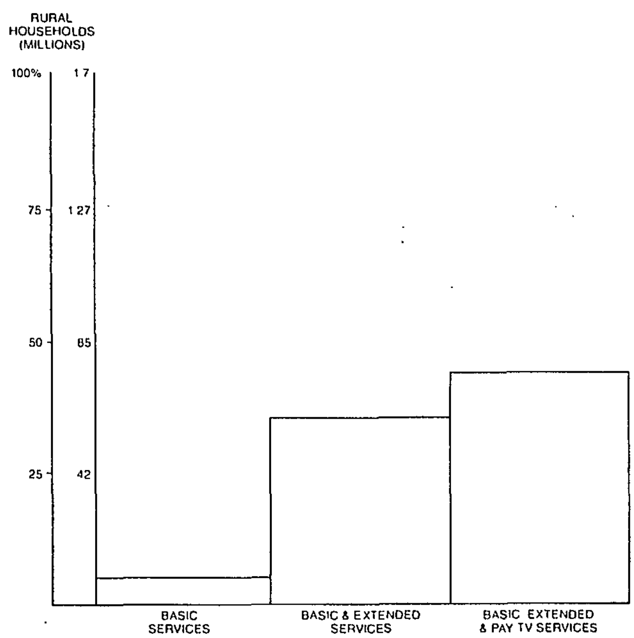


Figure 1-6B Potential market direct-to-home terminal maximum scenario

Table 1-10A Minimum Scenario Direct-to-Home Market Penetration

Terminal Costs	Basic %	Basic & Extended %	Basic & Extended & Pay %
Probable DBS Market for clusters of 20 H.H. and less – Percent of Total Rural Market for all Canada			
$100	2.8	7.6	16.4
200	2.6	7.1	15.1
300	2.4	6.4	13.6
400	2.1	5.6	12.1
500	1.8	4.8	10.4
600	1.5	4.0	8.8
700	1.2	3.3	7.2
800	.9	2.7	5.7
900	.8	2.1	4.4
1000	.6	1.5	3.3
1100	.4	1.1	2.4
1200	.3	.78	1.7

Table 1-10B Maximum Scenario Direct-to-Home Market Penetration

Terminal Costs	Basic %	Basic & Extended %	Basic & Extended & Pay %
$100	3.1	25.6	32.5
200	2.9	23.7	29.9
300	2.6	21.3	27.0
400	2.3	18.9	23.9
500	2.0	16.3	20.6
600	1.7	13.7	17.3
700	1.4	11.2	14.2
800	1.1	8.9	11.3
900	.85	6.9	8.7
1000	.64	5.8	6.5
1100	.46	3.8	4.7
1200	.34	2.6	3.3

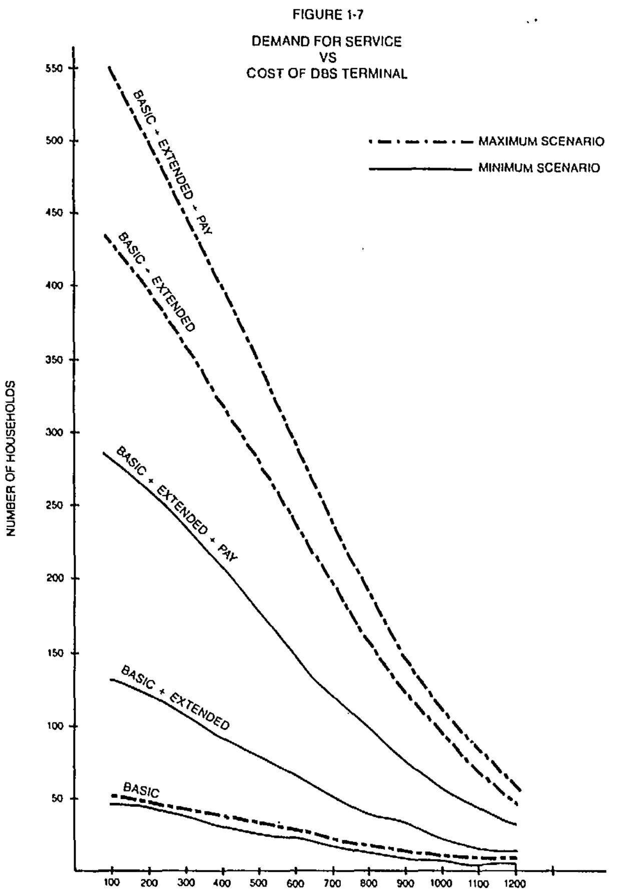


Figure 1.7 Demand for service vs cost of DBS Terminal

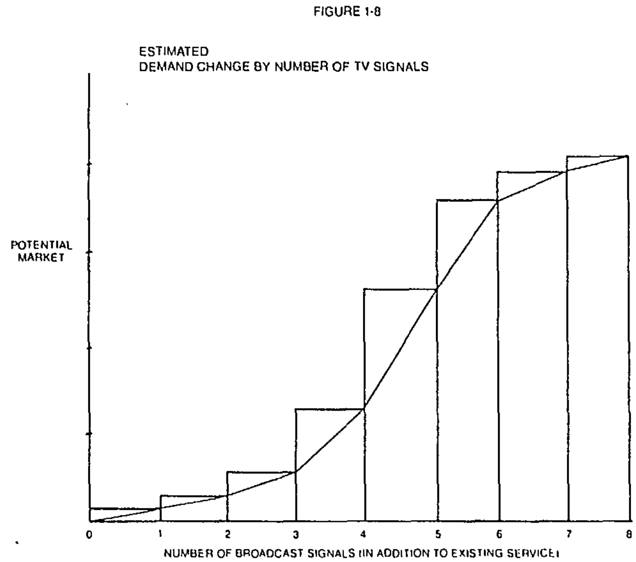


Figure 1.8 Estimated demand change by number of TV signals

1.5.2 Terminal Requirements

(1) DBS Terminals

Certain desirable terminal and service requirements were identified from the experience gained by Anik B pilot project users:

The equipment must be easy to install for a television repairman or technician; this especially applies to:

(a) cabling,
(b) setting antenna direction,
(c) securing the antenna to a firm but non-permanent foundation
(d) installation instructions,
(e) telephone assistance for special problems during installation

Equipment circuitry should be modular for quick replacement of parts in case of electronic failure.

Equipment should be designed for minimum repair and maintenance at remote sites subject to severe environmental conditions, where repair facilities are primitive and may be at a distance.

The terminal should be both modular and expandable to accommodate technological change:

(a) frequency changes
(b) changes in size of antennas
(c) improved performance with higher quality LNA

Shared use among several households may be a most desirable feature, especially for high cost terminals.

Signal quality should be such as to provide a 42 dB signal-to-noise ratio at the home terminal.

The terminal must be able to capture both radio and television services.

(2) Uplinks

For the "Minimum Number of Signals Transmitted" given in Table 1-5 of Section 1.4.3, we show TV and radio signals provided on a regional basis to derive maximum profit from local programming and to minimize time zone differences. An uplink is required in each beam for each TV signal transmitted. To provide both French and English CBC service in the East Beam, different methods of distribution should be studied, including two TV signals in one RF channel for some services.

For the Maximum Number of Signals Transmitted, detailed in Table 1-6 of Section 1.4.3, the Basic services comprise regional programming. One uplink per TV signal in each beam would be needed.

For the Extended and Pay services, however, a mix of both regional and national distribution should be studied.

For an interim DBS service using Anik C, maximum advantage should be taken of regional uplinking of broadcast signals to minimize the possible detrimental effect to local broadcasters and to maximize the local programming content. This scheme will have to be weighed against the cost of additional transmit earth stations.

1.6 Market Penetration Rate

This market study provides data for use in other aspects of this study and will be elaborated upon in the Economic Analysis provided in Task 3.

Preliminary conclusions can be drawn as follows:

(a) The broadcasters and program suppliers represent a very important element in the success of an interim DBS service. Their use of this service and the program content appeal will largely determine the end-user demand.

(b) In the study, potential market size for an interim DBS service is a function of the service being offered and the segment of rural Canadian households to which this service would be of interest. Basic services offer minimal demand, while Extended and Pay TV service has a much wider market.

(c) Interest in DBS services stems from the profit motive (meeting a market demand) or from public-policy motives (extension of services to underserved areas of a country). The Comsat proposal in the U.S. illustrates the importance of offering this service with a highly attractive Pay TV program package. Other countries considering DBS systems are motivated to extend TV services to underserved areas.

(d) The Direct-to-Home and Community experiments undertaken by the DOC using the Hermes and now the Anik B satellites have, by and large, proven the technical feasibility of a DBS system. Signal quality offered the home viewer in these broadcast pilot projects show that an interim DBS service from Anik C would provide quality signals via low-cost receive terminals.

The Economic Analysis of Section 3 has indicated that the maximum scenario providing Basic, Extended and Pay services is the most cost effective. Figure 1-9 demonstrates a possible schedule of introduction of these services. This schedule is based on Telesat's current market forecasts. The subject of market penetration with respect to users/subscribers is contained in Section 3.

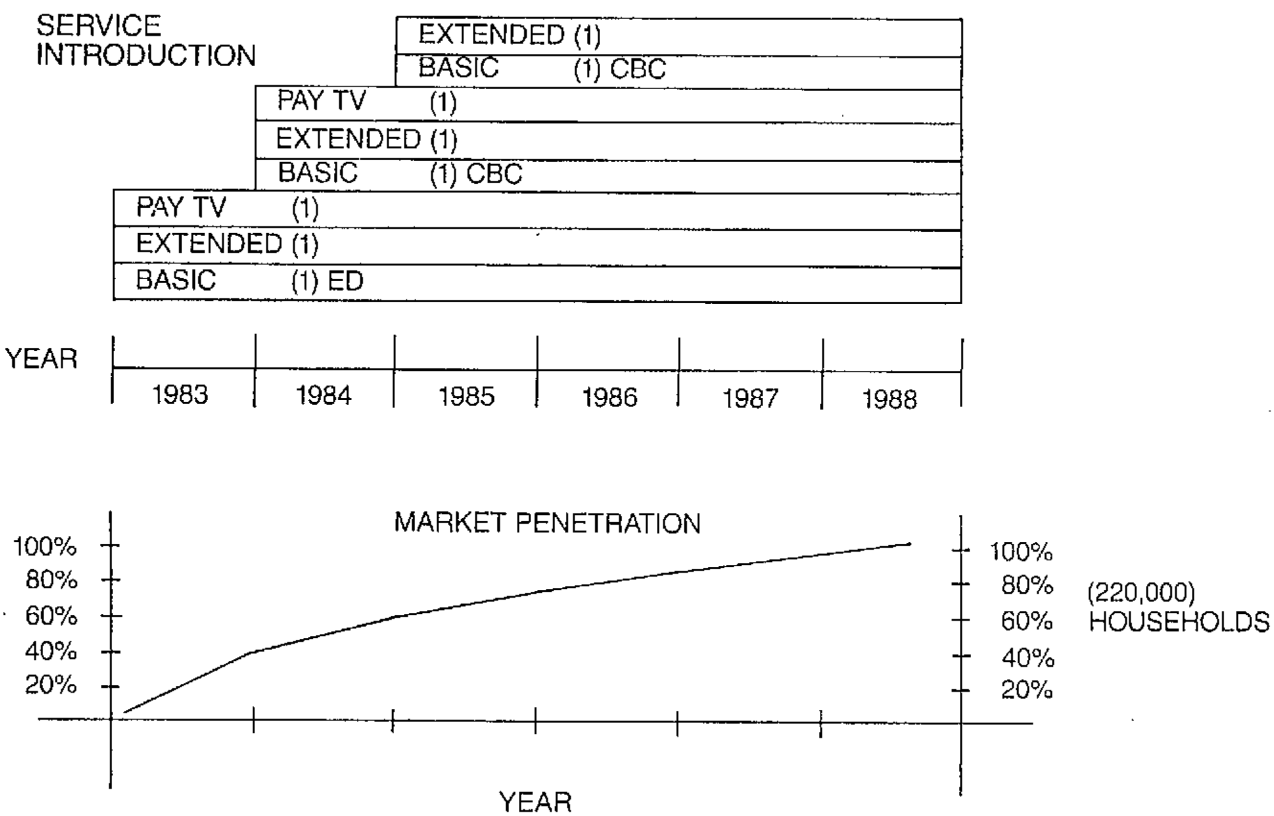


Figure 1.9 Market Penetration

Appendix A
To Section 1
Bibliography

Rural Communications Program

Department of Communications, April 1976.

Title:

Social Forecast, Working Group, Direct Broadcast Satellite.

Abstract:

Develops conclusions as to demographic trends through to the year 2001. It takes these trends and summarizes them as to their affect on D.B.S.. Data is presented in graphic form with descriptive summaries for each category.

Inter-Branch Working Group on Rural Communications, Department of Communications, July 1976.

Title:

Present Status of Rural Communications in Canada.

Abstract:

Describes the current situation in the rural areas by defining the nature and the magnitude of problems in the rural context. It also identifies the order of magnitude costs involved in the application of presently used technologies directed towards overcoming some of these problems which are identified.

Inter-branch Working Group on Rural Communications, Department of Communications, July 1976.

Title:

Present Status of Rural Communications in Canada.

Abstract:

Provide DOC management with an appreciation of telecommunications in rural areas of Canada by describing the current situation in these areas, and by defining the nature and magnitude of problems in the rural context. It is also intended to identify order of magnitude costs involved in the application of presently used technologies directed towards overcoming some of those problems which are identified.

Rural Communications Program, Department of Communications, Chang, K.Y., November 1978.

Title:

Integrated Distribution of Broadband and Narrowband Communications Services in Rural Areas with Coaxial Cable.

Abstract:

The implementation of a stand-alone distribution facility, whether broadband or narrowband, becomes a very costly undertaking and, because of the relatively small revenue base, becomes economically unviable in many cases. As a result, while most city dwellers have access to ten or more distinct television channels through a broadband cable TV system, cable TV services are virtually non-existent in rural areas. In this document, the technical, economic and operational feasibilities of using a single coaxial cable based broadband distribution network for the provision of broadband and narrowband communication services in rural areas are examined.

Rural Communications Program, Department of Communications, Ottawa, Canada, Billowes, C.A., May 1977.

Title:

Rural Broadcasting. A Preliminary Analysis and Review of the Issues and Considerations of Some Future Options.

Abstract:

The primary purpose of the report is to build on the July report and to give a specific orientation to the Rural Program which the July report did not undertake. This report analyzes the growth in broadcasting between 1969 and 1975 and finds that although growth in a number of TV stations, capital invested and revenue was in the order of 100% , coverage increase was much more modest. Private broadcasting profits did not keep pace with this growth and consequently are not adequate to make significant advances in second and third television services coverage.

The Bureau of Management Consulting Agency of the Department of Supply and Services Project No 1-1793 May 1977.

Title:

Levels of Choice in Canadian Off-Air Television Viewing

Abstract:

Identification of the levels of choice or number of program schedules in Canadian off-air television viewing

available to the Canadian public. Consists of maps indicating the areas of service by various number of networks.

The Bureau of Management Consulting, Agency of the Department of Supply and Services, Project No. 1-1793, May 1977.

Title:

Areas and Communities in Canada Without Off-Air Television Reception - A Survey.

Abstract:

Identification of those communities in Canada which do not receive any off-air television service other than by communications satellite and compilation of a data base specifying certain characteristics of these communities such as location, area and population.

A Study for the Rural Communications Program, Communications Canada, Ottawa, MacLean, L.C. and Weldon, K.L., April 1978.

Title:

Household Distribution in the Rural Areas of the Atlantic Provinces.

Abstract:

To provide information on household distribution relevant to the costing of broadcast and CATV delivery options. To present certain geographic factors, combination of geographic factors, and present detailed maps displaying household locations. To determine what portion of the Atlantic region each geographic type occupies. To provide general formulas for estimating certain parameters for the Atlantic Region as a whole, based on the estimation of calculating the total households in the rural part of Atlantic Canada.

Communications in Rural Areas Program - Federal Department of Communications, Ottawa, Regional Development Research Centre, University of Sherbrooke, Lacasse, Pierre, June 1978.

Title:

Study of the Distribution of Households in Rural Areas, Quebec - Ontario Region.

Abstract:

The main objectives of this study were:

1. to identify the various types of spatial distribution of households throughout the Quebec - Ontario Region;
2. to determine a call which was representative of each type of spatial distribution; and
3. to determine, for each typical cell selected, the distribution of households.
4. to transpose data from the typical cell to other cells of this type.
5. to check whether the proposed model may be generalized and whether it gives an accurate and reliable representation of the distribution of households throughout the entire tract.

Department of Communications, Ottawa, Fairbairn, K.J., July 1978.

Title:

Characterization of Typical Areas of Household Distribution in the Rural Portion of the Prairie Provinces.

Abstract:

Objective is to assist DOC in costing various potential communication systems to serve rural Canada. This study is concerned with the distribution of households in the rural portion of the prairie provinces and specifically its objective is to determine typical cells representing the household distribution in large regions of the prairies.

The Department of Communications, Rural Communications Program, Denike, Dr. Kenneth G., University of British Columbia, July 1978.

Title:

Geographic Distribution of Households Within Rural British Columbia

Abstract:

To Conduct a research study of the geographic distribution of households within rural British Columbia. The objectives of the assignment were the following:

(1) Identify the number of different types of cells and the number of cells of each type in rural British Columbia.

(2) Determine a representative cell for each cell type.

(3) Determine the geographic distribution of the households.

(4) Discuss how the information presented in (3) can be modified to provide an applicable model for similar cells.

(5) Provide a fairly reliable picture of the rural population throughout British Columbia.

(6) Discuss the relationship between population and household densities in rural British Columbia.

Miller Communications Systems Limited. Department of Communications, Bowen, Dr. R., August 1978.

Title:

A Feasibility Study of a 12/14 GHz SCPC Satellite Communications System to Meet Telephony Requirements in Rural Areas

Abstract:

The purpose of this study is to investigate the feasibility of using 12/14 GHz SCPC (single channel per carrier) earth stations to provide thin route telephony service to rural areas of Canada on the Anik C satellite.

Telecommunications Research Group, Simon Fraser University, Burnaby, B.C., August 1, 1978.

Title:

The Extent of Television Network Coverage in Rural Canada

Abstract:

This report is a summary of the information collected and synthesized concerning the distribution of television services throughout rural Canada for the Rural Communications Program of the Department of Communications in Ottawa. The object of this project is to ascertain the numbers of people in rural areas who could receive different numbers of TV network services, depending on where they live.

Rural Services, Department of Communications, Cormack, G., August 1978.

Title:

Television Network Coverage in Rural Canada Compared with that in the Census Metropolitan Areas (CMA).

Abstract:

The disparity of coverage in the rural areas of Canada relative to the CMA's is independent of language. English language TV gap is 2.6 and for French language it is a TV gap of 2.8 programs. The average large city dweller has access to 3.3 times more channels of distinctly different TV programs than the rural inhabitants.

Rural Communications Program, Department of Communications, Cormack, G.D. and Mougeot, L.T., 15 August 1978.

Title:

The Availability of Television in the Census Metropolitan Areas.

Abstract:

The approximately twelve million people living in Canada's 24 largest cities have, on average, access to 12.6 channels of distinctly different television. They have access to 5.8 channels of distinctly different English-language Canadian TV, 2.5 channels of distinctly different French language Canadian TV and 4.4 channels of distinctly different American TV.

Rural Communications Program, Department of Communications, Cormack, G.D. and Brown, S., December 1978.

Title:

The Clustering of Households in Rural Canada

Abstract:

The cost of new communication facilities for rural Canada depends upon where people live. This report summarizes and interprets the results recently obtained by four university researchers on this subject. The location of households throughout rural Canada is given through a set of maps of typical cells and appropriate scale-up factors that permit generalization to the whole of rural Canada. The data could be considered as an extension of present Statistics Canada information on population of settlements.

Richardson, K and Brown, S., December 1978.

Title:

Regional Demographic Studies for the Rural Communications Program, Summary Report and Analysis.

Abstract:

This report summarizes the data collected during the course of the four regional demographic studies conducted for the Rural Communications Program. These studies of the Atlantic Provinces (1), Quebec and Ontario (2), the Prairies (3), British Columbia (4) had the following:

(a) Document where the rural population and settlement is.

(b) Determine the major factors associated with current levels of telephone service.

(c) To identify a small number of typical areas which may be used for further technical, economic and social studies.

Interim Report No. 1, de Camprieu, Prof. R., Faculty of Management Sciences, University of Ottawa, Bourgeois, Prof. J.C., School of Commerce, Carleton University, January 8, 1979.

Title:

Demand for Rural Communication Services in Canada a Literature Review

Abstract:

The identification of the needs of rural people and of the existing facilities to satisfy them has been proposed as the overall objective of this project. "To survey the needs of rural domestic and business subscribers for existing and proposed communication services and to forecast short and long term demand for these services."

Study performed for Rural Communications Program Branch, Department of Communications, Comdat Telecommunications Inc. formerly L. Lee Associates, Ottawa, Canada, March 1979.

Title:

A Feasibility Study of Rural Radio Communications.

Abstract:

Overall index of Feasibility Study of Rural Radio Communications.

Volume 1 – Executive Summary

Volume 2 – Existing Services and Available Alternatives

Contains a discussion on the use and value of existing radio services in Canada and the United States, as well as an assessment of available alternatives.

Volume 3 - A High Technology Solution

The feasibility study proposes a high technology solution to the communication needs of rural Canadians.

Rural Communications Improvement Program, Doucet and Associates for Department of Communications, July 1979.

Title:

Cable TV Systems for Newfoundland, Technical and Economic Study, Final Report.

Abstract:

A technical and economic study for cabling rural communities with Cable TV services. Feasibility of cabling communities of population 500 or more with 25 households or more per road mile in province of Newfoundland and Labrador.

Rural Communications Improvement Program, Belanger, D., 28 August 1979.

Title:

Cable Television Systems in Newfoundland, Technical and Economic Study.

Abstract:

The growing need for providing unserved urban and rural communities with cable television service is an important social issue.

Lack of cable television service to these areas is due to the relatively high investment cost required to establish the local distribution system and to the cost of bringing to these distribution systems a suitable range of television signals.

D.G.B. Consultants for Department of Communications, September 1979.

CRTC

Title:

Multi-channel Rebroadcast Stations for use in Rural Areas in Canada.

Abstract:

A study looking at servicing rural areas by the use of rebroadcast systems. It develops a number of models of multichannel rebroadcasting stations able to deliver radio and TV services based on the geographical characteristics of these communities.

Report of the Committee on Extension of Service to Northern and Remote Communities, CRTC.

Title:

The 1980s: A Decade of Diversity, Broadcasting, Satellites, and Pay TV

Abstract:

These are the recommendations by the Therrien Committee as to how TV and radio services should be extended to remote and rural locations in Canada. This report was the result of the public meetings held by the CRTC in April 1980.

Volume 1 and Volume 2, CRTC, Minister of Supply and Services Canada, 1979.

Title:

Special Report on Broadcasting in Canada, 1968-1978

Abstract:

Detailed statistics prepared by the research staff of the CRTC from all the available sources; they present, generally, the figures for the years 1967 and 1977, although in some cases comparative figures are given for the mid-year 1972, and in others for all the years in this period. Coverage statistics relate to the availability to the Canadian public of Canadian and foreign television and radio stations. The statistics on audience patterns are related to category and source of program, and to the preferences of Canadian audiences for Canadian and foreign broadcasting stations.

CRTC, March 1978.

Title:

Report on Pay-Television.

Abstract:

The present report examines the issue of the possible introduction of a pay television system in Canada. The report outlines the historical context in which the current discussions on pay-television must take place. It also describes and examines the most recent submissions for a pay-television system for Canada; sets forth the Commission's conclusions on the issues at this time; and provides an indication of possible guidelines for the future introduction of pay-television.

A Report on the 1978 CRTC Survey, CRTC, March 1979.

Statistics Canada Sources

Title:

Cable Television, Survey of the Community Channel.

Abstract:

The survey was designed to meet three objectives:

1) to gather data on state-of-the-art cable programming.
2) to assess the influence of the Cable TV Policy and Regulations on the evolution of the channel.
3) to attempt to determine trends and factors likely to influence the future development of the channel.

Statistics Canada, 1976.

Title:

Computer Run Municipalities in Decreasing Population Order 1976.

Abstract:

Ranks the municipalities and incorporated villages and towns in 2 ways:

1) By highest to lowest population down to the level of 1 person. Gives name of town, type of village, province and population and a ranking number.
2) Alphabetic list of municipalities with population, rank and province.

Statistics Canada, November 1978.

Title:

Culture Statistics, Recreational Activities.

Abstract:

Frequency of participation in exercise, sport and physical recreation activities, the context of the participation, the facilities used, and the reasons why they took part in these activities. The responses to these questions can be combined with the considerable socio-economic, demographic, and attitudinal information collected to produce profiles of the participants and non-participants in sport or exercise.

Statistics Canada, February 1979.

Title:

Population Projections for Canada and the Provinces.

Abstract:

They reflect the future growth trends, the emerging age-sex structure and the population distribution across the country under the stated assumptions. Four alternative sets of projections are included in this report to cover the plausible range of variation in the factors governing the future growth of population.

Statistics Canada, 1977.

Title:

Telecommunications Statistics.

Abstract:

This report deals with telecommunication carriers involved in international telecommunications including Telesat Canada. It provides industry statistics on Telegraph and Cable Systems with financial and operating data on telecommunications carriers other than telephone systems. It aims at monitoring the growth and changes in this area of the telecommunications industry.

Statistics Canada, April 1979.

Title:

Market Research Handbook.

Abstract:

A convenient source of information and reference for all those who are engaged in analyzing the many aspects of Canadian markets on the local, provincial, regional and national level.

Statistics Canada, November 1976.

Title:

Consumer Prices and Price Indexes, July-September 1976.

Abstract:

This report presents a synopsis of current consumer price index movements for each of the three months in the reference quarter, at both the urban Canada and the regional cities' level. This is presented in the form of descriptive analysis supported by tabular and graphic information.

Provides a detailed historical summary of monthly consumer price index movements in recent years.

Place-to-place comparative retail price information forms.

Appendices serving as sources of reference for the statistical data presented in the preceding segments of the report.

Statistics Canada, November 1978.

Title:

Radio and Television Broadcasting 1977.

Abstract:

Data are compiled on the broadcasting year from annual returns received from CRTC licensees.

The survey covers all commercial broadcasting stations, the regional television network. Cable television, Pay TV and non-commercial broadcasting stations operated by religious groups, educational institutions and provincial governments are not included.

Statistics Canada, April 1978.

Telecommission Reports

Title:

Dwellings and Households. Dwellings. Private Households and Families.

Abstract:

Final counts from the 1976 Census on dwellings, private households and families as well as total persons and average number of persons per private household and per family, for Canada and provinces.

Department of Communication by University of Toronto, Study 2 (bXi) 1970.

Title:

Communications in Canada, A Statistical Summary.

Abstract:

Statistical summary of telecommunications sector in Canada by:

1. Time series on revenue, prices and income and demand for telecom services.
2. Estimated production functions for all telecom services, estimated input requirements for telecom services.
3. Estimating investment functions for telecom.
4. Demand for telecom and communications equipment.

Department of Communications,
Project Team Approach, Study 4 (a), 1971.

Title:

The Future of Communications Technology.

Abstract:

The following method was used:

1. the future environment was defined.
2. the basic technologies were laid out.
3. the impact of new technological developments.
4. advances and their affects on the overall systems.
5. conclusions are drawn from technical considerations.

TCTS; CNCP Telecommunications, Study 2(e), March 1970.

Title:

Telecommunication Carriers, Market Projection and Analysis.

Abstract:

This study presents the projections and analysis of the telephone and telecommunication companies in Canada. The forecast period is from 1970's through the 1980's and inputs population and economic data to project the demand on Telecommunications Services and new services to be introduced.

The Department of Communications, Study 8(d), Ottawa 1971.

DOC Papers

Title:

Multiservice Cable Telecommunication Systems – The Wired City.

Abstract:

This particular study investigates the present state of cable telecommunication systems in Canada. It explores the probable evolution from existing systems to future systems that could provide "total" telecommunication for Canadian cities. In addition the study considers the impact of multiservice cable telecommunication systems on urban areas.

Day, J, CRC/DOC, IAF 30th Congress, September 1979.

Title:

The Application of Lower Power Satellites for Direct Television Broadcasting.

Abstract:

Discusses the use of Anik B for low powered DBS reception. Gives technical data with tables, maps and charts on the performance of Anik B and the quality of reception.

Davies, N.G., CRC/DOC, IAF October 1978.

Title:

CTS/Hermes – Experiments to explore the application of advanced 14/12 GHz communications satellites.

Abstract:

Hermes was a high powered (59 dBW) satellite 15 technical experiments and 21 social experiments. Technical description of Hermes with beam pattern. Experimentors listed with their applications.

Davies, N.G., Department of Communications, Ottawa, Ontario, 1978 IEEE.

Title:

The Transition from CTS/Hermes, Communications Experiments to Anik-B Pilot Projects.

Abstract:

The Department of Communications in Canada and NASA in the U.S.A. cooperated to build and then launch the Communications Technology Satellite (CTS), now named Hermes. The objectives of the program were to develop 14/12 GHz spacecraft technology and to explore possible future services. 39 experiments will have been carried out by the end of 1978. These experiments have technical and social objectives to explore new services in telemedicine, tele-education, community communications, broadcasting and administrative services.

Department of Communications, May 1980.

Title:

A Satellite Delivered Direct-To-Home Television Pilot Project.

Abstract:

The primary purpose of the proposal is to test and evaluate in a field setting a reasonable quantity of Canadian manufactured terminals which will be located in small communities and private homes in poor service areas.

Day, J.W.B., Davies, N.G. and Douville, R.J., Communications Research Centre. Department of Communications.

Journals and Reports

Title:

The Application of Lower Power Satellites for Direct Television Broadcasting.

Abstract:

The use of 12 GHz satellites for TV broadcasting directly to individual homes and small communities has been the subject of analysis and design study by groups in many countries. Accumulated experience in Canada with 12 GHz operation and the evolution of technology are leading to changes in the concept of direct broadcasting such that lower power satellites may be capable of meeting the requirements.

Smith, Delbert D., Satellite Communications, May 1980.

Title:

The Impact of Space Policy on Direct Broadcast Satellites.

Abstract:

The implementation of DBS systems for the United States is dependent not only upon communications policy, but space policy as well.

In a general strengthening of private sector research and development capabilities since it would encourage investment in space related systems which in turn would increase the revenue potential for future operational DBS systems. The need for federal expenditures to compensate for deficiencies in private sector research and development activities would be reduced.

Seaman, L.T., Acts Astronautics, Vol. 5, 21 September 1977.

Title:

Japanese broadcast satellite.

Abstract:

The Japanese domestic broadcast satellite, "Medium-Scale Broadcasting Satellite. It is an experimental system capable of evaluating new concepts in satellite TV systems that promises advancement in the economic coverage of a large, well-defined geographical area and in high quality TV reception in all sectors of the broadcast area.

Collette, R.C. and Fromm, H.H., European Space Agency, Direct Satellite Broadcastings, August 1977.

Title:

Individual and Collective Reception - Technological and Financial Aspects.

Abstract:

The minimum antenna aperture must be around 0.8 m for directivity and gain reasons.

NASA - Lewis Research Centre - 1979 13p.

Title:

Telecommunication Service Markets Through the Year 2000 in Relation to Millimeter Wave Satellite Systems.

Abstract:

NASA is currently conducting a series of millimeter wave satellite system market studies to develop 30/20 GHz satellite system concepts that have commercial potential. Four contractual efforts were undertaken: two parallel and independent system studies and two parallel and independent market studies. The marketing efforts are focused on forecasting the total domestic demand for long haul telecommunications services for the 1980-2000 period. Work completed to date and reported in this paper include projections of geographical distribution of traffic: traffic volume as a function of urban area size: and user identification and forecasted demand.

NASA - Washington, D.C., July 1977.

Title:

Analysis of Economics of a TV Broadcasting Satellite for Additional Nationwide TV Programs.

Abstract:

The influence of a TV broadcasting satellite, transmitting four additional TV networks was analyzed. It is assured that the cost of the satellite systems will be financed by the cable TV system operators. The additional TV programs increase income by attracting additional subscribers. Two economic models were established: (1) each local network is regarded as an independent economic unit with individual fees (cost price model) and (2) all networks are part of one public cable TV company with uniform fees (uniform price model). Main results of the study are: the installation of a TV broadcasting satellite improves the economics of CTV-networks in both models; the overall coverage achievable by the uniform price model is significantly higher than that achievable by the cost price model.

European Space Agency, Paris (France) Rosetti, C. - 1975 5p.

Title:

Satellite Video and Sound Broadcasting. Technico-Economic Considerations for Industrialized and Developing Countries.

Abstract:

Reasons are given for introducing broadcasting satellites in industrialized and developing countries. Choice of the frequency band is discussed from a systems economics viewpoint. National coverage is seen as the most probable coverage. Possible ground receivers are reviewed with regard to performance and costs. The importance of international co-operation is underlined.

Mitre Corp., McLean, Va. Office of Telecommunications Policy, Washington, D.C. (402 364) - July 1974.

Title:

Cable Television Financial Performance Model. Description and Detailed Flow Diagram.

Abstract:

The cable television financial model consists of a set of computer programs intended to aid policymakers in the evaluation of the financial and economic ramifications of various policy alternatives. The program that comprise the model can be used in examining cable television at three levels: the individual cable television system, the multiple system operator (MSO), and the entire cable television industry. The model is also capable of being used at several levels of policymaking the local level the state level, and the Federal level including the Office of Telecommunications Policy, the Office of Telecommunications (DOC), and the Federal Communications Commission.

Stanford Research Inst., Menlo Park, California, Office of Telecommunications Policy, Washington, D.C., Panko, R.R., Edwards, G.G., Penchos, K., Russell, S.P., May 1975 37p.

Title:

Analysis of Consumer Demand for Pay Television Executive Summary.

Abstract:

Demand for pay cable television and broadcast pay (subscription) television is analyzed. Data from current pay cable operations are studied as are data from live attendance at spectator events, television viewing, consumer surveys and early pay television experiments. An upper bound on current demand is estimated, as are upper bounds on subscribership and revenue growth over time. Demand parameters of particular interest in the assessment of economic interactions.

MITRE Corp., McLean, VA. MITPEK Div. National Transportation Policy Study Commission, Washington, D.C.

Title:

The Impact of Telecommunication on Transportation Demand through the Year 2000.

Abstract:

This report analyzes the interactions of transportation and telecommunication as they exist today and in the future, especially as regards the effects of telecommunication on transportation demand. It analyzes the development of four major telecommunication services — voice, video, data and interactive cable television — and reports estimates of their substitutability for transportation service. It reports present and possible future impacts on government investment and regulation.

Weinhouse, Norman, Hughes Aircraft, 1980.

Title:

Required Signal/Noise Ratio for Satellite Feed to Cable TV Systems.

Abstract:

Confusion over S/N ratio for CATV is due to the fact that cable operators measure noise performance at VHF (C/N) at a subscriber drop and the satellite feed is measured at baseband (S/N). Also, satellite signals are FM of a microwave carrier while cable systems utilize vestigial sideband modulation of a VHF carrier.

First Report on Prospects for Additional Networks, FCC Network Inquiry Special Staff, Besen, Stanley M., January 1980.

Title:

Direct Broadcast Satellites: Legal and Policy Options.

Abstract:

This report looks at alternative networks för TV communication.

FCC by Network Inquiry Special Staff.

Title:

Interconnection of Broadcasters: Technology Costs and Regulatory Policies.

Abstract:

Describes existing methods of providing nationally distributed programs to local broadcasters, the rates charged for these services and FCC regulation of rate structures and entry in terrestrial microwave and satellite interconnection.

Smith, D., May 1980.

Title:

The Impact of Space Policy on DBS Satellite Communications.

Abstract:

Short 3 page article on DBS. Quotes political sources for the push for space activities. States 5 objectives for U.S. involvement in Space R&D.

British Broadcasting Corp., Redmond, James, SERT Journal, July 1977.

Title:

Direct Broadcasting to the Home Via Satellite.

Abstract:

The BBC will not benefit from the use of DBS due to the fact that they believe there is little demand for additional TV channels and that the present coverage of 99.5% of the population does not warrant it. The quality of the BBC system is much higher with 625 line PAL colour system as opposed to a 405 NTSC line standard available with a DBS.

FCC, NTIS, Das, A., July 1975.

Title:

The Coming "Broadcast" satellites: Where They Should and Should not be used in Delivering Education Services.

Abstract:

The use of satellites should be predetermined and thereby utilize them as economically as possible.

Ministry of Posts and Telecommunications, April 1978.

Title:

Space Program in Japan, BSE Project.

Abstract:

Describes the technical aspects of Japan's BSE Direct Broadcast Satellite Project. A high powered 12 GHz band satellite transmitting 2 channels of signals.

Satellite Communications, Le Duc, D., February 1978, p34.

Title:

DBS Service for Western Europe: A Hidden Barrier.

Abstract:

A review of what European countries are doing to utilize DBS and how it will help them reduce their communication costs.

Blackman, N., NTIS, 12 July 1977.

Title:

Direct Satellite Broadcasting.

Abstract:

Discusses the issues involved with DBS and describes how this service would be applied.

Federal Ministry for Research & Technology, West Germany, Becker,D, June 1974.

Title:

Analysis of Economics of a TV Broadcasting Satellite for Additional Nationwide TV Programs.

Abstract:

The use of a TV broadcasting satellite transmitting 4 TV programs is analyzed as to the economics and influence on the development of cable TV networks. The results show an improvement economically for Cable TV and that the overall coverage achievable is significantly higher by the use of uniform pricing of space segment to all local networks.

Federal Communications Commission, Network Inquiry Special Staff, Besen, Stanley M., January 1980.

Title:

First Report on Prospects for Additional Networks. Direct Broadcast Satellites: Legal and Policy Options.

Abstract:

Direct Broadcast Satellites: Consultants are working with the Network Inquiry Special Staff, preparing a report which, together with the report on Interconnection of Broadcasters, will describe the technology available to broadcast television signals directly to home receivers from satellites and how much satellite broadcast services might be offered to the American public.

Federal-Provincial Conference of Communications Ministers, Toronto, Ontario, 1979.

Appendix B
To Section 1
References

References

1 Proceedings of the 1979 WARC, footnote 3787A.

2 Interview with Harry Rice, VP of TV Distribution, RCA Americom

3 "Western Europe: The Development of DBS Systems" by Roberto Grandi, Journal of Communication, Spring 1980.

4 Presentation by O. Roscoe at the International Institute for Communications, September 1980.

5 "Present Status of Rural Communications In Canada," July 1976, DOC

6 "Social Forecast", Working Group, Direct Broadcast Satellite, DOC, April 1976.

7 "Man on the Move," 1976, DOC

8 A settlement is defined as a cluster of some 175 or more households within a closely dispersed area averaging 4 square miles. "Clustering of Households in Rural Canada", DOC, December 1978.

9 "Geographic Distribution of Households Within Rural British Columbia" July 1978, DOC

10 "Rural Canada Models of Multichannel Broadcasting Stations" by DGB Consultants for DOC, September 1979.

11 "Demand for Rural Communication Services in Canada – A Literature Review", DOC, January 8, 1979.

12 "The Availability of Television in the Census Metropolitan Areas", DOC, August 15, 1978.

13 In a Focus Group, a professional moderator introduces a study theme to a small group of consumers.

14 Demand for Rural Communication Services in Canada – Focus Groups and Research Instruments, DOC, December 1979.

15 DOC/Telesat meeting wih CCTA, October 3, 1980.

16 CBC Brief to the Therrien Committee on the Extension of Services and Pay TV.

17 CAB Brief to the Therrien Committee on the Extension of Services and Pay TV.

18 Telesat/DOC Meeting with the CAB, October 30, 1980.

19 Ontario Educational Communications Authority Satellite Program, Anik B Conference, Public Archives, June 12, 1980

20 Interactive Instructional Television Project. Dept. of Distance Education, BCIT, ACCC Conference, Wolfville, N.S., May 29, 1980

21 Inukshuk News, May 1980.

22 The Inukshuk Project Inuit Tapirisat of Canada.

23 Low-Power Broadcasting Satellite Trials in Canada, C.Billowes/DOC; P Bowers of OECA; E. Rose/BCTV.

24 Interim Evaluation Report on the Anik B Direct Broadcasting Field Trial. C. Billowes, DOC, June 1980.

25 The Application of Lower Power Satellites for Direct Television Broadcasting. J. Day, N Davies and R. Douville, DOC, September 1979 DOC reference 79-226.

26 A Satellite-Delivered Direct-to-Home Television Pilot Project. DOC, May 1980.

27 Trip Report. Visit to Anik B Pilot Project Terminals, Northern Ontario, D. Umbach, Sept. 1980.

Appendix C
To Section 1
Minimum and Maximum Scenario

1.0 Probable Market

Minimum and Maximum Scenario

For both the minimum and maximum scenarios, the potential markets were calculated as outlined in Table 1-8A. The probable markets were calculated as follows:

Minimum Scenario

	Basic Services	Basic & Extended	Basic & Ext. & Pay
Expected Penetration into Market	85%	55%	20%

Maximum Scenario

	Basic Services	Basic & Extended	Basic & Ext. & Pay
Expected Penetration into Market	95%	75%	30%

These figures are estimates and they are based on the following:

- It was reasoned that Basic penetration would likely reach 85% and 95% in the minimum and maximum scenarios as this service is being offered to those who receive no television signals.
- Extended services were compared to a cable introduction. The penetration rate for cable T.V. service is currently 70% of the total homes passed by cable.[1] Minimum and maximum penetrations for the Extended services were estimated to be 55% and 75% respectively.

Forecasted penetrations for Pay TV are believed to be in the order of 22% to 40% of cabled households in Canada[2]. Minimum and maximum penetrations of 20% and 30% respectively were estimated for the purpose of this study.

The following describes the calculations in determining the probabilistic market:

[1] "Feasibility Study For A Canadian Satellite Program Package", *Tamec Inc – DGB Consultants Inc.*, March 1980, p. 87.

A) Calculations – Minimum Scenario

Potential Basic Market	72,000 H.H.
Potential Basic & Extended Market	260,000 H.H.
Potential Basic & Ext. & Pay Market	1,278,000 H.H.

Probable Basic
= .85 x 72,000 = 61,200 H.H.

Probable Basic & Extended
= 61,200 + (260,000 – 61,200) x .55 = 170,540 H.H.

Probable Basic & Ext & Pay
= 170,540 + (1,278,000 – 170,540) x .20
= 392,032 H.H.

B) Calculations – Maximum Scenario

Potential Basic Market	72,000 H.H.
Potential Basic & Extended Market	720,700 H.H.
Potential Basic & Ext. & Pay Market	1,278,000 H.H.

Probable Basic Market
= .95 x 72,000 H.H. = 68,400 H.H.

Probable Basic & Extended
= (68,400) = (720,700 – 68,400) x .75 = 557,625 H.H.

Probable Basic & Ext & Pay
= 557,625 + (1,278,000 – 557,625) x .30
= 773,740 H.H.

These figures yield probable markets for both scenarios which can then be used to calculate price sensitivities as shown in the following section.

2.0 Terminal Cost Sensitivity

Terminal Cost Sensitivity

The probable markets derived in the previous section have been sensitized to terminal price. The price range for the terminals was set between \$100 and \$1200, using increments of \$100. Distributions were chosen to reflect how this market may react to different prices.

[2] *Cable Communications*, February 1981, p. 26.

The following assumptions were made with respect to determining these distributions.

(a) The market sensitivity to terminal cost would be minimal at both the upper and lower ends of the price scale (i.e. $100 and $1200 per terminal). This is due to market saturation occuring at these points.

(b) The market has been somewhat conditioned to terminals costing about $500. Therefore, we have established this as a point of inflection about which two distributions occur.

(i) In the $500-$1000 terminal cost range, a normal distribution has been used. A 50% probability is associated with the $500 price and this probability reduces normally as the price increases to $1000.

(ii) In the $100-$500 terminal cost range, a 1-x normal distribution was used. A 50% probability is associated with the $500 price and this probability increases normally 1-x as the price reduces to $100.

The results of this analysis are shown in Tables C-1 and C-2.

Table C-1 Minimum Scenario

Probability (P)	Probable MKT	Basic Services 61,200	Basic & Ext. Services 170,540	Pay Services 392,032
		* P x 61,200	P x 170,540	P x 392,032
.7881		48230	134400	309000
.7275		44220	124070	285200
.6554		40111	111770	256940
.5793		35450	98795	227100
.5000		30600	85270	196016
.4207		25750	71745	164930
.3446		21100	58770	135100
.2743		16790	46780	107535
.2119		13000	36140	83070
.1587		9700	27065	62215
.1150		7050	19610	45085
.0808		4950	13780	31676

* Values in this Table are derived by multiplying each probability by the probable market.

Table C-2 Maximum Scenario

Probability (P)	Probable MKT	Basic Services 68,400	Basic & Ext. Services 557,625	Pay Services 773,740
		* P x 68,400	P x 557,625	P x 773,740
.7881		53400	439465	609785
.7275		49760	405670	562895
.6554		44830	365470	507110
.5793		39624	323030	448230
.5000		34200	278815	386870
.4207		28776	234590	325510
.3446		23570	192160	266630
.2743		18762	152956	212240
.2119		14494	118160	163955
.1587		10855	88500	122790
.1150		7872	64127	88980
.0808		5527	45056	62520

* Values in this Table are derived by multiplying each probability by the probable market.

Appendix D
To Section 1
Glossary of Terms

Glossary of Terms

Areal – Locations having fewer than 1 person/sq. mile

Broadcaster/program supplier – The customer who leases the space segment to supply programming to be received by the end-user.

Direct-to-home service – The direct reception of TV and radio signals from a satellite to an individual home.

Direct-to-community – The direct reception of TV and radio signals from a satellite to a community reception terminal and distributed locally to individual homes.

Ecumene – The inhabited areas of the country.

End-user – The customer who receives the satellite signal on a direct-to-home or a direct-to-community basis.

Functional Specifications – The non-technical description of how the equipment should operate by describing the functions which it will perform.

Interim DBS Service – The reception of satellite signals on a direct-to-home and community service basis from a fixed service satellite.

Pure DBS Service – The reception of satellite signals on a direct-to-home or community basis from a DBS satellite of power and frequency temporarily specified by WARC 79.[1]

Regional Coverage – This refers to the coverage by a single beam of Anik-C which covers one-quarter of Canada.

Rural – Areas where the population density lies between 1 and 1000 people/sq. mile

Signal – Refers to a single television signal using any combination of power and bandwidth on the transponder.

Appendix E
To Section 1
Canadian Demographics

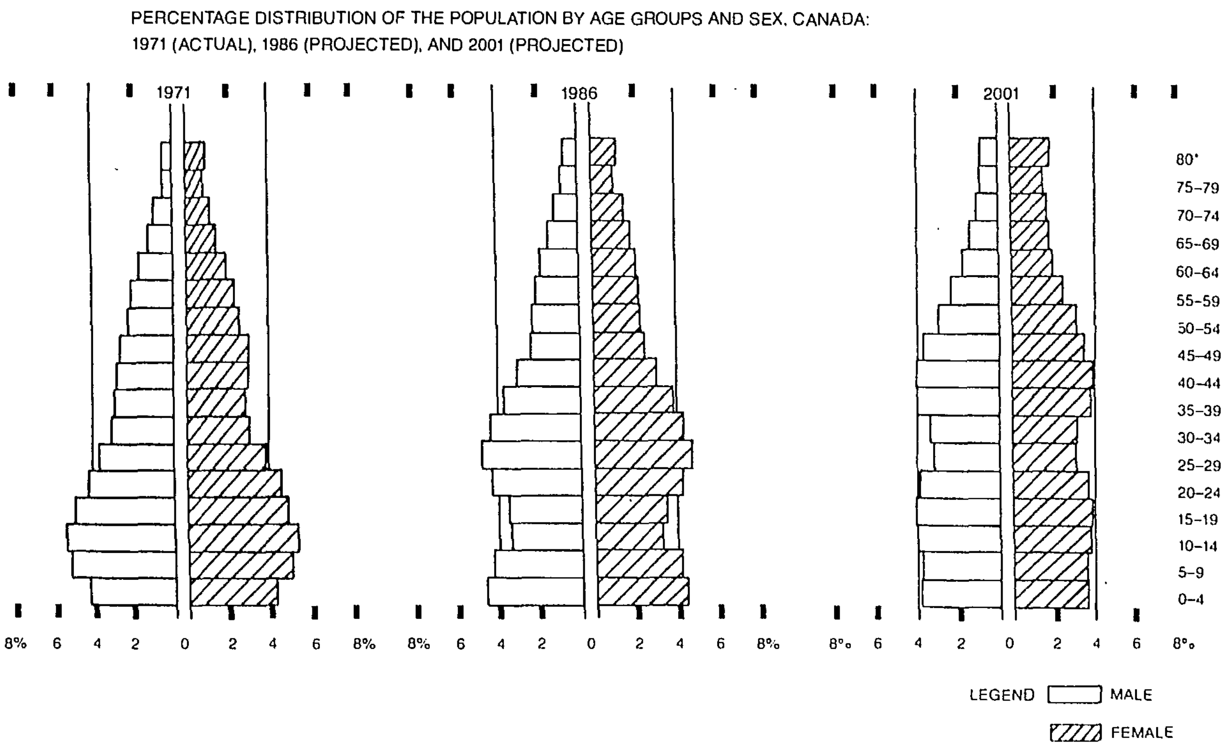


Figure E-1 **Percentage distribution of the population by age groups and sex. Canada: 1971 (Actual), 1986 (Projected), and 2001 (Projected)**

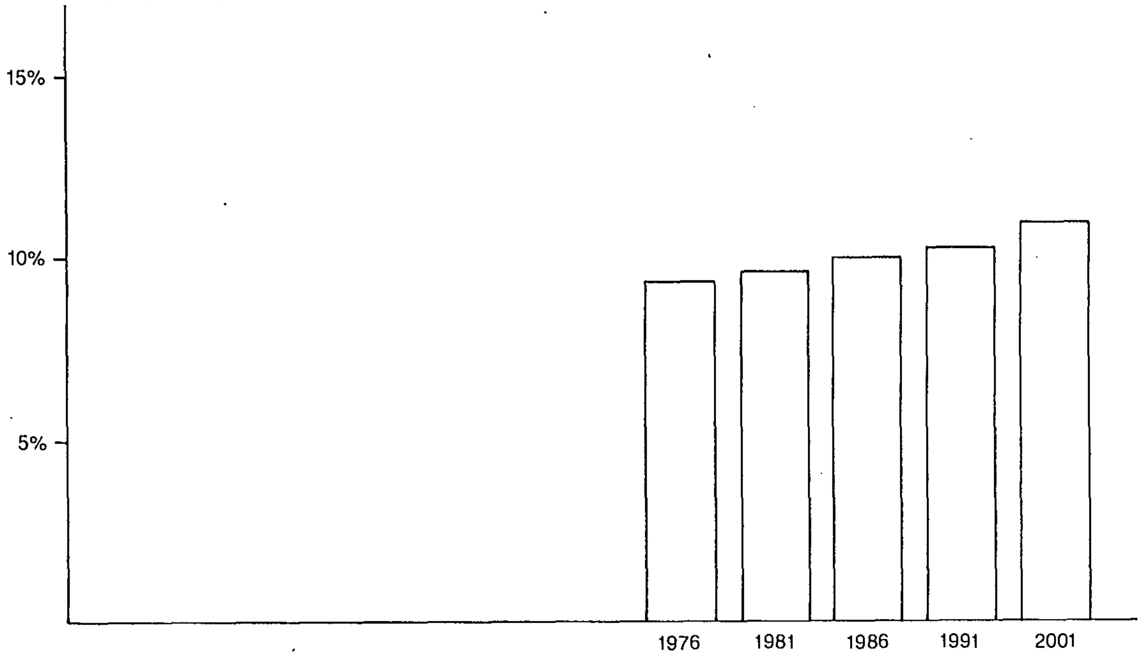
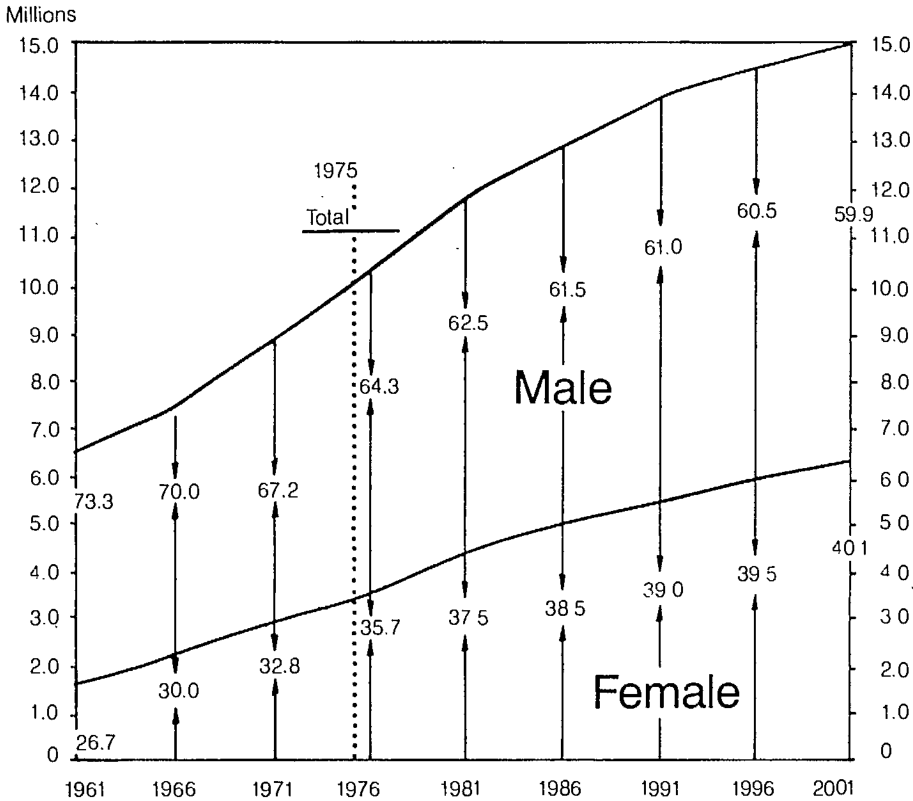


Figure E-2 **Persons 65 and older, as percentage of the population, Canada 1976-2001 (Projection D)**

Figure E-3 Observed and Projected Changes in the Population of Canada and Provinces, 1966–2001; Projections B

Province or Territory	1966-1971	1971-1976	1976-1981	1981-1986	1986-2001	Province or Territory	1966-1971	1971-1976	1976-1981	1981-1986	1986-2001
	Amount of Change (In Thousands)						Percentage of Change				
Canada	1,553.4	1,278.0	1,626.2	1,786.1	4,396.9	Canada	7.76	5.93	7.12	7.30	16.74
Newfoundland	28.7	31.6	38.2	46.2	118.1	Newfoundland	5.81	6.05	6.90	7.80	18.50
Prince-Edward Island	3.1	2.9	4.0	5.8	11.0	Prince-Edward Island	2.85	2.99	3.49	4.89	8.84
Nova Scotia	33.0	13.0	19.7	24.4	31.1	Nova Scotia	4.36	1.64	2.46	2.97	3.67
New Brunswick	17.8	19.8	21.2	24.7	41.6	New Brunswick	2.88	3.12	3.24	3.66	5.94
Quebec	247.0	131.4	218.6	241.9	299.0	Quebec	4.27	2.17	3.54	3.79	4.51
Ontario	742.2	667.0	817.6	885.7	444.7	Ontario	10.66	8.65	9.76	9.64	24.26
Manitoba	25.1	11.1	20.6	24.9	21.5	Manitoba	2.60	1.12	2.06	2 44	2.05
Saskatchewan	–29.1	–45.5	–37.7	–35.6	–192.0	Saskatchewan	3.06	4.91	4.28	4.22	23.78
Alberta	164.7	140.7	172.6	189.3	509.9	Alberta	11.25	8.64	9.75	9.75	23.93
British Columbia	310.9	296.6	340.5	366.1	1,067.2	British Columbia	16.59	13.57	13.72	12.97	33.48
Yukon	4.0	2.7	3.1	3.5	11.1	Yukon	27.77	14.67	14.69	14.46	40.07
Northwest Territories	6.1	6.7	7.7	9.1	33.9	Northwest Territories	21.25	19 25	18.55	18.49	58.14

Source : Statistics Canada, Population Projections 2001



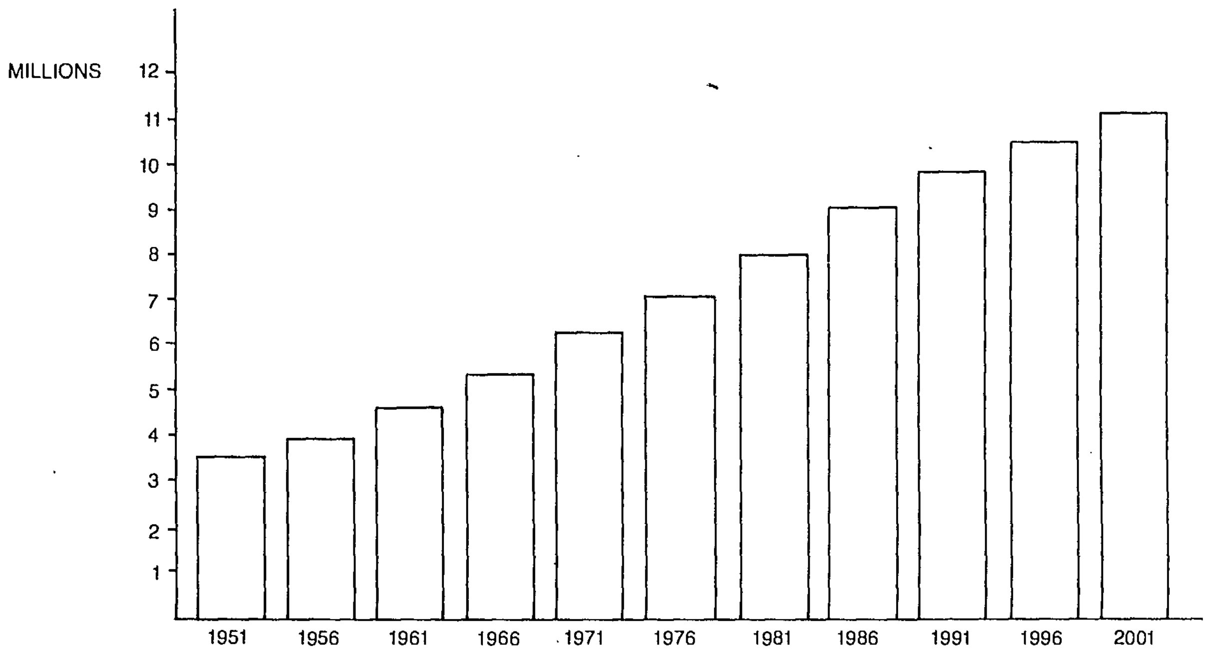
Source : Z Zsigmond, Statistics Canada

Figure E-4 Total Labour Force - Percentage Distribution by Sex

Figure E-5 Standard Hours of Work

Standard Work Week[1]	1951	1957	1961	1966	1971
Office Workers	38.6	37.9	37.7	37.4	37.6
Plant Workers	43.6	41.6	41.3	41.0	39.3

[1] Standard work week relates to manufacturing. The standard working hours are specified in a collective agreement, or fixed by the employer for his workers.
Source : *Perspective Canada* p. 99



SOURCE: STATISTICS CANADA, POPULATION PROJECTIONS ... 2001

Figure E-6 Number of Households in Canada, 1951-2001

Figure E-7 Actual and Projected Average Size of Households, Canada 1951-2001

Year	Number of Persons per Household		Projection 1
1951	4.18	1976	3.28
1956	4.07	1981	3.11
1961	3.98	1986	3.01
1966	3.85	1991	3.02
1971	3.56	1996	3.02
		2001	2.99

Source: Statistics Canada. Household and Family Projection. 2001 76 (Modified)

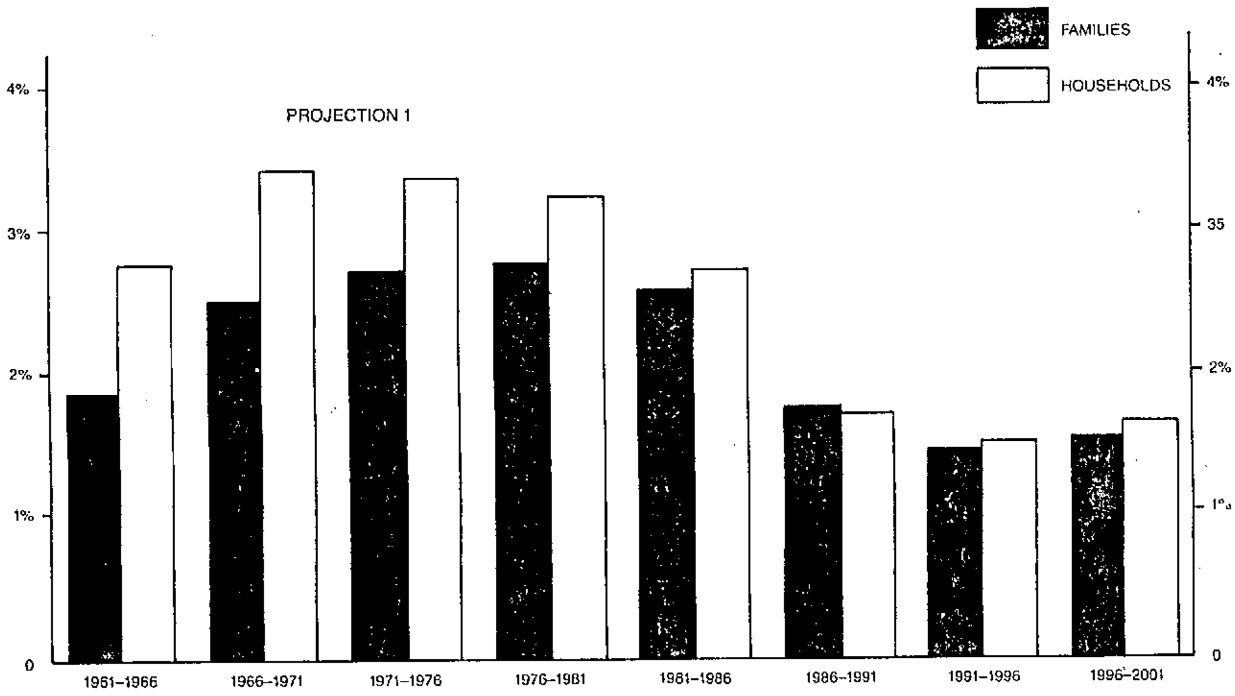
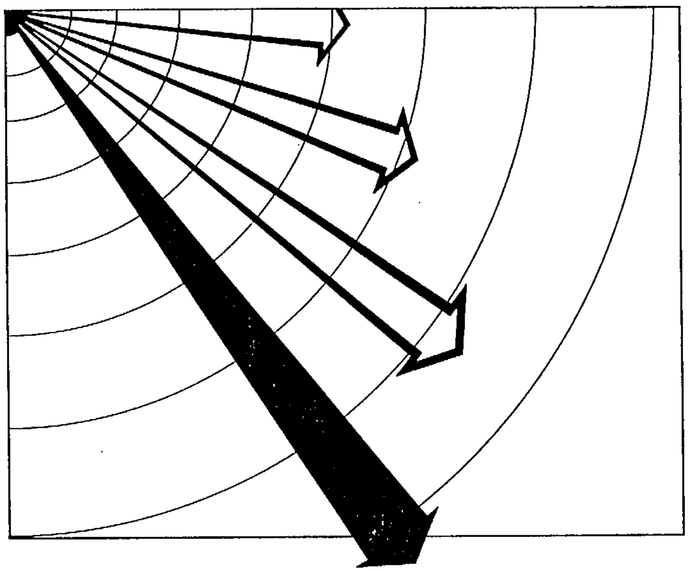


Figure E-8 Annual Per Cent Growth, Households and Families, Canada, 1961-2001

Section 2 – Technical Analysis



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2.1.0 Introduction

The concept of a low powered Direct Broadcast Satellite (DBS) relative to what was originally postulated in ITU planning for DBS satellites has received considerable attention in recent years. This interest is perhaps a direct result of the success of the Anik B pilot projects, and a realization that ITU planning was somewhat premature in setting high satellite EIRP requirements based upon earth terminal technology which was still in its infancy.

The similarity observed between the EIRP levels of Anik C and the 12/14 GHz subsystem of the Anik B suggests that Anik C satellites could serve as a vehicle for implementaton of interim DBS services in Canada. It is the purpose of this report to consider the technical viability of such services via the Anik C satellites.

The objective of the exercise is to employ the available means and resources offered by the system to provide television services of acceptable quality to urban and rural communities. In so doing, the shortcomings of the interim DBS services in terms of signal quality, reliability and coverage capability should be identified and be accompanied by suitable recommendations for alleviating the problems in the design of possible future DBS satellites.

Based on the results of the DOC Rural Communications Program, approximately 24% of Canadians live in rural areas and a great majority of the rural population lies south of the 60° parallel. Beyond the northern provincial boundaries, the population concentration is less than one per square mile (Figure 1-3).

In view of the coverage capability of the Anik C satellites and the associated power levels within the provinicial boundaries, it is an easy task to demonstrate the ability of the spacecraft to provide good quality DBS services within this region. In fact receive antenna sizes about 1 meter (3-feet) may be employed over a significantly large area to deliver what is generally known as a good DBS grade of service. The technical feasibility of such a system has already been proven by the DOC pilot projects carried via the Anik B 12/14 GHz transponders which possess comparable power levels in the respective region.

The task in hand, therefore, is not to prove the ability of the AnikC series in providing DBS services, but rather, to employ the available means and resources in an efficient way to extend the range of DBS services beyond the provincial boundaries to include the high Arctic regions of the country.

The Anik C spot beams are generated by an array of feed horns illuminating the reflector assembly of the satellite in an offset position. The offset angle of the reflector body principally determines the position of the spot beams relative to the earth in much the same way as an optical mirror. A closed-loop RF tracking system on board the satellite, fed by an earth beacon, examines the position of the beams relative to the beacon location and compensates for inaccuracies caused by the spacecraft motion. Therefore, to shift the beam patterns from the nominal position towards north, the tracking station must be appropriately relocated to change the reference position of the satellite RF pointing mechanism.

In the process of determining an optimum pointing tilt angle for the provision of nation-wide television services via a single Anik C satellite, the following important factors must be considered.

(a) A "threshold of acceptance" in the perceived quality of television pictures must be established which is based on subjective evaluations by typical viewers. The result, in conjuction with the satellite coverage patterns, will serve to define regions with sufficient signal power to deliver TV services with a quality better than or at least equal to the so called threshold for a given set of receive terminal characteristics. In the process of adopting a performance criteria, the RF power limitations of interim DBS satellites must be taken into consideration.

(b) A system AVAILABILITY objective best suited for DBS services must be defined. This essentially sets a limit to the maximum expected percentage of the time that the received signal level is allowed to fall below the objective level under faded conditions.

(c) In order to minimize the system's margin in favor of the smaller size antennas, the expected signal degradations due to a multitude of factors such as propagation effects and satellite pointing losses have to be carefully evaluated over the entire coverage area. The resolution of the process in identifying regions exhibiting significant contrasts in the expected losses has to be adequate to allow for fine tuning of the spot beam configuration. In this way, the assymmentrical nature of the individual spot beams can be exploited to fulfill more closely the coverage objectives.

(d) The system must not be overly conservative. Adequate but not exhorbitant system margins must be included to provide acceptable quality service with cost reduced earth terminals. Careful consideration must be given to the improvements likely to take place in low-cost receiver technology in the near term future.

Based on the outcome of (a) to (d) and the shape of the individual beams, an optimum tilt angle must be determined. The task should be carried out in a fashion providing sufficient power for moderately sized receive antennas in the extreme north, without jeopardizing the coverage of the southern strip which constitutes the bulk of the potential market for small-size receive antennas. Failure to do so could have significant effects on the marketability of the services provided in terms of the cost and practicality of the receive-only terminals, in view of the number of the potential end users in southern Canada. Consequently, an equitable trade-off must be established between the acceptable antenna sizes in northern and southern Canada, partly dictated by the economic aspects of the problem

Since the system priorities are not clearly defined at this point of time, Section 2.6.0 of this report provides coverage contours for both the nominal beam position (no tilt) as well as 0.25° northern tilt which is adopted as a trial figure. However, the supplied information in the report is adequate enough to lead to an optimum pointing angle once the priorities are clearly established.

In what follows, Section 2.2.0 is devoted to definition of a suitable performance objective for interim DBS services. Section 2.3.0 investigates in detail the propagation effects and the satellite antenna pointing losses for different regions in Canada. The analysis is based on measured data in Canada and generally accepted slant-path propagation models. Section 2.4.0 establishes the overall system concepts in terms of the space segment, uplink design and the receive terminal characteristics. A detailed link analysis is carried out in Section 2.5.0 and finally, Section 2.6.0 is intended to demonstrate the extent of TV services that can be offered by the Anik C satellites.

2.2.0 Performance Objective

One of the most controversial issues associated with video broadcasting by satellite concerns setting the acceptable performance standards. This is especially important in dealing with an interim DBS system where RF power is in short supply.

Many studies have been carried out to try to quantify the level of acceptable performance. The CCIR recommendation for DBS type service is a minimum video signal-to-noise ratio (S/N) of 42 dB into television sets. The corresponding signal quality has been rated excellent by 50% of sampled viewers (Report 215-3). Assuming the recommended CCIR system parameters, the corresponding carrier-to-noise ratio is about 12 dB.

Similar analysis has also been carried out in Canada. For example, to establish a "Threshold of Acceptance" in the perceived quality of television pictures, a comprehensive subjective laboratory test has been conducted recently by Behaviour Research Associates under a Contract with the Department of Communications. A satellite link simulator was used to provide the test programs. The signal was intentionally attenuated to a set of known levels to simulate faded conditions. The attenuated signal was subsequently fed into a typical low-cost receiver. The resulting programs were then recorded on a good quality video tape recorder to be used for subjective evaluation.

Two distinct groups of people were chosen from geographically separated regions. The first group from Sultan, Ontario having access to only one TV channel with poor signal quality, and the second group from Toronto enjoying more than 19 available TV channels on a regular basis.

Among many interesting outcomes of the research project were the responses of the two groups to a post-experimental questionaire. The groups were asked to identify the lowest level of picture quality that they would find ACCEPTABLE for home viewing ON A REGULAR BASIS without detracting from program enjoyment.

The responses for a 95% confidence level, indicated an acceptable signal quality equivalent to C/N = 9 dB for the poorly served community, and C/N = 11 dB for Toronto inhabitants. These findings are in accord with the results of the Hermes and Anik B pilot projects which indicate that the high quality signals originally thought to be necessary for DBS purposes may not be essential, particularly in the underserved areas.

The difference in the expressed threshold of acceptance for the two groups implies that the end user may be willing to accept a lower grade of service which he finds suitable based on his habitual exposure to the locally available signal quality and the required investment for procurring better services.

* The initial approach taken by Telesat towards adopting an acceptable, yet practical, performance objective for the interim services was to select a S/N = 42 dB as the unfaded system's performance objective at a C/N of 12 dB. This value of C/N was then used to arrive at a set of coverage contours to demonstrate the extent of the services that could be offered by the Anik C satellites. Based on the results of an extensive propagation study and pointing loss budget of the satellite beam patterns, it is concluded that with the exception of a few isolated cases, the expected <u>faded performance</u> of the system within the specified contours is better than 11 dB for 99% of the time and 9 dB for 99.9% of the time. This does not imply, however,that the total worst case fade levels associated with the specified availabilities are 1 and 3 dB respectively. In fact the estimated total downlink losses (including noise enhancement) for different regions in Canada ranges from 0.5 to 2.5 dB for 99% and 1.5 to 6.5 dB for 99.9% availability. However, as is shown in the attached coverage maps, (Appendix C) the special shape of the contours labeled by the recommended antenna sizes, and their relative positions with respect to the desired coverage regions results in partial compensation of the required margin.

2.3.0 Propagation Effects and Pointing Losses

2.3.1 Rain Attenuation and Atmospheric Absorption

Rain attenuation and absorption losses are functions of several factors and vary significantly for different climatic regions in Canada. Figure 2.3.1 divides Canada into 14 regions according to the expected signal attenuation level due to propagation effects for a satellite located about 112° West longitude. The rain statistics which were used are based on measured results in Canada, (Figures 2.3.2, 2.3.3), and are extracted from a recent publication by DOC.[2] These two maps can be used to derive the expected long term rainfall statistics in Canada. For estimation of atmospheric absorption losses, water vapour concentration maps produced by National Bureau of Standards[3] are used (Figures 2.3.4 and 2.3.5.). The expected rain attenuation and the absorption losses for both uplink and downlink corresponding to these regions are listed in Table 2.3.1. The numbers specified above the rain attenuation columns are the exceedance probabilities (in percent) associated with the listed attenuation levels.

It is to be mentioned that for severe cloud bursts, the sky background noise temperature increases significantly. Depending on the attenuation level, the increased sky temperature results in a higher antenna noise temperature (noise enhancement) which in turn degrades the receive system G/T.

To minimize the effects of the uplink losses on the downlink power level, which may well be significant for uplinks in Eastern Canada due to high rainfall rates, either a practical uplink power control scheme should be devised or the satellite's nominal operating point has to be selected close to saturation. However, the inclusion of 2 TV programs in one RF channel which results in substantial savings in terms of the cost per television program, may not allow the full advantage of the latter scheme mainly due to intermodulation problems. This is presently under study by Telesat to determine an optimum operating point. However, in the following sections, it is assumed that the uplink fade is compensated for by either of the above mentioned approaches.

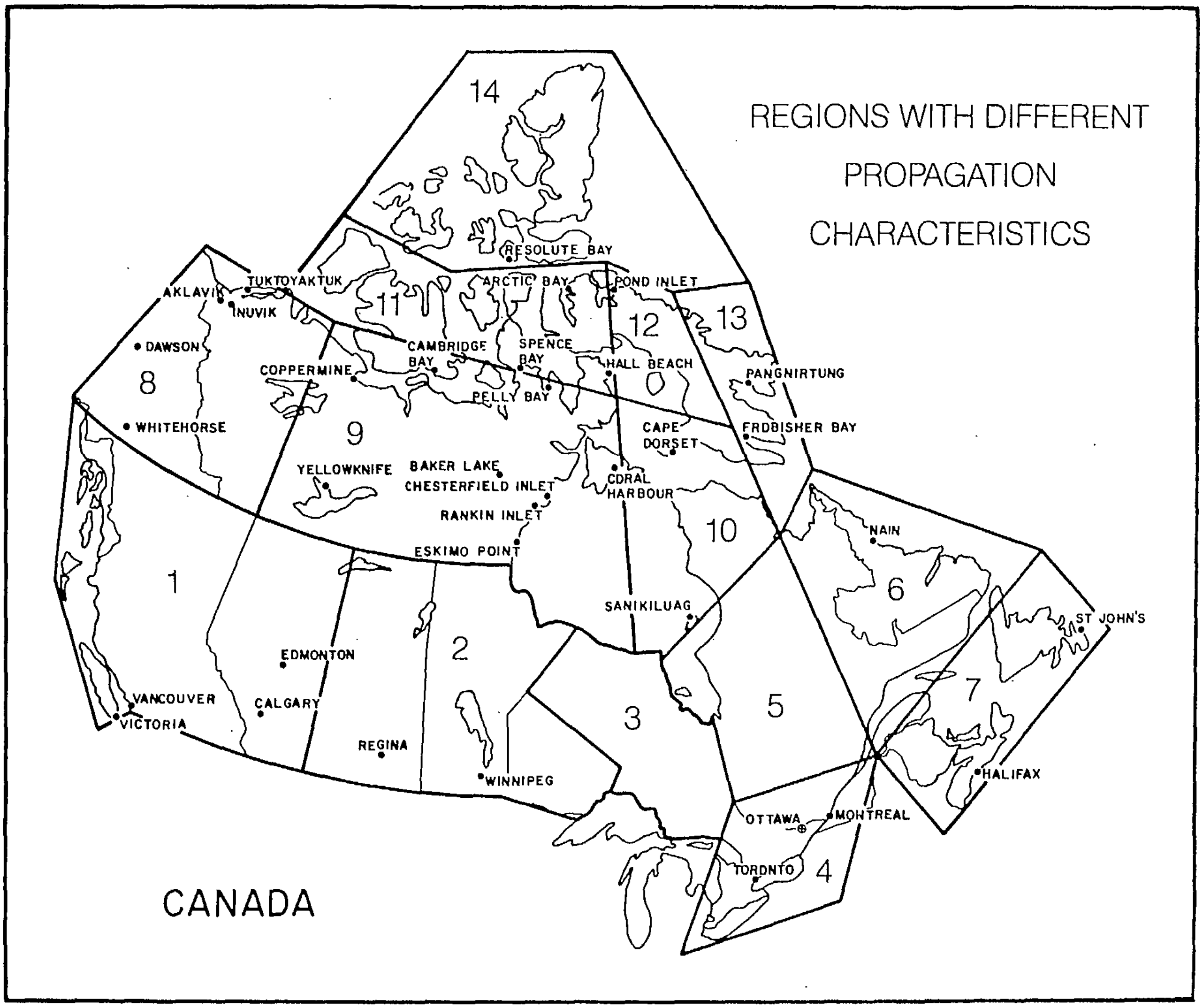


Figure 2.3.1

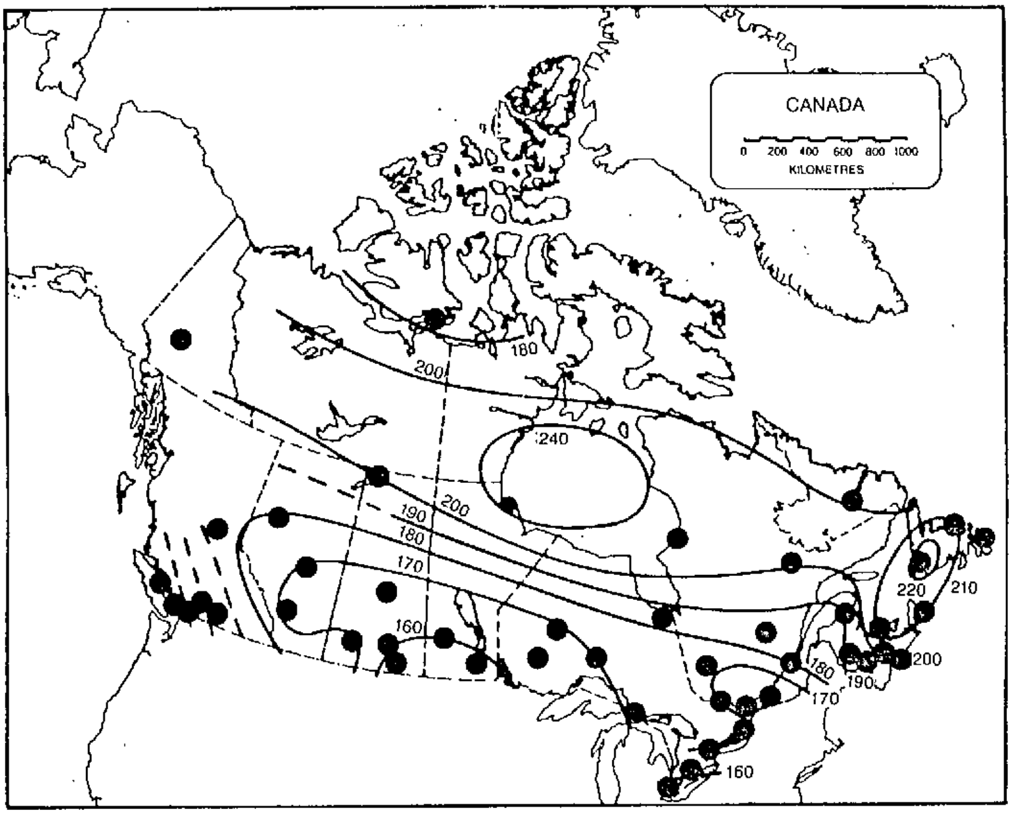


Figure 2.3.2 Contours of constant γ. The numerical values shown beside the isopleths correspond to -100γ.

Rain Rate mm/h $= 100\,(\text{Probability}/P_o)^{\frac{1}{\gamma}}$

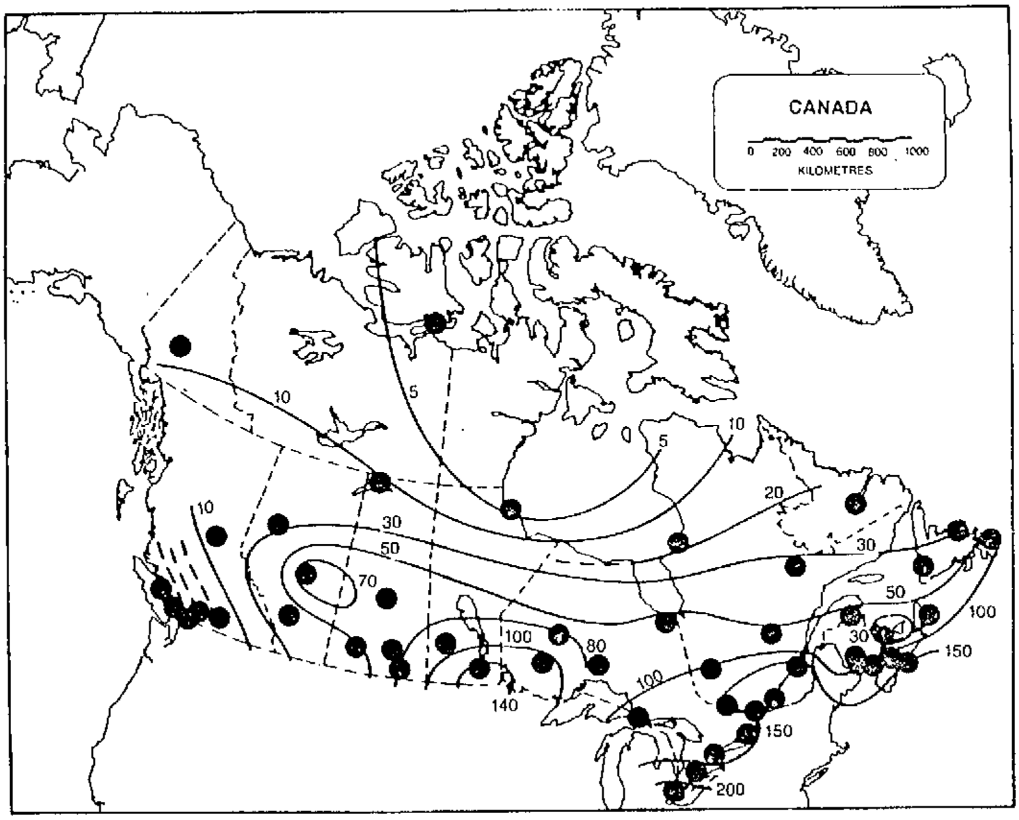


Figure 2.3.3 Contours of constant P_o against a background showing the location of all stations employed. The numerical values shown beside the kilometres isopleths correspond to $10^7 P_o$.

Rain Rate mm/h $= 100\,(\text{Probability}/P_o)^{\frac{1}{\gamma}}$

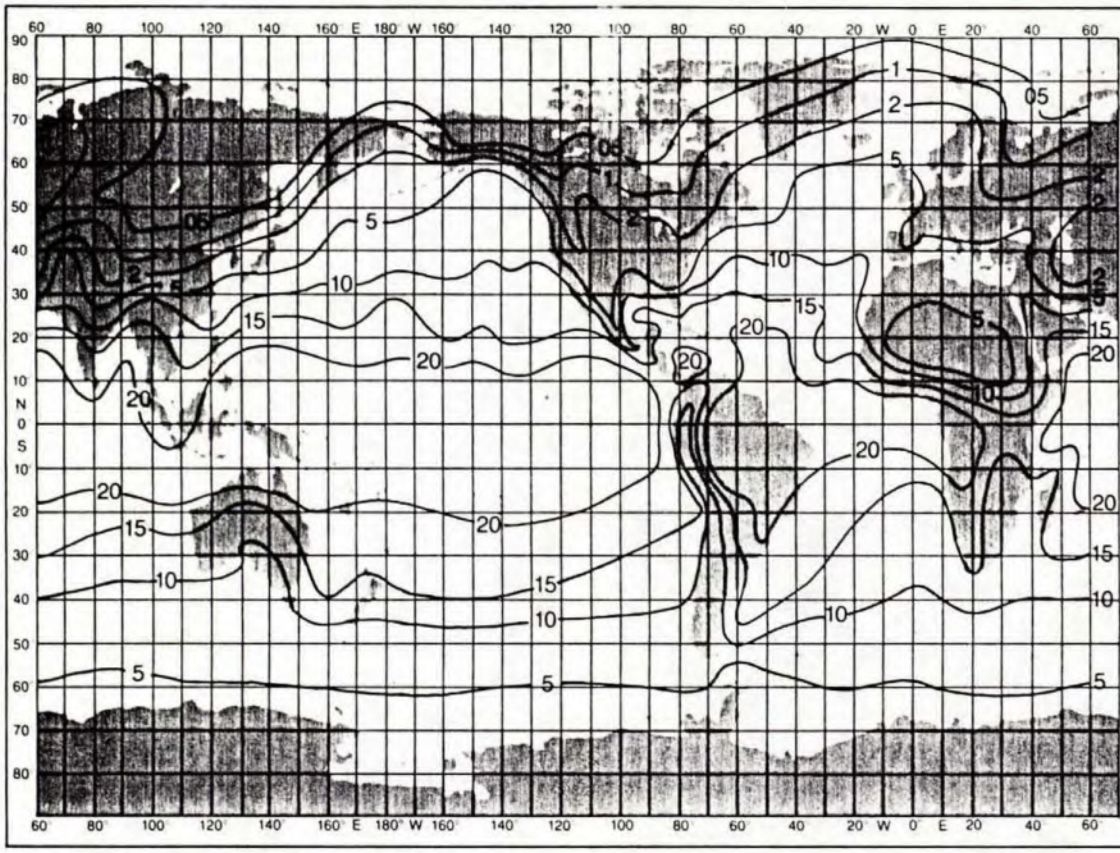


Figure 2.3.4 Water vapour concentration (g/m³), February

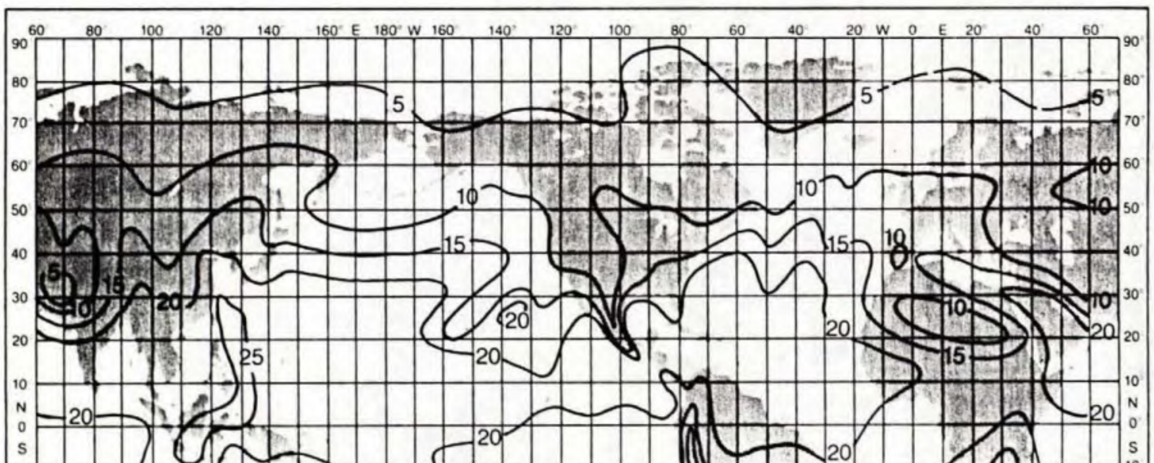


Figure 2.3.5 Water vapour concentration (g/m³), August

Table 2.3.1 Rain Attenuation and Atmospheric Absorption Loss for Regions defined in Figure 2.3.1, Satellite Longitude 112.5° West

	Uplink				Downlink			
	Atmospheric Absorption Loss dB		Rain Attenuation dB		Atmospheric Absorption Loss dB		Rain Attenuation dB	
Region	August	February	0.1%	1.0%	August	February	0.1%	1.0%
1	0.2	0.1	1.3	0.3	0.2	0.1	0.8	0.2
2	0.3	0.1	1.5	0.2	0.2	0.1	1.0	0.1
3	0.3	0.1	1.3	0.2	0.2	0.1	0.9	0.1
4	0.3	0.2	2.5	0.4	0.2	0.1	1.5	0.3
5	0.4	0.2	1.4	0.3	0.2	0.1	1.0	0.2
6	0.6	0.3	1.7	0.4	0.4	0.3	1.2	0.3
7	0.6	0.3	6.1	1.6	0.4	0.2	4.1	1.2
8	0.3	0.2	0.6	0.1	0.2	0.2	0.4	0.1
9	0.3	0.2	0.7	0.1	0.2	0.2	0.5	0.1
10	0.4	0.2	1.1	0.1	0.3	0.2	0.8	0.1
11	0.5	0.3	0.4	0.1	0.4	0.2	0.3	0.1
12	0.5	0.3	0.4	0.1	0.3	0.3	0.3	0.1
13	0.7	0.4	0.6	0.1	0.5	0.3	0.4	0.1
14	0.7	0.4	0.4	0.1	0.6	0.4	0.3	0.1

2.3.2 Low Elevation Angle Fading

Low elevation angle fading, which may become significant for angles below 10 degrees during summer months, does not generally coexist with strong rain attenuation events for the particular system under consideration. This is due to the fact that for the Anik C system, low angles are only experienced by a few remote isolated communities like Resolute Bay, Artic Bay and Pond Inlet (approx. 6°) which have low rainfall rates.

The available measured data in Canada indicate that the low elevation fade statistics in Canada in the high arctic region during summer months is close to what is experienced in southern Canada during winter months. For this reason, in order to estimate the fade distribution in the extreme north, the available data for winter obtained at Ottawa are used.[4] Very little information is available on the frequency dependence of low elevation angle fading. The results of a few experiments, however, indicate that even though a significant frequency dependence is observed for angles below 3°, the results generally converge for angles above 5°.[5]

2.3.3 Satellite Antenna Pointing Loss

The pointing error budget associated with the satellite antenna RF tracking loop in the steady-state phase is estimated to be ±0.025° in satellite coordinates. This results in a worst case pointing loss less than 0.3 dB for regions well within the provincial boundaries and approaches 1 dB for northerly remote communities such as Resolute Bay depending on the specific RF channel. Table 2.3.2 and 2.3.3 list the estimated pointing losses associated with a number of northern communities for a 0.25° tilt angle, with quarter Canada and half Canada coverage respectively.

Table 2.3.2 Satellite Antenna Pointing Loss for Quarter Canada Coverage (Channels 1 and 8) Tilt Angle = 0.25° North Satellite Longitude = 112.5° West

	dB Loss	
Location	Ch 1	Ch 8
Aklavik	0.4	0.4
Arctic Bay	0.6	1.0
Baker Lake	0.4	0.3
Cambridge Bay	0.5	0.4
Cape Dorset	0.6	0.7
Chesterfield Inlet	0.3	0.3
Coppermine	0.4	0.4
Coral Harbour	0.3	0.3
Eskimo Point	0.3	0.3
Frobisher Bay	0.7	0.8
Hall Beach	0.5	0 5
Inuvik	0.5	0.4
Pangnirtung	0.7	0.8
Pelly Bay	0.5	0.5
Pond Inlet	0.6	0.7
Rankin Inlet	0.3	0.3
Resolute	0.6	0.8
Sanikiluaq	0.3	0.3
Spence Bay	0.5	0.6
Tuktoyaktuk	0.5	0.4
Nain	0.3	0.3

Table 2.3.3 Satellite Antenna Pointing Loss for Half Canada Coverage (Channels 1 & 8) Tilt Angle = 0.25° North Satellite Longitude = 112.5° West

Location	Pointing Loss dB	
	Ch 1	Ch 8
Aklavik	0.4	0.5
Arctic Bay	0.7	0.9
Baker Lake	0.4	0.6
Cambridge Bay	0.5	0.6
Cape Dorset	0.5	0.7
Chesterfield Inlet	0.4	0.3
Coppermine	0.4	0.4
Coral Harbour	0.4	0.5
Eskimo Point	0.3	0.3
Frobisher Bay	0.6	0.6
Hall Beach	0.5	0.5
Inuvik	0.4	0.5
Pangnirtung	0.8	0.7
Pelly Bay	0.5	0.6
Pond Inlet	0.6	0.7
Ranking Inlet	0.3	0.3
Resolute	0.7	0.9
Sankiluaq	0.4	0.3
Spence Bay	0.5	0.7
Tuktoyaktuk	0.5	0.7
Nain	0.5	0.4

2.3.4 Downlink Loss

Since the contributors to the total loss budget have different, often uncorrelated origins and causes, the total downlink loss should not be determined by simply summing up the worst case estimates. On the other hand, a case-by-case study is quite complicated in view of the extent of the coverage area. A more reasonable approach seems to be the one which leads to loss estimates on a regional basis. The potential problem areas can then be identified and be treated on a case-by-case basis.

Table 2.3.4 was prepared after a careful study of the dominant contributing loss mechanisms over the 14 regions depicted in Figure 2.3.1. The total downlink loss is shown for each region for both 1% and .1% of the time and the potential problem cases with losses more than 3 dB are identified by an asterisk. In evaluating the pointing loss, the satellite antenna beam configuration envisaged for interim DBS services (0.25° northern tilt) is assumed.

With respect to the total C/N calculated for 99.9% and 99% of the time, it is important to realize that these estimates are "beam-edge" values for locations which fall exactly on the coverage contours included in this report, whereas most of the population centres in the north and south fall well within the coverage contours and, therefore, experience higher signal levels.

It is worthwhile to note that a great majority of the cases enjoy what is generally considered to be a good DBS grade of service; that is, a C/N greater than or equal to 11 dB for 99% of the time, and 9 dB for 99.9% of the time. It should also be mentioned at this point that 99.9% availability is approximately equivalent to an average period of only nine hours per year during which the received C/N at a location on the boundary of a coverage area falls below the specified level. Similarly, an availability objective of 99% corresponds to 7 hours of monthly average period, some of which will occur during off hours or non-prime viewing time.

It should be noted that the above availability figures do not include service outages due to equipment failures. However, the expected outage time due to the uplink and downlink equipments is expected to be quite small.

For instance, based on Telesat's experience with low cost uplink facilities, yearly equipment availability of 99.95% is achievable. As far as the receive terminals are concerned, the equipment should have a frequency of repair comparable to that of television sets to be generally accepted by the public. Therefore, the total equipment outage is expected to constitute a small fraction of the system outage due to propagation effects, and the system availability is effectively controlled by the propagation factors.

The two cases identified by asterisks in Table 2.3.4 occur in Regions 7 and 14 of Figure 2.3.1, where the 99.9% carrier level is below 9 dB. In both cases, however, the 99% objective is about 9.5 dB. As for reception at the edge of coverage in region 7, if increased fade margin is desired, it can be provided by using a slightly larger receive antenna.

In the case of Region 14, it is expected that the likely applications in this region will be to serve small communities rather than individual subscribers and, therefore, the use of slightly larger antennas will not be a significant disadvantage.

Table 2.3.4 Total Downlink Loss Budget and System Performance for an Unfaded C/N = 12 dB, Tilt = 0.25° North, Satellite Longitude = 112.5° West

Region	Atm. Abs. Loss dB	Pointing Loss dB	Rain Attenuation dB 0.1%	Rain Attenuation dB 1.0%	Low Elevation Angle Fading Below Mean Signal Level 0.1%	Low Elevation Angle Fading Below Mean Signal Level 1.0%	Total Loss dB 0.1%	Total Loss dB 1.0%	Expected C/N† (Unfaded C/N = 12dB) 99.9%	Expected C/N† (Unfaded C/N = 12dB) 99.0%
1	0.2	0.2	0.8	0.2	—	—	1.2	0.6	10.5	11.4
2	0.2	0.2	1.0	0.1	—	—	1.4	0.5	10.2	11.5
3	0.2	0.2	0.9	0.1	—	—	1.3	0.5	10.2	11.5
4	0.2	0.2	1.5	0.3	—	—	1.9	0.7	9.2	11.2
5	0.2	0.1	1.0	0.2	—	—	1.3	0.5	10.1	11.5
6	0.4	0.3	1.2	0.3	—	—	1.9	1.0	9.4	10.9
7	0.3	0.3	4.1	1.2	—	—	4.7	1.8	5.7*	9.6
8	0.2	0.6	0.4	0.1	—	—	1.2	0.9	10.6	11.1
9	0.2	0.5	0.5	0.1	—	—	1.2	0.8	10.5	11.2
10	0.3	0.6	0.8	0.1	—	—	1.7	1.0	9.8	11.0
11	0.3	0.7	0.3	0.1	1.2	0.7	2.5	1.8	9.5	10.2
12	0.3	0.6	0.3	0.1	1.4	0.9	2.6	1.9	9.4	10.1
13	0.4	0.6	0.4	0.1	1.1	0.6	2.5	1.7	9.3	10.3
14	0.5	0.9	0.3	0.1	1.5	1.0	3.2	2.5	8.7*	9.5

* Potential problem area
† Including downlink noise enhancement due to rain

2.4.0 Overall System Concepts

2.4.1 Space Segment

The Anik C communications subsystem utilizes 11.7 - 12.2 GHz and 14 - 14.5 GHz for the downlink and uplink bands respectively. The frequency and polarization plan for the system is shown in Figure 2.4.1. Frequency reuse is achieved through the use of two orthogonal linearly polarized signals. The cross polarization isolation provided by the satellite is better than 30 dB over the entire coverage area. The 500 MHz frequency spectrum is divided into 16 RF channels (8 per polarization). Each RF channel is 54 MHz wide and is designed to accommodate either analog FM transmissions (including two TV carriers and additional radio programs) or digital traffic. The channel centre frequencies of the two polarizations are offset by 13 MHz to minimize cross polarization interference. Signals received by the satellite are translated in frequency and re-transmitted with the same polarization with which they were received. The eight vertical channels are transmitted by the western Canada beams and eight horizontal channels are directed toward eastern Canada. The available power of the individual RF channels can be distributed over the respective coverage region (East for horizontal, West for vertical) through the use of the quarter Canada spot beams or the half-Canada coverage beams. For example, horizontal channels can each be routed to either east or east central beams or illuminate the entire eastern region with lower power, through the combined eastern beam.

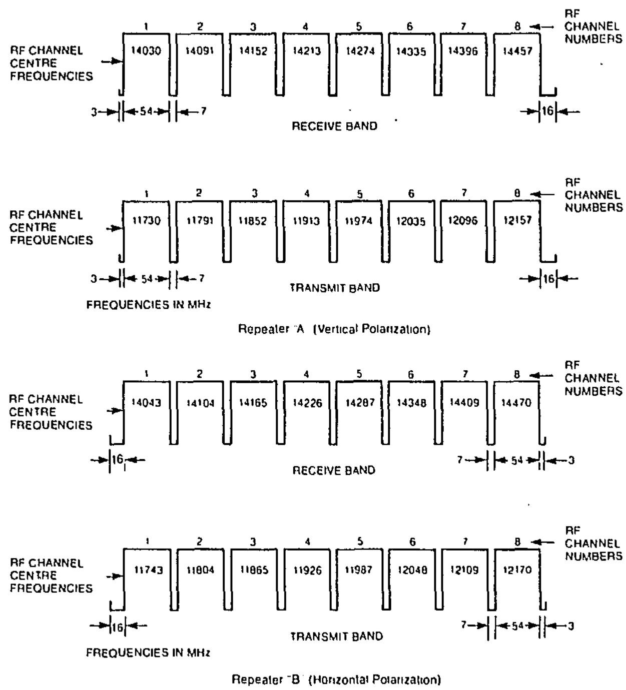
The receive sensitivity of each of the 16 RF channels can be adjusted independently by ground commands which can switch out a 2.5 dB RF attenuator from the repeater path. The receive C/T with the RF switchable attenuator in circuit is -123.5 dBW/K.

2.4.2 Antenna Subsystem

The satellites communication antenna is formed by two orthogonal grid reflectors (one for each polarization) attached to each other and illuminated by two sets of horns. On-station telemetry and tracking functions are also performed by the same antenna. The receive patterns for both polarizations at the nominal boresight position provide a minimum G/T = 3 dB/K over southern Canada.

The EIRP level of the spot beams starts from 50-51 dBW at the beam centres and tapers off slowly at first and then more rapidly with increasing distance from the beam centres. The provincial boundaries (excluding northern Quebec) are effectively illuminated by a minimum EIRP level of 45 dBW.

Anik C 14/12 GHz Frequency and Polarization Plan



Anik C 14/12 GHz Communications Subsystem

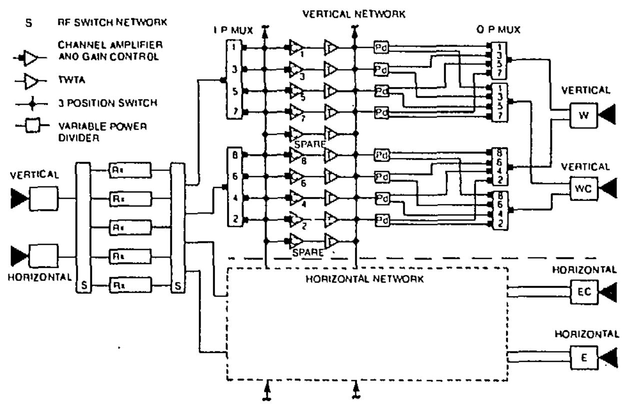


Figure 2.4.1 Frequency plan and communications subsystem of Anik C.

2.4.3 Channel Capacity

The usable RF bandwidth of each channel (54 MHz) is sufficient to accommodate 2 TV programs with their associated sound subcarriers. Depending on the required signal quality for video services, additional audio subcarriers (ASC) or separate carriers (SCPC) for radio programming can be accommodated. The maximum number of allowable radio program channels is determined by the number of video programs present in the RF channel and the tolerable level of intermodulation interference. Alternative schemes available for distributing additional sound programs by a DBS system were studied earlier at Telesat and the results are provided separately in Appendices A & B.

A recent series of laboratory tests conducted at CRC for evaluation of sound program services indicate that both audio subcarrier and SCPC methods are workable.[6] With a single TV per RF channel mode, it has been shown that up to four sound programs can be carried as ASC or SCPC within a 20 MHZ bandwidth (depending on the requirements) with no perceptible degradation in the quality of the video signal.

The tests were conducted with only one video signal present, however it is expected that each of the two TV carriers sharing a 54MHz transponder can be accompanied by one radio program with no significant degradation in video quality.

2.4.4 Earth Segment

Based on the results of a market study as part of the present project, the minimum number of signals required per beam is forcasted at 4 TV carriers plus 4 radio programs. The upper bound specified is essentially the full capacity of the satellite or 8 TV signals plus 8 radio programs within each spot beam.

Presently, the suppliers of the TV and radio programs are not clearly defined, therefore, it is not known whether the programs will be originated from a single uplink station within a region or will have to be locally separated. In addition to regional TV program distribution schemes, national services may also be regarded as a potential market. Therefore, a common design uplink station must have built-in capability for the distribution of both regional and national programming.

Moreover, in certain cases, one TV signal per RF channel may be preferred to two, due to downlink power considerations. This implies that a single uplink station may be required to operate in mixed mode, depending on the downlink power requirements.

For these reasons, the uplink stations will be designed with a high degree of flexibility; that is, the RF combining network will be modular. The services can start with only one TV signal present and subsequently be expanded, as needed, without interrupting the existing services. Each TV channel can be routed to any of the spot beams and the network readily lends itself to mixed mode operations.

2.4.5 Uplink Design

In the design of the uplink stations, it is assumed that the program suppliers are within major cities. Since several stations within a region may originate uplink signals, the selected antenna size should be sufficiently small to avoid excessive increase in the uplink cost per progam due to the multiple uplink antenna costs. It is also noted that small-size antennas require larger size HPA's. However, the differential cost between HPA's of a few hundred watts to a few kilowatts is not very significant, and antenna cost tends to dominate.

Figure 2.4.2 shows the recommended RF combining network for the uplink stations. A separate HPA is assumed for each TV program to facilitate level control of the individual carriers. It is assumed that only odd or even channels are allocated to each station. This reduces the loss associated with the combining network and, therefore, the required HPA power. However, if allocation of adjacent channels becomes unavoidable in later stages, a 3 dB hybrid in conjunction with a larger size HPA will alleviate the problem. The two-digit TV program notation used in Figure 2.4.2 represents the RF channel number and the associated TV signal.

The existence of the manual switches facilitates servicing and future expansion. In the one TV per RF Channel case, the block designated "alternative #1" of the desired channel can be replaced by "alternative #2." One standby unit is included in the recommended network. However higher degrees of redundancy can easily be integrated as desired.

Based on the Anik C flight antenna measured data, Tables 2.4.1 to 2.4.3 are prepared to show the required uplink power at different cities. A satellite antenna tilt of 0.25° is assumed.

A 5 meter antenna seems to be a good candidate for the uplink stations as a measure to reduce the cost of the antenna, the support structure and the foundation. In one TV per channel mode, a 1KW HPA is quite adequate and provides a comfortable margin above the required power level as shown in Table 2.4.2. For two TV mode, a 500-Watt HPA is generally sufficient to provide ample power to accommodate uplink power control requirements, Table 2.4.3.

2.4.6 TVRO Terminals

TVRO terminal technology in Canada has evolved significantly over the years of experimentation with the high powered Hermes Satellite and subsequently through the use of Anik B 12/14 GHz transponders. Since the development of the first laboratory prototype receiver at CRC with 6.5 dB noise figure, the electronics performance has been improved drastically. The industry prototype units for Anik B pilot projects were produced with noise figures within the range 4 to 4.5dB Recent contacts with industry indicate that a 3 dB front-end noise figure is within reach for mass production in the next two years. Consideration of the recent advances in the design of the low-noise FET transistors at 12 GHz, and also extrapolation of the past progress in this dynamic field all lead to a high prospect of attaining noise figures close to 2 dB.

Related antenna technology has also been significantly improved. Efficiencies of the order of 70% for small receive antennas are becoming standard. Andrew has recently developed a 1.8 m high gain 12 GHz receive-only antenna which utilizes a multimode corrugated feed. The antenna parameters are given in Figure 2.4.3.

The midband gain specification is 46 dB corresponding to 78% efficiency, and the minimum efficiency across the 500 MHz band exceeds 73.9%. The antenna noise temperature is 35°K for 20 degrees elevation angle and

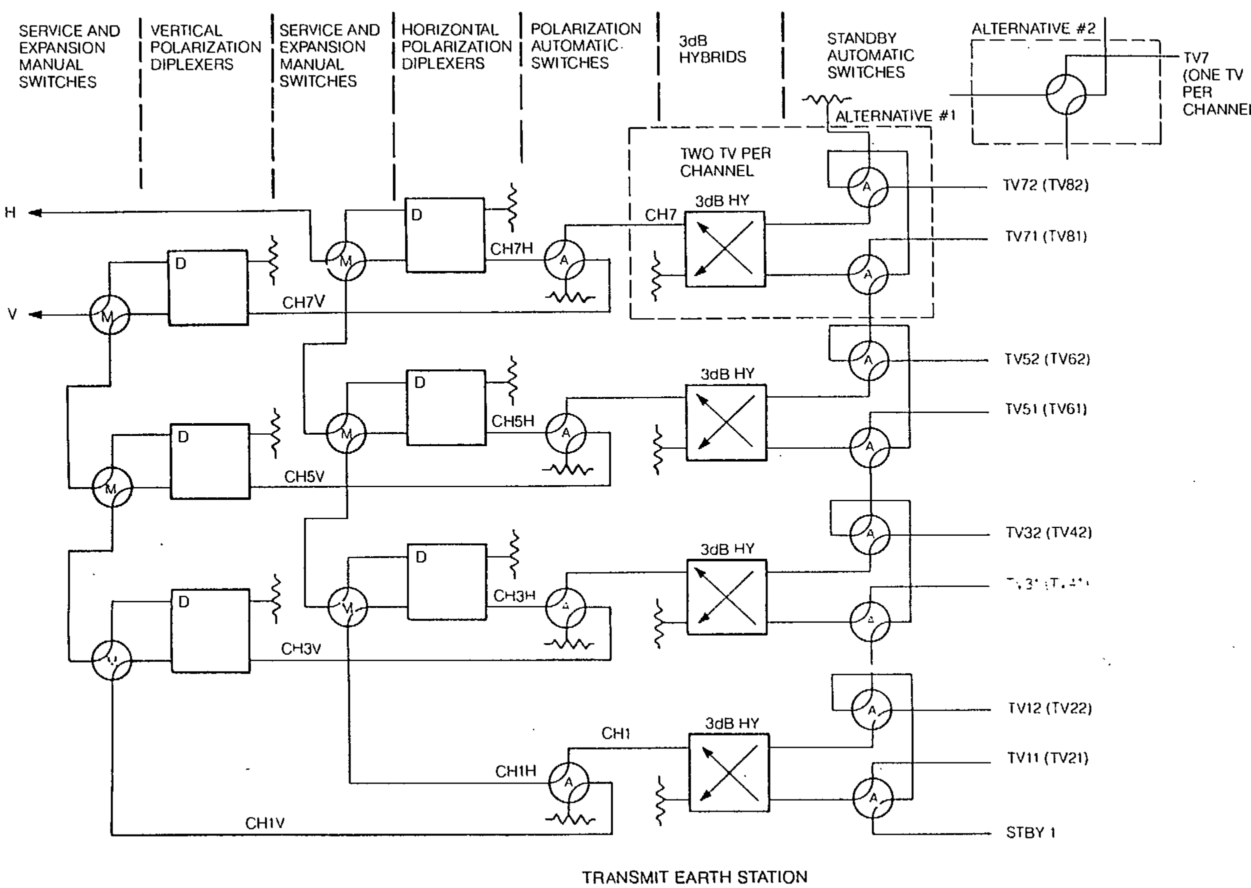


Figure 2.4.2 RF combining network

Table 2.4.1 Satellite G/T at Major Cities, Tilt = 0.25° North, Satellite Longitude = 112.5° West

City	G/T dB/K		Pointing Loss dB		Worst Case Expected G/T dB/K	
	Vertical	Horizontal	Vertical	Horizontal	Vertical	Horizontal
Vancouver	2.0	3.2	0.4	0.3	1.6	2.9
Calgary	3.6	4.2	0.3	0.3	3.3	3.9
Edmonton	5.5	5.8	0.2	0.2	5.3	5.6
Regina	3.6	5.5	0.3	0.2	3.3	5.3
Winnipeg	4.2	4.2	0.4	0.4	3.8	3.8
Toronto	5.0	4.2	0.2	0.4	4.8	3.8
Montreal	5.5	5.8	0.2	0.2	5.3	5.6
Ottawa	5.5	5.8	0.2	0.2	5.3	5.6
Halifax	4.0	3.0	0.4	0.4	3.6	2.6
St. John's	5.5	4.5	0.3	0.3	5.2	4.2

Table 2.4.2 Uplink Parameters for One TV per RF Channel

Parameter	Unit	Vancouver	Calgary	Edmonton	Regina	Winnipeg	Toronto	Montreal	Ottawa	Halifax	St. John's
Satellite G/T (expected)	dB/k	1.6	3.3	5.3	3.3	3.8	3.8	5.3	5.3	2.6	4.2
Saturating Flux Density	dBW/m²	–80.7	–82.4	–84.4	–82.4	–82.9	–82.9	–84.4	–84.4	–81.7	–83.3
Input Backoff per Carrier	dB	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Required Earth Station EIRP	dBW	81.3	79.6	77.6	79.6	79.1	79.1	77.6	77.6	80.3	78.7
Combining Network Loss	dB	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4
Feeder Loss	dB	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Miscellaneous Losses	dB	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
5m Antenna Gain at 14 GHz 65% Efficiency	dB	55.4	55.4	55.4	55.4	55.4	55 4	55.4	55.4	55 4	55.4
Required Net HPA Power	Watt	677	458	289	458	408	408	289	289	537	372
Recommended HPA Power	Watt	1000	1000	500	1000	1000	1000	500	500	1000	1000
HPA Output Backoff	dB	1.7	3.4	2.4	3.4	3.9	3.9	2.4	2.4	2.7	4.3

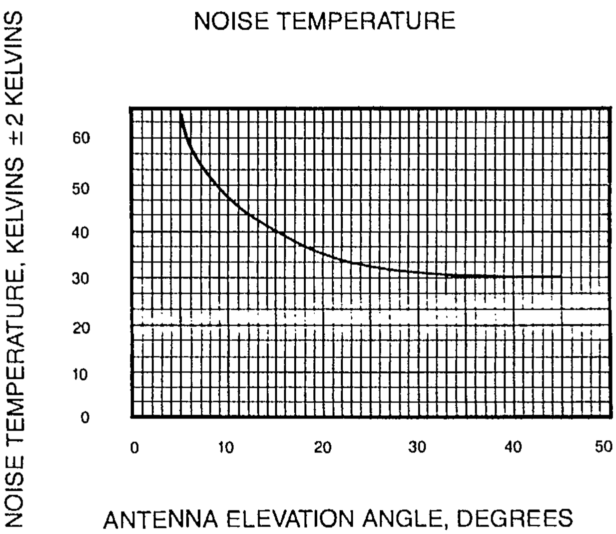
Tilt Angle = 0.25° North
Satellite Longitude = 112.5° West

Table 2.4.3 Uplink Parameters for Two TV per RF Channel

Parameter	Unit	Vancouver	Calgary	Edmonton	Regina	Winnipg	Toronto	Montreal	Ottawa	Halifax	St. John's
Satellite G/T (expected)	dB/k	1.6	3.3	5.3	3.3	3.8	3.8	5.3	5.3	2.6	4.2
Saturating Flux Density	dBW/m²	-80.7	-82.4	-84.4	-82.4	-82.9	-82.9	-84.4	-84.4	-81.7	-83.3
Input Backoff per Carrier	dB	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0
Required Earth Station EIRP	dBW	74.3	72.6	70.6	72.6	72.1	72.1	70.6	70.6	73.3	71.7
Combining Network Loss	dB	4.6	4.6	4.6	4.6	4.6	4.6	4.6	4.6	4.6	4.6
Feeder Loss	dB	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Miscellaneous Losses	dB	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
5m Antenna Gain at 14 GHz 65% Efficiency	dB	55.4	55.4	55.4	55.4	55.4	55.4	55.4	55.4	55.4	55.4
Required Net HPA Power	Watt	282	191	121	191	170	170	121	121	224	155
Recommended HPA Power	Watt	500	500	250	500	500	500	250	250	500	500
HPA Output Backoff	dB	2.4	4.1	3.1	4.1	4.6	4.6	3.1	3.1	3.4	5.0

Till Angle = 0.25° North
Satellite Longitude = 112.5° West

1.8 m ANTENNA CHARACTERISTICS*



Operating Frequency, GHz	11.7 – 12.2
Polarization	Linear
Gain, dBi ± 0.2dB at 11.95 GHz	46.0
Noise Temperature, kelvins	
at 10° elevation	47
at 20° elevation	35
at 30° elevation	32
VSWR maximum	1.3
Isolation, dB	35
Half-Power Beamwidth, degrees	0.91
Pattern Envelope (PE) Number	3400
Output Flanges	WR-75

The Andrew 1.8 metre, 12 GHz receive only earth station antenna has been designed to achieve high gain. The use of the multimode corrugated feed together with the excellent reflector surface accuracy results in an antenna efficiency of 73%.

Figure 2.4.3 1.8m antenna characteristics

*Andrew Bulletin 1206

rises to 55° K for 6° elevation angle (high arctic region). Large size antennas with the same efficiency are not reported yet, nevertheless, if market demands, there seems to be no technical barrier to generating larger-size antennas with comparable efficiencies.

Depending on the mode of operation (1 TV or 2 TV per RF channel), the satellite EIRP level at a location and the desired minimum picture quality, the required antenna size for a TVRO terminal varies significantly across Canada. The range is from about 1 meter at the centre of the spot beams to about 4.5 meter at extreme northern locations.

Figures 2.4.4 and 2.4.5 are block diagrams of two typical DBS terminal designs. Depending on the method of radio program transmission (ASC or SCPC), the video and radio programs are separated and directed to the associated receivers. If a standard television set is being used as a monitor, the demodulated video signal and the audio subcarrier will have to be re-modulated with standard techniques to provide the required vestigial sideband VHF signal.

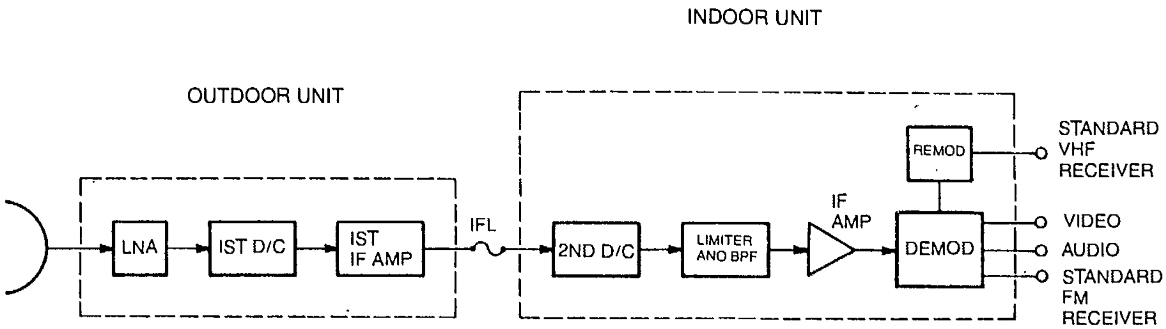


Figure 2.4.4 DBS Terminal With ASC Radio Program Capability

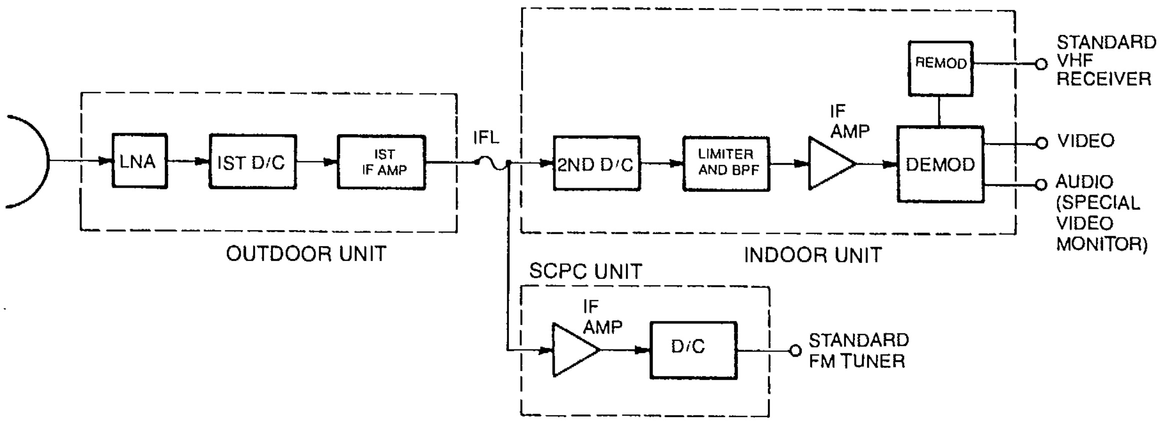


Figure 2.4.5 DBS Terminal with SCPC radio program unit

2.4.7 Signal Scrambling

The implementation of Subscription Television Services (STV) and Pay TV on American CATV systems has produced a number of video scrambling devices which are available on the open market. These devices fall into two broad categories with respect to technique: (1) "sine-wave" type and (2) "video processing" type; and two categories of hardware implementation: (1) "RF coding/decoding and (2) "baseband" coding/decoding.

Until recently, none of the systems were directed towards the satellite distribution market. But interest in Pay TV and Teleconferencing has resulted in some systems being developed which can meet the market demands as they appear. The "baseband" coding/decoding implementation is used and either "sine-wave" or "video processing" or combinations of the two are applied in the scrambling process.

Also, of related interest, are complete STV "Systems" which include the scrambling device, addressable command and remote billing equipment and the transmission of the commands and scrambled video to individual subscriber's locations. Two of these systems, the Oak "Total Control" System and the American Television Corp. "SSAVI-1" System, have been reviewed to determine their applicability for use on a satellite link. In both cases the "system" as described cannot be directly operated for a satellite service. This is because both systems are configured for use in CATV or MDS distribution facility, and as such, have included transmission interfacing (such as VSB modulation, RF scrambling, commands sent via the FM Radio band, etc.) which cannot be used in a satellite application. However, with suitable modifications and redesign, the principles and addressability features of both systems can certainly be applied to an equivalent system which

Table 2.4.4 Summary of Signal Scrambling Techniques for Satellite Use

System	Method	Effectiveness	Audio Scrambled	Decoder Cost (1980)
Oak (Orion)	Analogue-combined synch inversion, random line inversion, pseudorandomly controlled.	Good	Yes-available as digital sound in synch or sub-carrier with encryption	About $1K (large quantities) *also* a simple version, no audio scrambling for ≈ $500
IT & T	Synch suppression and alternate line inversion	Good	Yes-digitized	$4K-$5K (small quantities)
Pay TV Corp.	Alternate line inversion	Poor	No	$100-$200 (large quantity)
ATC (SSAV-1)	Synch suppression and random line inversion	Good	Yes	Not quoted
Microtime	Digital-frame store and scramble	Excellent	No	$12K (small quantity)
Westinghouse	Digital-line store and scramble	Excellent	Yes (digitized)	$32K (small quantity)

would rely on the satellite link as the distribution vehicle. As long as a scrambled baseband signal is provided to and from the satellite link (or suitable conversion equipment is provided at each end as part of the earth station equipment), and a method of transmitting the command signals - either as data in the vertical interval or by combining FSK tones above the program audio signal - can be included as part of the system cost, then the STV system can function in the same way as it would in a CATV environment.

A concise summary of the important features of most of the currently available scrambling systems suitable for satellite distribution is included in Table 2.4.4,.

A preliminary view of the techniques with respect to ensuring privacy of satellite TV signals at moderate cost places the Oak and ATC equipment as the most likely candidates, with Oak having already done extensive demonstrations via satellite and therefore having a competitive edge. For Direct-to-Home use, however, the decoder costs are, in our opinion, still far too high. Comsat, as part of their DBS work, are apparently developing their own scrambling system but, no information is yet available on their approach.

2.4.8 Carriage of Radio Programming

Several schemes are available for Radio Program distribution by a Direct Broadcast Satellite, each offering various advantages for certain applications. However, the preferred method must result in inexpensive hardware modifications and/or additions to the basic TVRO terminals. Multiple Audio Subcarriers and separate audio carrier methods seem to be the viable candidates for radio program distribution.

A qualitative study of the available schemes for provision of multiple sound (mono and stereo) for a DBS System, their advantages and disadvantages was conducted earlier at Telesat and the results are included in Appendices A and B to Section 2. For interim services via Anik C, however, preliminary studies indicate that for the two TV per transponder case, one radio program subcarrier per video can be included with no significant degradation in the video performance. For the one TV case, larger numbers of subcarriers or SCPC carriers can be accommodated at the expense of a lower powered video carrier.

2.5.0 Link Analysis

2.5.1 Space Segment Parameters

2.5.1.1 EIRP and G/T

The values of EIRP and G/T for the Anik C satellite depend on polarization, depth of coverage and individual shape of the spot beams. Tables 2.5.1 and 2.5.2 provide typical values of G/T and EIRP at major cities. Two different beam positions are considered (0° and 0.25°) for the assumed satellite longitude at 112.5° west. In these tables, major cities have been used purely for convenience, not because they constitute a particular target market for Direct-to-Home type service. In order to make the link calculations tractable and reduce the complexity of the presented data, it is assumed that the satellite G/T experienced at all major cities is 3 dB/K. Since the system is principally downlink limited, the actual variation of G/T for different cities has negligible effect on the received signal quality.

For generating the coverage maps (Appendix C, Figures 1-24), two sets of distinct EIRP levels are assumed. Each set corresponds to a particular mode of operation, namely, one TV or two TV per RF channel.

In the coverage maps included in this report, the EIRP levels are replaced by antenna sizes which together with a specific receiver (LNA N.F. = 3 dB) yields an unfaded total carrier-to-noise ratio of about 12 dB. Table 2.5.3 lists the EIRP levels used for generating these maps.

2.5.1.2 Saturating Flux Density (SFD)

For a saturating carrier, the satellite receive C/T is -126 dBW/K. A 2.5 dB attenuator is inserted in the RF path of each individual channel at the beginning of life, to be removed subsequently in the event of TWTA gain degradation. With the 2.5 dB pad inserted in the RF paths, the C/T for a saturating carrier is -123.5 dBW/K and the saturating nominal flux density is given by the following equation,

$$SFD = 44.5 - \left(\frac{G}{T}\right)_{dB} + \left(\frac{C}{T}\right)_{dB} \text{ dBW/m}^2$$

Table 2.5.1 Typical Satellite G/T Levels at Major Cities for 0° and 0.25° Tilt Angle

	G/T dB/K			
	Vertical		Horizontal	
City	0°	0.25°	0°	0.25°
Vancouver	4.8	1.6	4.8	2.9
Calgary	5.3	3.3	5.3	3.9
Edmonton	5.0	5.3	5.8	5.6
Regina	5.3	3.3	5.3	5.3
Winnipeg	5.2	3.8	5.2	3.8
Toronto	5.3	4.8	5.3	3.8
Montreal	5.8	5.3	5.8	5.6
Ottawa	5.8	5.3	5.8	5.6
Halifax	5.3	3.6	5.3	2.6
St. John's	5.3	5.2	5.3	4.2

Table 2.5.2 Typical Satellite EIRP Levels at Major Cities for 0° and 0.25° Tilt Angle

	EIRP dBW			
	Combined		Quarter	
City	0°	0.25°	0°	0.25°
Vancouver	49.3	47.2	50.8	49.2
Calgary	50.3	49.3	51.3	50.8
Edmonton	50.3	50.3	50.8	51.3
Regina	48.7	47.2	51.3	50.0
Winnipeg	47.1	45.7	50.2	48.5
Toronto	50.3	48.1	51.3	49.7
Montreal	50.3	49.1	50.1	49.2
Ottawa	50.8	49.6	50.0	50.0
Halifax	48.2	45.5	50.8	48.5
St. John's	48.7	47.8	51.3	49.7

2.5.2 Earth Station Parameters

2.5.2.1 Uplink

For the one TV per RF channel case, the operating point is assumed to be 1 dB input back-off. The resulting output back-off is approximately 0.1 dB. For the two TV per RF channel mode, the assumed input back-off is 8 dB per carrier and the corresponding output back-off is 5 dB. The noise bandwidth is taken to be 18 MHz. A detailed uplink budget was presented in Tables 2.4.2 and 2.4.3 for the two modes of operation.

2.5.2.2 Downlink

The receive antenna dimensions considered in this report for the preparation of the coverage maps are 1.2 m, 1.8 m, 2.5 m, and 4.5 m. However, within each coverage area, it may be possible to use smaller size antennas depending on the actual received power level (as shown in Table 2.5.2).

Table 2.5.3 EIRP Levels Associated with the Contours of Coverage Maps

One TV		Two TV	
Antenna Size m	EIRP dBW	Antenna Size m	EIRP dBW
1.2	47	1.8	48
1.8	43	2.5	45
2.5	40	4.5	40
4.5	35		

Table 2.5.4 Receive Terminal Parameters

Antenna Diameter	1.2m	1.8m	2.5m	4.5m
Antenna Efficiency	70%	70%	70%	70%
Antenna Gain (dB)	42	45.5	48.4	53.5
System G/T (dB/K)	16.4	20.0	22.8	27.9

System Noise Temperature (6° Elevation Angle)

Antenna Noise	55°K
Mismatches, losses, etc.	10°K
D/C Noise	5°K
LNA (3dB N.F.)	289°K
T_{System}	359°K

Table 2.5.4 contains the receive terminal parameters for different antenna sizes. The antenna noise temperature assumed is 55°K which is the expected clear sky temperature for a 1.8 m antenna with 6° elevation angle. In the majority of cases, the actual elevation angle is close to 20° and, therefore, the antenna noise temperature is lower than the assumed value.

2.5.3 Link Budget

The link calculations, performed for both the one TV and two TV per channel modes of operation, are shown in Table 2.5.5. The interference budget associated with adjacent satellites is listed individually in Table 2.5.6 shown on pages 2.18 and 2.19. Table 2.5.7 shows the modulation parameters and the expected FM improvement factor for both video and audio subcarriers.

Table 2.5.5 Link Calculations

Parameter	Unit	One TV per RF Channel				Two TV per RF Channel		
		1.2m	1.8m	2.5m	4.5m	1.8m	2.5m	4.5m
Uplink								
Satellite G/T	dB/K	3	3	3	3	3	3	3
Saturating Flux Density	dBW/m²	–82	–82	–82	–82	–82	–82	–82
Input Backoff per Carrier	dB	1	1	1	1	8	8	8
Required Flux Density	dBW/m²	–83	–83	–83	–83	–90	–90	–90
C/N_o Thermal	dB-Hz	104	104	104	104	97	97	97
Noise Bandwidth	MHz	18	18	18	18	18	18	18
C/N Thermal	dB	31.5	31.5	31.5	31.5	24.5	24.5	24.5
Downlink								
Satellite EIRP (at saturation)	dBW	47	43	40	35	48	45	40
Output Backoff	dB	0.1	0.1	0.1	0.1	5	5	5
Satellite EIRP per Carrier	dBW	46.9	42.9	39.9	34.1	43	40	35
Path Loss*	dB	206.1	206.1	206.1	206.1	206.1	206.1	206.1
Earth Station G/T	dB/K	16.4	20.	22.8	27.9	20.	22.8	27.9
C/N_o Thermal	dB-Hz	85.8	85.3	85.2	85.3	85.5	85.3	85.5
Noise Bandwidth	MHz	18	18	18	18	18	18	18
C/N Thermal	dB	13.3	12.8	12.7	12.8	12.9	12.8	12.9
Interference (C/I)								
Adjacent Satellite								
– uplink	dB	36.9	36.9	36.9	36.9	29.9	29.9	29.9
– downlink	dB	21.4	20.9	20.8	21.9	21.0	20.9	22.0
Adjacent channel								
– uplink	dB	37.8	37.8	37.8	37.8	30.8	30.8	30.8
– downlink	dB	38.9	38.9	38.9	38.9	33.9	33.9	33.9
Cross-Polarization								
– uplink	dB	36.2	36.2	36.2	36.2	28.2	28.2	28.2
– downlink	dB	—	—	—	—	—	—	—
Total Interference	dB	21.0	20.5	20.4	21.4	19.3	19.2	20.0
Total Unfaded C/N	dB	12.6	12.1	12.0	12.2	11.8	11.7	11.9

* Included Path Loss is typical of South Eastern Canada which experiences a relatively high level of satellite interference. For Northern Canada, this loss is 0.2 dB higher (6° elevation angle). However, the extra loss is more than off-set by lower level of adjacent satellite interference.

Table 2.5.7 FM Improvement

Video Performance		
Wideband predetection bandwidth	18	MHz
Peak video deviation	6.3	MHz
Noise weighting de-emphasis	13.3	dB
RMS to peak-to-peak conversion factor	6.1	dB
Video baseband	4.2	MHz
Implementation Margin	1.0	dB
Video FM improvement factor	30	dB
Over deviation	32	%

Audio Subcarrier Performance		
Peak deviation of carrier by audio subcarrier	1.0	MHz
Subcarrier frequency	5.14	MHz
Peak subcarrier deviation by audio	60	KHz
Audio baseband	15	KHz
Weighting and de-emphasis	10.6	dB
Implementation margin	2	dB
Improvement factor relative to C/N_v	36	dB
$C/N_{ASC} = 2.3 + C/N_v$ dB		

Radio Program Subcarrier Performance		
Peak deviation of carrier by radio subcarrier	1.05	MHz
Subcarrier frequency	5.41	MHz
Peak subcarrier deviation	60	KHz
Audio baseband	15	KHz
Weighting and de-emphasis	10.6	dB
Implementation margin	2	dB
Improvement factor relative to C/N_v	36	dB
$C/N_{ASC} = 2.3 + C/N_v$ dB		

2.6.0 Coverage Maps

The coverage maps provided in this report (Appendix C, Figures 1-24) demonstrate the extent of TV services that can be offered by the AnikC satellites.

The depicted earth map is the projection of Canada as viewed from the satellite in orbit. This map is essentially the angular view of the antenna and therefore can be directly related to the satellite's receive and transmit patterns.

Each contour labeled by a specific receive antenna diameter forms a region in which the received unfaded C/N is about 12 dB or better depending on the actual received power level. To appreciate fully the picture quality received within the contours, Tables 2.6.1 and 2.6.2 are prepared which list the recommended antenna sizes and the expected C/N at many points within the contours for 99.9% and 99% of the time. Both nominal pointing and 0.25° tilt angle are considered.

It is quite clear that in most cases, a small receive terminal (1.2 m for 1 TV and 1.8 m for 2 TV) is able to provide exceptionally good picture quality at these centres, and that in many cases the design performance (11 dB for 99% of the time) is exceeded by several dB.

This is because the power levels specified in Table 2.5.3 only apply to the locations falling on the contour lines, whereas, a large portion of the desired service areas fall well within the coverage contours and consequently receive higher signal levels.

Table 2.6.1 Expected Receive C/N at Major Cities, One TV per RF Channel

City	Antenna Size m	Half Canada 0.° 99.9%	Half Canada 0.° 99%	Half Canada 0.25° 99.9%	Half Canada 0.25° 99%	Antenna Size m	Quarter Canada 0.° 99.9%	Quarter Canada 0.° 99%	Quarter Canada 0.25° 99.9%	Quarter Canada 0.25° 99%
Vancouver	1.2	13.0	14.1	10.9	12.0	1.2	14.5	15.6	13.0	14.1
Calgary	1.2	14.0	15.1	13.0	14.1	1.2	15.0	16.1	14.6	15.7
Edmonton	1.2	14.0	15.1	14.0	15.1	1.2	14.5	15.6	15.1	16.2
Regina	1.2	12.1	13.6	10.6	12.1	1.2	14.7	16.2	13.5	15.0
Winnipeg	1.2	10.5	12.0	9.1	10.6	1.2	13.6	15.1	12.0	13.5
Toronto	1.2	12.9	14.9	10.7	12.7	1.2	13.9	15.9	12.3	14.3
Montreal	1.2	12.9	14.9	11.7	13.7	1.2	12.7	14.7	11.8	13.8
Ottawa	1.2	13.4	15.4	12.2	14.2	1.2	12.6	14.6	12.6	14.6
Halifax	1.8	10.8	14.5	8.1	11.8	1.2	9.7	13.4	7.4	11.1
St. John's	1.8	11.3	15.0	10.4	14.1	1.2	10.2	13.9	9.1	12.8

Table 2.5.6 Adjacent Satellite Carrier-to-Interference Ratio C/I (dB)

C/I Uplink (dB)		C/I Downlink (dB)		C/I Total (dB)		Receive Antenna Size (M)
1 TV	2 TV	1 TV	2 TV	1 TV	2 TV	
36.9	29.9	21.4	—	21.3	—	1.2
		20.9	21.0	20.8	20.5	1.8
		20.8	20.9	20.7	20.4	2.5
		21.9	22.0	21.8	20.3	4.5

Adjacent Satellite Interference Calculations†

Parameter	Unit	Uplink 1 TV	Uplink 2 TV	Downlink 1 TV 1.2 m	Downlink 1 TV 1.8 m
Desired Signal:					
Transmit EIRP	dBW	80.0	73.0	46.9	42.9
Occupied Bandwidth	MHz	18	18	18	18
Spectral Density, S_d	dBW/MHz	67.4	60.4	34.3	30.3

Parameter	Unit	Uplink C2 116°W	Uplink C3 109°W	Uplink SBS I 106°W	Uplink SPC II 119°W	Uplink GSTAR (1) 100°W	Uplink GSTAR (2) 103°W	Downlink C2				Downlink C3			
Interfering Signal:															
Transmit EIRP	dBW	79.0	74.2	83.3	89.4	89.0	89.0	49.0				46.2			
Occupied Bandwidth	MHz	50	27	43	72	36	36	50				27			
Spectral Density, S_i	dBW/MHz	62.0	59.9	67.0	70.8	73.4	73.4	32.0				31.9			
Sidelobe Isolation:															
Antenna Size*	m	8	8	7	7	5.5	5.5	1.2	1.8	2.5	4.5	1.2	1.8	2.5	4.5
Efficiency*	%	70	70	65	55	55	55	70	70	70	70	70	70	70	70
Boresight Gain	dBi	59.8	59.8	58.4	57.6	55.5	55.5	42.0	45.5	48.4	53.5	42.0	45.5	48.4	53.5
Sidelobe Gain 32-25 log θ D≥ 4.5m 33-25 log θ D< 4.5m	dBi	18.4	18.4	11.7	11.7	4.6	7.6	19.4	19.4	19.4	18.4	19.4	19.4	19.4	18.4
Sidelobe Isolation, G_s	dB	41.4	41.4	46.7	45.9	50.9	47.9	22.6	26.1	29.0	35.1	22.6	26.1	29.0	35.1
$C/I = S_d - S_i + G_s$ (2 TV)	dB	39.8	41.9	40.1	35.5	37.9	34.9	–	24.5	24.4	25.5	25.1	24.6	24.5	25.6
$C/I = S_d - S_i + G_s$ (1 TV)	dB	46.8	48.9	47.1	42.5	44.9	41.9	24.9	24.4	24.3	25.4	25.0	24.5	24.4	25.5

* In the uplink, asterisk refers to the transmit earth station antenna of the interfering satellite system. In the downlink, however, it refers to the receive earth station of the desired satellite system.

† Listed figures are the expected C/I levels corresponding to the associated contours depicted in the anik C coverage maps.

Table 2.5.6 Adjacent Satellite Interference Calculations (cont'd)

Downlink				
1 TV		2 TV		
2.5 m	4.5 m	1.8 m	2.5 m	4.5 m
39.9 18 27.3	34.9 18 22.3	43.0 18 30.4	40.0 18 27.4	35.0 18 22.4

Downlink															
SBS I				SPCC II				GSTAR (1)				GSTAR (2)			
42.0 43 25.7				50.4 72 31.8				44.0 36 28.4				44.0 36 28.4			
1.2 70	1.8 70	2.5 70	4.5 70	1.2 70	1.8 70	2.5 70	4.5 70	1.2 70	1.8 70	2.5 70	4.5 70	1.2 70	1.8 70	2.5 70	4.5 70
42.0 12.7	45.5 12.7	48.4 12.7	53.5 11.7	42.0 12.7	45.5 12.7	48.4 12.7	53.5 11.7	42.0 5.6	45.5 5.6	48.4 5.6	53.5 4.6	42.0 8.6	45.5 8.6	48.4 8.6	53.5 7.6
29.3	32.8	35.7	41.8	29.3	32.8	35.7	41.8	36.4	39.9	42.8	48.9	33.4	36.9	39.8	45.9
38.0	37.5	37.4	38.5	31.9	31.4	31.3	32.4	42.4	41.9	41.8	42.9	39.4	38.9	38.8	39.9
37.9	37.4	37.3	38.4	31.8	31.3	31.2	32.3	42.3	41.8	41.7	42.8	39.3	38.8	38.7	39.8

Table 2.6.2 Expected Receive C/N at Major Cities, Two TV per RF Channel

City	Antenna Size m	Half Canada 0.° 99.9%	Half Canada 0.° 99%	Half Canada 0.25° 99.9%	Half Canada 0.25° 99%	Antenna Size m	Quarter Canada 0.° 99.9%	Quarter Canada 0.° 99%	Quarter Canada 0.25° 99.9%	Quarter Canada 0.25° 99%
Vancouver	1.8	11.5	12.6	9.4	10.5	1.8	13.0	14.1	11.4	12.5
Calgary	1.8	12.5	13.6	11.5	12.6	1.2	10.0	11.1	9.5	10.6
Edmonton	1.8	12.5	13.6	12.5	13.6	1.2	9.5	10.6	10.0	11.1
Regina	1.8	10.6	12.1	9.1	10.6	1.2	9.7	11.2	8.5	10.0
Winnipeg	2.5	11.8	13.3	10.4	11.9	1.8	12.1	13.6	10.5	12.0
Toronto	1.8	11.4	13.4	9.2	11.2	1.8	12.4	14.4	10.8	12.8
Montreal	1.8	11.4	13.4	10.2	12.2	1.8	11.2	13.2	10.3	12.3
Ottawa	1.8	11.9	13.9	10.7	12.7	1.8	11.1	13.1	11.1	13.1
Halifax	3.7 2.5	11.9 8.5	15.5 12.2	9.2 5.8	13.0 9.6	2.5	11.1	14.8	8.8	12.5
St. John's	2.5	9.0	12.7	8.1	11.8	2.5	11.6	15.3	10.5	14.2

Note: The above table is based on an input backoff of 8 dB per carrier (5 dB output backoff). However, it may be possible to operate the satellite TWT at 6 dB level without creating significant intermodulation interference. This would increase the total C/N by approximately 0.5 dB.

2.7.0 Conclusions

Based on the information provided in this technical report, it is concluded that the Anik C satellite with its antenna tilted about 0.25° north can provide very good direct-to-home radio and television services to almost all parts of Canada using antenna diameters of 1.8 - 2.5 m with two TV per RF channel. The required receive antenna size in some areas may have to increase to 3 - 4.5 m depending on the mode of operation, (one TV or two TV signals per RF channel) the geographical location of the service area, and the quality of the receiver.

The quality of the TV signal received in most of Canada would be better than 12dB (S/N = 42dB) for 99% of the year while employing a 1.2 m antenna in the one TV mode and a 1.8 m antenna in two TV mode. The coverage of the extreme north can be achieved by utilizing larger antennas (2.5 m for one TV mode, 4.5 m for two TV mode), and in some isolated locations, a better receiver.

The uplink stations could use a 5 meter antenna and HPA sizes of 1000 watts for uplinking one TV signal per RF channel or 500 watts for two TV signals. A maximum of 32 TV programs can be distributed via four spot beams or the two lower powered larger size combined beams.

Radio program distribution can be achieved either as subcarriers associated with the video signal or as seperate carriers within the same RF channel. High quality radio programming (mono or stereo) can also be provided by utilizing a dedicated RF channel.

Appendix A
To Section 2
Multiple Sound for a DBS System

I. Introduction

This Appendix briefly considers alternative techniques for the provision of multiple audio signals per video program for a DBS system.

While several schemes are available for this purpose, each offering various advantages, the preferred methods must result in inexpensive hardware modifications and/or additions to the basic receive stations. DBS terminals are designed specifically to be low cost and consequently any modifications must be consistent with this design philosophy.

Of the various techniques capable of providing multiple audio signals, only two schemes are felt to be consistent with the above constraint:

1. Multiple audio subcarriers, and
2. Separate SCPC audio carrièrs

These two schemes are discussed below. The relative advantages of the two alternatives are assessed only qualitatively since detailed analysis is beyond the scope of this study.

For completeness, three other schemes for delivering multiple sound with each video signal are also highlighted:

3. Single audio subcarrier with multiplexed baseband;
4. Separate multiplexed audio carrier, and
5. Integrated video and sound signals.

While each of these three methods provide certain advantages, they are more applicable to high quality systems where relatively expensive hardware can be justified. Consequently, these schemes are only briefly discussed.

II. Preferred Techniques

A. Multiple Audio Subcarriers

In this scheme, each audio signal modulates a seperate subcarrier of the main video carrier. The baseband of the video carrier, therefore, consists of the video signal plus 3 - 5 audio subcarriers located at frequencies above the video baseband. The subcarrier frequencies should be chosen as close to the video baseband as possible, to minimize the impact on the video carrier bandwidth and power requirements, but with sufficient separation to minimize degradations due to intermodulation products and adjacent carrier interference.

The preferred modulation technique for the audio subcarriers is FM as it provides acceptable quality using relatively simple and inexpensive hardware. Digital modulation schemes are presently a more costly solution.

At the receive DBS stations, the main video carrier is demodulated to yield the video baseband and the 3 - 5 audio subcarriers. The video signal is filtered and fed to the terminal output. Each of the receive stations then demodulates the audio subcarriers by tuning to the appropriate subcarrier frequency. A simplified block diagram of a DBS station featuring multiple subcarriers is illustrated in Figure 1.

The multiple audio subcarrier technique offers significant advantages in that it is the scheme that best meets the constraint outlined in the Introduction. That is;

The technique is relatively simple, inexpensive, and easily implemented. The only additions to the basic DBS terminals are the audio subcarrier receivers which are quite inexpensive. No other modifications to the receive stations are required. it is also possible to translate the subcarriers to a proper band which can be directly demodulated by standard FM receivers.

However, the multiple audio subcarrier approach results in modifications to the transmitted video carrier and consequently introduces a number of concerns relating to video signal performance, as highlighted below:

1. The additional subcarriers lead to increased deviation of the main video carrier as well as an extended video carrier baseband. This results in overdeviation of the video carrier which may necessitate a reduction in the video deviation.
2. The mixing of the audio subcarriers with the main spectral components of the video signal during filtering and demodulation leads to intermodulation products that fall within the video baseband. To minimize the degradation effects of these intermodulation products, the video carrier IF filter and discriminator must exhibit high linearity characteristics.

In addition, the multiple subcarrier technique requires that all sound programs be transmitted from the same location as their associated video signal, i.e. the sound and video signals cannot be independently uplinked from different stations. The programs can originate at diverse locations, however, and be transmitted to the video uplink earth stations via terrestrial or satellite circuits.

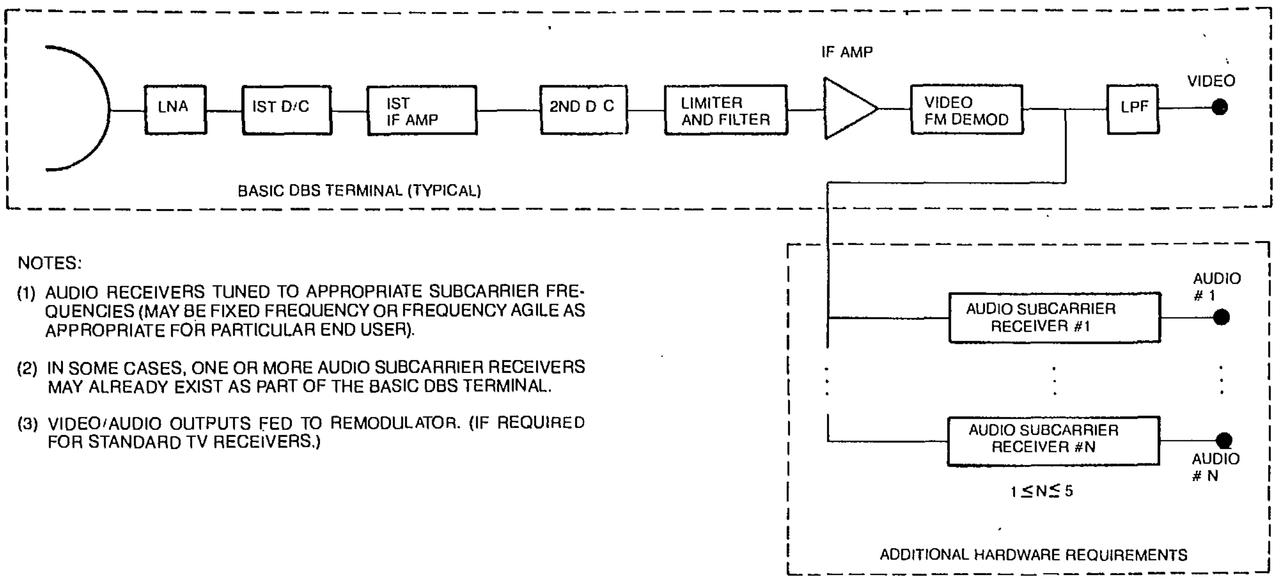


Figure 1 DBS Terminal configuration featuring multiple audio subcarriers

B. Separate SCPC Audio Carriers

This method eliminates the need for audio subcarriers by featuring independent SCPC carriers for each audio program. The 3 - 5 audio carriers could be transmitted in the same RF channel as the associated video carrier, or alternatively, the SCPC audio carriers for all of the video programs could be transmitted in a common RF channel that does not contain a video signal. In the second case, the RF channel could be dedicated entirely to audio SCPC transmissions or could be shared with stereo FM radio carriers, depending on channel capacity considerations.

For this application, FM is preferred to digital modulation techniques, as it provides acceptable quality using relatively simple and inexpensive hardware.

If the audio signals are carried in the same RF channel as their associated video signal, the 3 - 5 SCPC carriers should be assigned frequency slots near the edges of the RF channel to minimize interference from the video carrier. The video carrier bandwidth is automatically reduced due to the audio subcarrier removal, however if this reduction is insufficient then tighter video carrier filtering (i.e. overdeviation) would be required. Audio carrier frequencies should be selected to minimize the impact of intermodulation products falling both within the video baseband as well as on the audio carrier. The satellite TWTA can still operate at or near saturation with each audio carrier transmitted at about 20 dB below the video carrier. Care must be taken to ensure the correct levels of the audio carriers at the output of the satellite TWTA as there will be a small signal gain suppression effect. Additional RF power at the transmit stations is required to offset this phenomenon.

If the audio signals for all the video programs are carried in a common RF channel dedicated to this purpose, the equal level audio carriers are assigned to frequencies within the RF channel bandwidth such that intermodulation noise peaks do not fall on the carriers.

A simplified block diagram of a typical DBS station employing SCPC audio carriers is illustrated in Figure 2.

The SCPC carrier technique offers two advantages over the multiple audio subcarrier method:

1. The main advantage is that there is little or no impact on the video signals. If all the audio carriers are assigned to a common RF channel dedicated to this purpose then the video programs are not affected at all by the audio transmissions.

However, if the audio carriers are assigned to the same RF channel as their associated video program, there is a small reduction in video signal-to-noise and carrier-to-noise ratios (typically 0.5 dB) due to satellite TWTA power sharing. In addition, to ensure adequate spectrum within the RF channels for audio carriers, tighter filtering of the video signal, and consequently some overdeviation, may be required. This would have to be determined by detailed system analysis. There is also the possiblility of intermodulation degradation of the video signal, particularly during uplink video carrier propagation fades (should the video and audio carriers be transmitted from different locations) when audio carrier gain suppression decreases and both the audio carriers and the intermodulation products increase. However, tests carried out on a similar video/audio system have indicated that the video signal is not noticeably impaired even under fairly heavy fading conditions. In fact, the system exhibits less susceptibility to intermodulation degradation than the multiple audio subcarrier scheme.

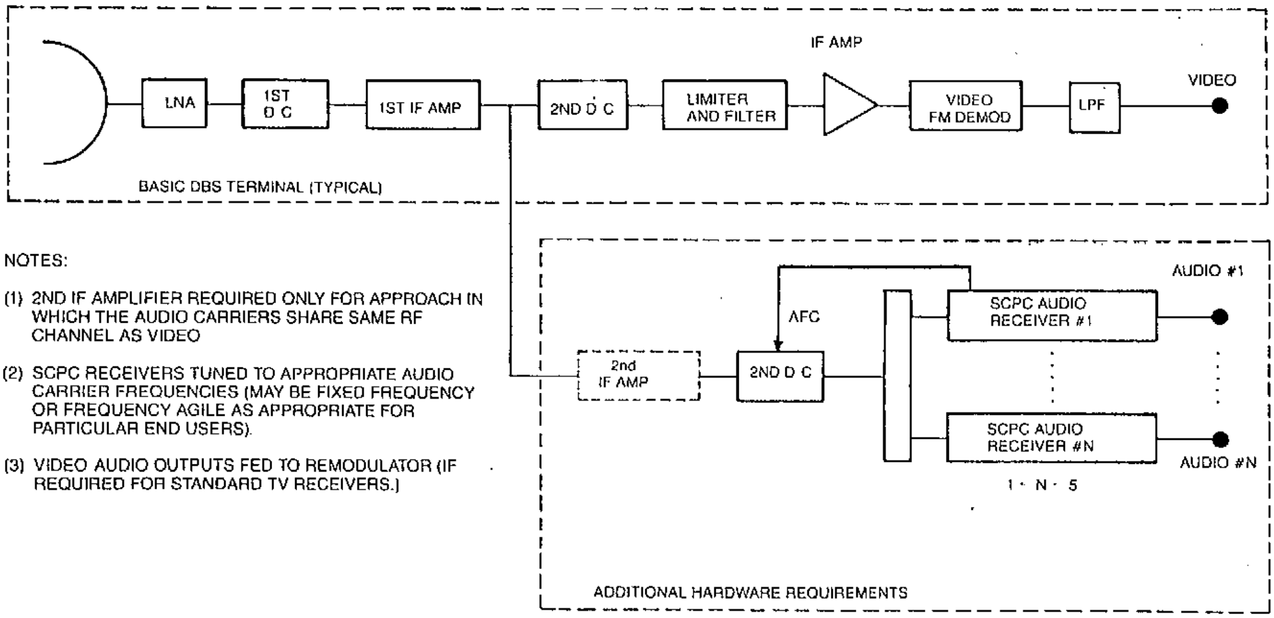


Figure 2 DBS Terminal configuration featuring separate SCPC audio carriers

2. The second advantage of the SCPC approach is its flexibility, in that the audio signals are independent of the video and can, therefore, be transmitted from different originating locations, if desired. As well, failure of the video transmit equipment would not necessarily affect audio service.

However, the SCPC carrier method exhibits the following disadvantages with respect to the multiple audio subcarrier scheme:

1. The SCPC receivers are higher in cost than subcarrier receivers. This is due to the more complex hardware involved, including downconverters, automatic frequency control units and narrowband filters. Further, additional RF hardware is required at the transmit locations to accommodate the SCPC carriers.
2. The phase noise performance of the local oscillator in the outdoor unit of the DBS terminal may limit audio signal quality.
3. For the approach in which the audio carriers access a dedicated audio RF channel, higher space segment utilization is incurred which may limit the capabilities of the DBS satellite to handle additional services.

III. Other Techniques

C. Single Audio Subcarrier with Multiplexed Baseband

In this technique, the 3 - 5 audio programs associated with each video channel are multiplexed into a composite signal which in turn modulates a subcarrier of the main video carrier. The subcarrier is located above the video baseband at a frequency chosen to minimize intermodulation between the audio and video signals. Either frequency division multiplexing (FDM) or time division multiplexing (TDM) of the audio channels may be employed.

Standard FDM techniques would use single sideband modulation to generate a composite baseband consisting of 3 - 5 audio signals shifted in frequency according to a chosen multiplex plan, similar to FDM grouping of voice channels for telephone transmissions.

TDM schemes would involve digital encoding of the individual audio channels and interleaving of the data bits from each of the channels into a composite data stream. Various schemes are possible for performing the signal processing. One system developed in the U.S., known as Digital Audio for Television (DATE), samples 15 kHz audio signals at a 34.4 kHz rate and encodes the samples using 14 bit PCM. Instantaneous companding reduces the requirement to 11 bits per sample to which 2 additional bits are added for error control and companding control. Four encoded audio channels are combined into a single data stream at 1.79 Mbps which modulates the subcarrier using quadrature phase shift keying. Good subjective audio performance is maintained down to a bit error rate of one in 10.[5]

The main advantage of the single audio subcarrier schemes is that they reduce intermodulation interference between the audio and video signals. However, as outlined in Section II, the level of intermodulation impairment introduced by either of the two preferred techniques would likely be acceptable, which minimizes the advantage offered by the signal subcarrier schemes.

This limited advantage is more than offset by the cost of the hardware required for both the FDM and TDM approaches. The present high hardware costs are not consistent with the low cost objective of DBS terminals and, therefore, this technique is not presently considered as a serious option.

Another disadvantage is that video signal performance may be reduced since the relatively wideband subcarrier may lead to video overdeviation and/or signal-to-noise reduction. In addition, the limited availability of standard hardware for this application leads to inflexible implementations.

D. Separate Multiplexed Audio Carrier

This scheme is very similar to method (C) discussed above except that the audio is transmitted as a separate carrier rather than a subcarrier of the video. The FDM or TDM approaches discussed above are used to generate the composite audio signal. This multiplexed audio signal then modulates a carrier that is transmitted either at the edge of the RF channel containing the associated video program or else in a seperate RF channel with other multiplexed audio carriers.

For the approach in which all the audio carriers are transmitted in a dedicated RF channel separate from the video, this technique offers an advantage over the multiplexed subcarrier scheme in that the video signal performance is unaffected. This is achieved at the cost of higher space segment utilization.

However, as for the multiplexed subcarrier method, this technique cannot be considered as a viable option for DBS application due to the present high cost of the multiplexing and transmission hardware. As well, the limited availability of standard hardware for this application results in inflexible implementations.

E. Integrated Sound and Video Signals

In this technique, the sound programs are digitally encoded and inserted into the non-information portions of the analog video signal. Modifications to the video signal format at the transmit location to accommodate the audio programs are corrected at the receive locations by the appropriate hardware prior to passing the signal to the TV receivers. As well, the receive hardware recovers the audio signals and reconverts them into analog format.

Two of the systems proposed for integrating sound and video signals include:

Method 1 — TV-PCM6

This system, developed by Standard Electric Lorenz in the Federal Republic of Germany, inserts two 15 KHz PCM encoded sound signals into the modified horizontal blanking interval of the video signal. The two input analog audio signals are each sampled at twice the video signal line frequency using 10 bit per sample instantaneously companded PCM. In each line, 40 sound bits (2 samples of each audio program) plus 3 control bits are inserted on the back porch of the modified horizontal blanking interval at a bit rate of 8.86 Mbps. To accommodate the sound bits, the colour burst and synch pulse are both reduced.

The audio quality, consistent with CCIR standared (REC. 505, 1974), provides an unweighted signal-to-noise ratio of 60 dB. The system can operate down to a bit error rate of about one in 10^6 before noticeable distortion becomes prevalent. The TV-PCM6 system operates with 625-line PAL, but can be easily adapted to NTSC system with 525 lines.

The 625/PAL version of TV-PCM6 has been successfully tested via the Intelsat and Symphonie satellites.

Method 2

This experimental system, also developed in Germany, replaces the complete horizontal blanking interval of each line of the video signal by an 88 bit PCM data stream which contains the encoded samples of four 15 kHz sound channels plus information about colour subcarrier frequency and line synchronization.

Several other schemes have also been proposed for integrating sound and video signals (see CCIR, Rep. 488-2, 1978). The advantages of these integrated techniques is that they do not affect the bandwidth or power requirements of the video carriers, and hence video signal transmission performance is unaffected. As well, since a single carrier contains the video and audio information, no intermodulation products are generated in the nonlinear satellite RF channel.

However, the integrated sound and video schemes suffer from two main disadvantages. The first disadvantage is that the hardware is inflexible and, in some cases, only experimental. Only methods for integrating two or four audio channels have been proposed which may not be consistent with system requirements.

The main disadvantage, however, is the high cost of the signal processing hardware which cannot be justified for DBS applications where low cost implementations are imperative.

Appendix B
To Section 2
Stereo FM Radio for a DBS System

I. Introduction

By dedicating an RF channel to stereo FM radio transmission, a DBS Satellite would provide users with the choice of a number of stereo FM programs to complement their video reception. Appropriate hardware at the DBS terminals would permit the FM signals to be fed directly into commercial VHF stereo FM receivers.

This report briefly outlines alternate methods of carrying multiple stereo FM radio programs in a dedicated DBS RF channel. Preliminary assessment of the potential RF channel capacity is also provided.

Several alternatives are conceivable for this application. Three of the more attractive schemes are briefly discussed here. All three feature a number of separate carriers accessing the common RF channel using frequency division multiple access (FDMA) techniques. As in all FDMA systems, care must be taken in the design to account for intermodulation degradation due to the mixing of the multiple carriers while passing through the non-linear satellite TWTA. Operation at TWTA saturation can only be considered if intermodulation-free carrier slots can be assigned, e.g. a Babcock's plan. Should the available RF bandwidth be insufficient to accommodate inter-modulation-free operation, the satellite TWTA would have to be backed-off to the quasi-linear region. Detailed trade-off studies would be required to accurately determine the optimum TWTA operating point that best accommodates downlink power versus intermodulation impairments.

The three alternatives are classified according to the baseband signal that modulates the separate FDMA carriers, as follows:

Method #1

Each carrier is modulated by one complete stereo radio program with the stereo baseband signal arranged according to the standard pilot-tone configuration.

Method #2

Each carrier is modulated by a single channel of a stereo program (i.e. L or R). In this case, two carriers are required to provide the complete stereo information.

Method #3

Each carrier is modulated by more than one stereo program. This scheme is most applicable to digital transmission techniques.

In all cases, the receive DBS stations are each equipped with a frequency agile receiver which may be tuned to demodulate any of the FDMA carriers. For Method #2, two receivers are required to receive a complete stereo program. For Method #3, a single receiver provides more than one stereo program. Following demodulation, the received signals are fed to a remodulator which first regenerates the standard stereo pilot-tone baseband configuration (not required for method #1) and then modulates an FM carrier in the VHF FM broadcast bands using commercial broadcast frequency deviations (i.e $\pm$ 75 KHz).

For community DBS stations that may require more than one stereo program at the same time, a separate set of demodulator(s) and remodulator is required for each stereo program.

A simplified block diagram of a typical DBS station featuring stereo FM radio reception is illustrated in Fig. 1.

II. Method #1

In this scheme, the stereo radio programs each FM modulate a separate FDMA carrier. The standard pilot-tone for commercial FM stereo broadcasting is maintained with the exception that increased frequency deviation is featured over the satellite link in order to achieve a high quality signal. The increased frequency deviation results in greater FM improvement than standard broadcast systems. This offsets the lower carrier to noise density ratio available over the satellite link, thus maintaining a high signal to noise ratio.

In order to maximize FM improvement, the frequency deviation for the satellite transmissions is chosen as high as possible while still maintaining adequate margin above FM threshold. The objective assumed in the preliminary analysis was a carrier to noise ratio of 12 dB for 99% of the worst month, which is the same as the video objective. Although audio signals are more sensitive to FM threshold degradations than video signals, it is expected that the audio demodulators will feature superior threshold performance than the video demodulators, thereby permitting a common carrier to noise specification. This objective should be reviewed once the actual threshold characteristics of the audio receivers are determined.

Based on the signal parameters listed in Table 1, preliminary analysis has shown that between 5 and 10 stereo radio programs could be carried in a single RF channel. The actual number could be determined by more detailed analysis of intermodulation signal impairments. The detailed analysis would also determine the optimum satellite TWTA operating point, which would likely be in the range of 3-8 dB input backoff from saturation.

The maximum number of wideband (1.5 MHz) FDMA carrier slots available in a 27 MHz bandwidth channel is 16.

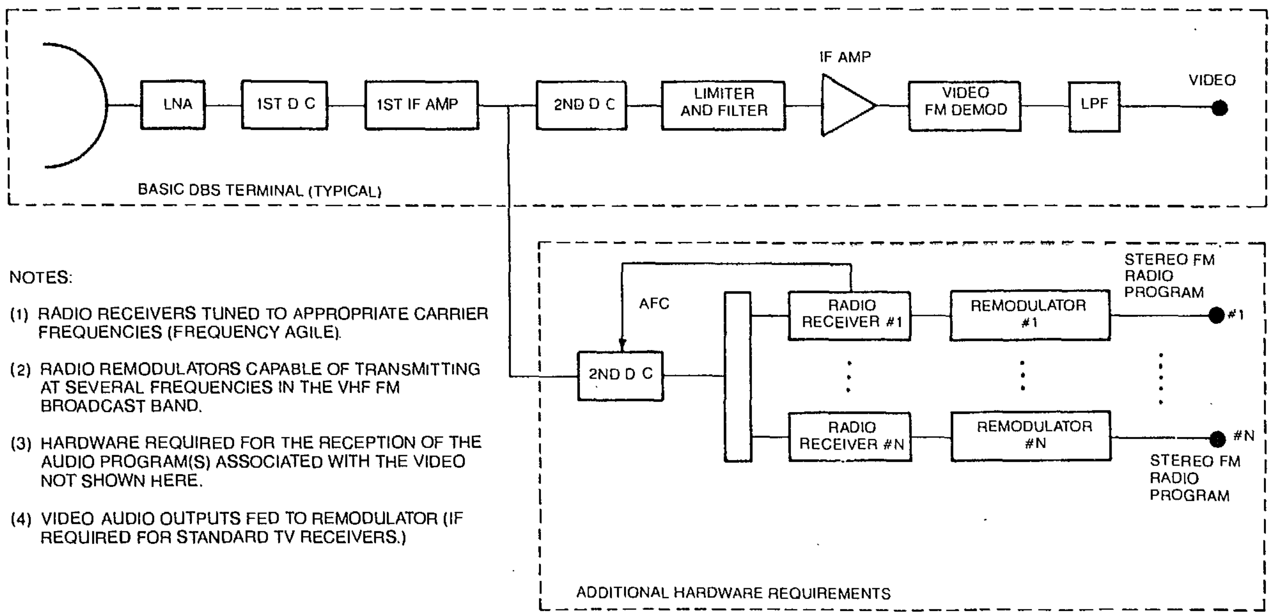


Figure 1 DBS Terminal configuration featuring stereo FM radio reception.

Note that if the signal-to-noise performance objective is reduced, more stereo programs could be carried in the RF channel. For example, if the S/N is relaxed to 55 dB (uweighted) the system parameters change as follows;

Peak deviation	± 585 KHz
Carrier noise bandwidth	1.2 MHz
Max. no. of FDMA carrier slots available	20

and the RF channel capacity increases by about 25%.

Table 1 Stereo FM Radio Program Parameters (Method #1)

Performance Objectives	
S/N	58 dB (unweighted)
C/N	12 dB, for 99% availability
Signal Parameters	
Peak deviation (total)	± 740 KHz
Carrier noise bandwidth	1.5 MHz
Pilot-tone Baseband Configuration	
L + R signal	0.04-15 KHz
L − R signal	23-53 KHz, DSBSC modulated
Pilot	19 KHz

III. Method #2

This scheme involves modulating the FDMA carriers with only one channel (L or R) of a stereo radio program. Consequently a pair of carriers is required to transmit a complete stereo program.

Some of the advantages of such a system are that:

(1) The baseband extends only to 15 KHz, rather than 53 KHz as in the pilot-tone configuration, resulting in superior noise performance when using FM modulation.

(2) The commercial FM radio de-emphasis network is matched with the noise spectral density at the FM demodulator output, resulting in a high de-emphasis improvement. For the pilot-tone arrangement, the de-emphasis network is not ideally matched with the noise spectrum accompanying the L-R signal, which is the stereo component that ultimately defines S/N performance.

(3) Since no pilot is transmitted, the full frequency deviation is available to the radio program signal. In the pilot-tone system 10% of the deviation must be assigned to the pilot.

(4) Excellent stereo channel separation is achieved since the two stereo channels are transmitted via separate carriers.

These advantages result in a significantly greater FM improvement than that available with Method #1. Consequently, the optimum frequency deviation is reduced as follows:

Peak deviation	± 175 KHz
Carrier noise bandwidth	0.4 MHz
Max. No. of FDMA carrier slots available	60

In addition, the corresponding satellite power required is reduced by about 6 dB with respect to Method #1, resulting in approximately four times as many carriers per RF channel or twice as many stereo programs (two carriers per stereo program).

However, there is a cost impact at the DBS stations in that two receivers are required for each stereo radio program. As well, the remodulator must carry out the additional function of regenerating the pilot-tone baseband, as required for commercial stereo FM broadcasts.

IV. Method #3

This method features a multiplexed baseband arrangement in which more than one stereo radio program modulates a single FDMA carrier. It is unlikely that such a scheme would be used for analog systems, however it is well suited to digital sound transmission schemes.

One example is the DATE sound system which was described previously (1). With the DATE coder, two separate stereo programs are digitally encoded and multiplexed into a common bit stream at 1.79 Mbps which then modulates an FDMA carrier using quadrature phase shift keying. With the use of forward error correction (FEC) coding techniques it is expected that between 5 and 10 FDMA carriers, i.e. 10-20 stereo programs, could be accommodated within a single RF channel. More detailed analysis would be required of inter-modulation degradation and optimum FEC coding schemes before the final capacity could be determined. Other digital coding and modulation schemes are also conceivable for this application.

Although this method offers improved RF channel capacity with respect to Method #1, the DBS terminal hardware is likely to be considerably more expensive. The cost of the digital processing hardware is presently quite high, although it may be possible to significantly decrease this cost should an anticipated large market justify the use of LSI technology in the design and manufacturing of the digital equipment.

V. Conclusions

Method #1, in which each FDMA carrier is modulated by one complete stereo program featuring the standard pilot-tone system baseband arrangement, is the preferred technique for stereo FM program transmissions, primarily since it results in the lowest cost modifications to the standard DBS receive stations. The corresponding RF channel capacity is expected to be in the range of 5-10 stereo programs, each providing an unweighted signal-to-noise ratio at the VHF remodulator of 58 dB. Higher capacity is possible with a reduction in signal performance, as outlined earlier.

(1) See Appendix A,
"Multiple Sound for a DBS System"

Method #2 and #3 both provide higher RF channel capacity than Method #1, however both also result in more expensive hardware costs at the DBS terminals. It is expected that the RF channel capacity attainable with Method #1 would be acceptable for a stereo FM radio service. However, should higher capacity be required, then either Method #2 or method #3 should be considered. The choice between these two methods would then likely be based on hardware costs. With presently available hardware, Method #2 would be less expensive, however digital LSI technology may lead to low cost digital processing hardware in the near future, which would significantly lower the costs associated with Method #3.

Appendix C
To Section 2
Coverage Maps
of Anik C

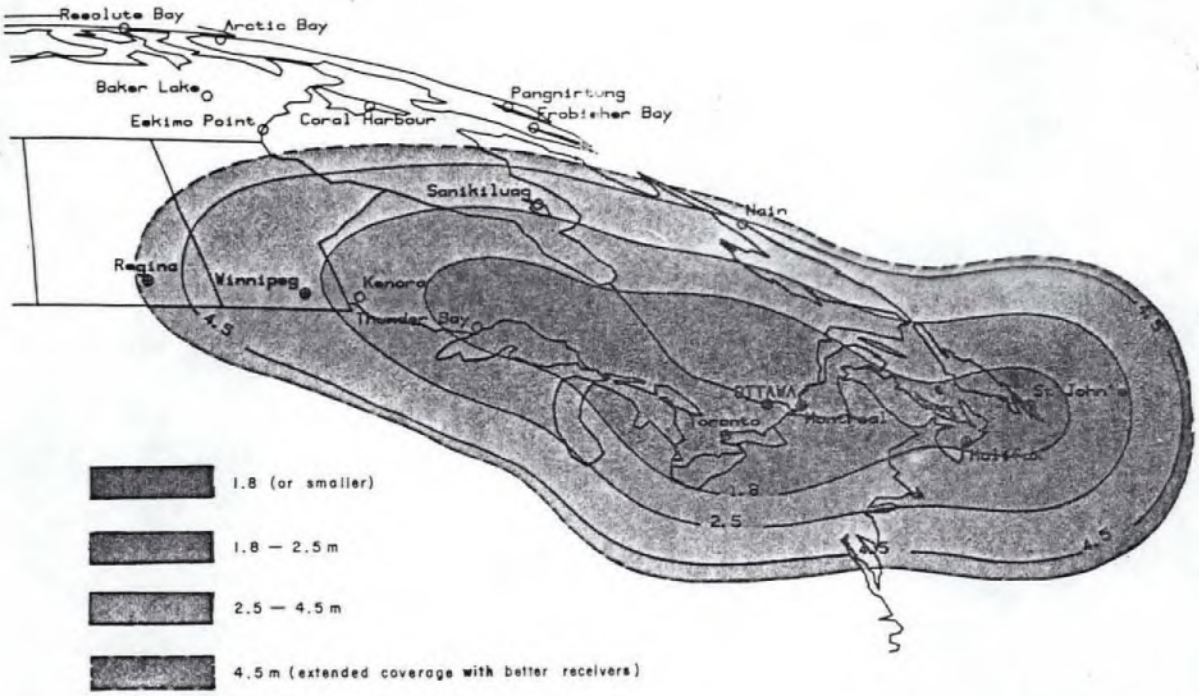


FIGURE I ANIK C COVERAGE – EAST HALF CANADA BEAM – 0° TILT

2 TV PER RF CHANNEL

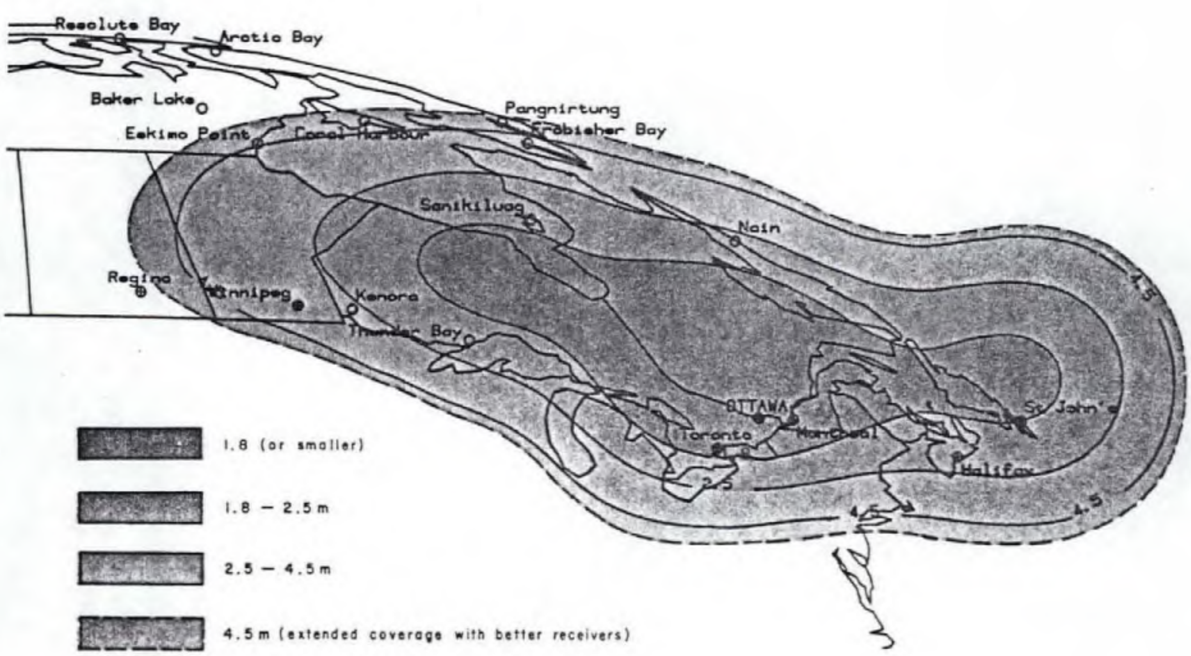


FIGURE 2 ANIK C COVERAGE – EAST HALF CANADA BEAM – 0.25° TILT

2 TV PER RF CHANNEL

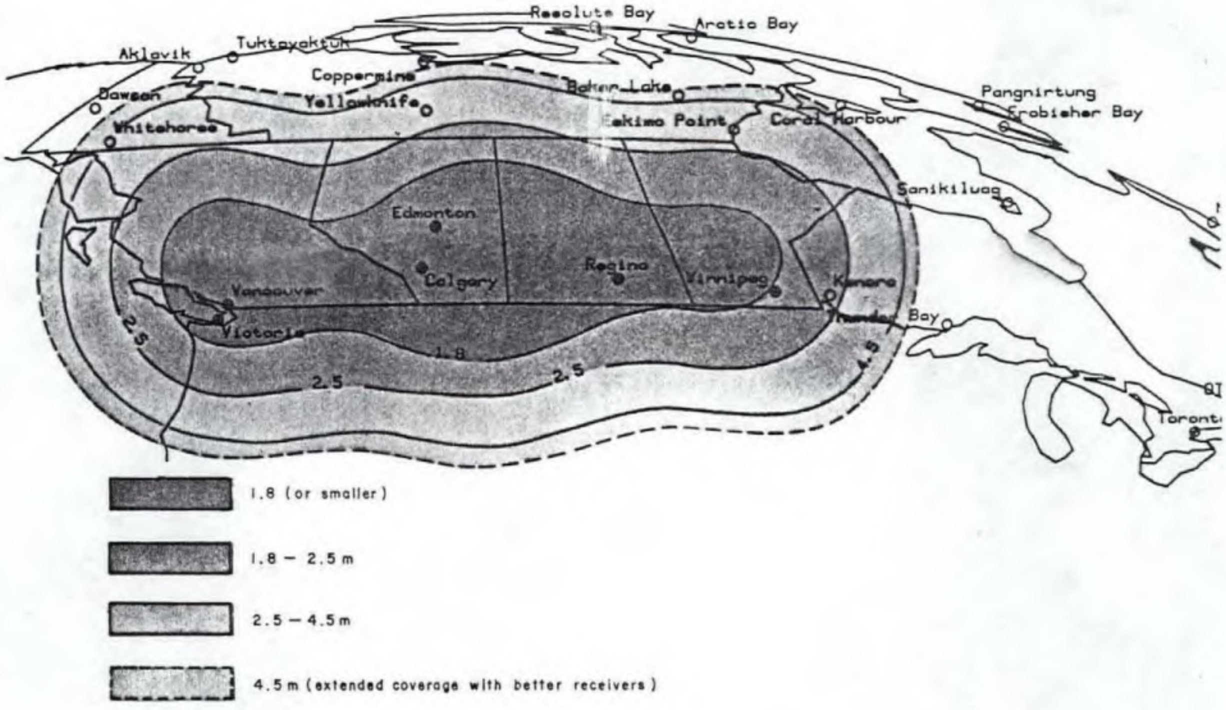


FIGURE 3 ANIK C COVERAGE – WEST HALF CANADA BEAM – 0° TILT
2 TV PER RF CHANNEL

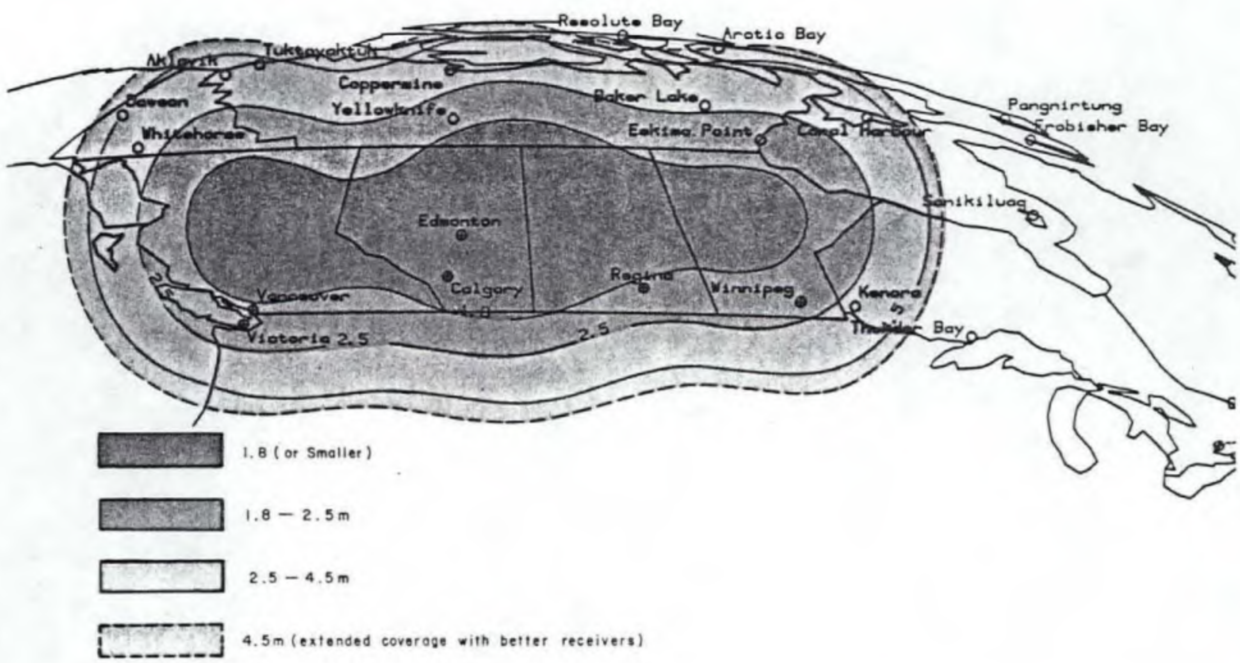
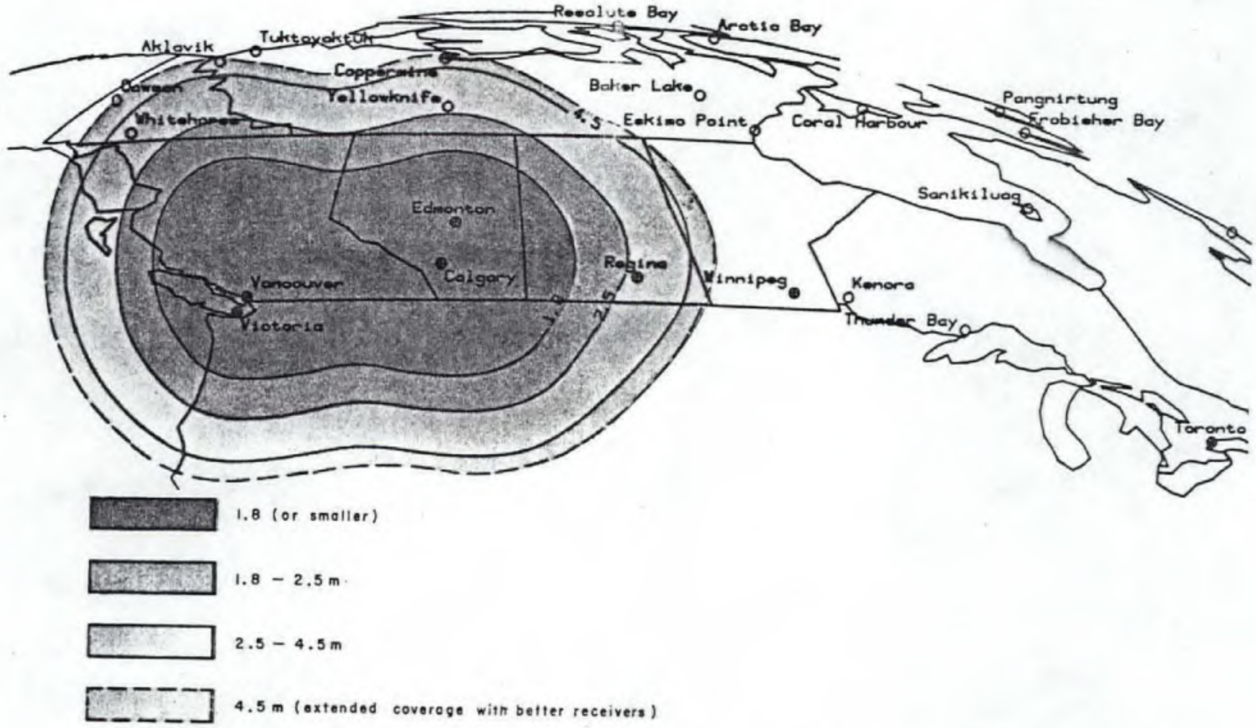


FIGURE 4 ANIK C COVERAGE – WEST HALF CANADA BEAM – 0.25° TILT
2 TV PER RF CHANNEL



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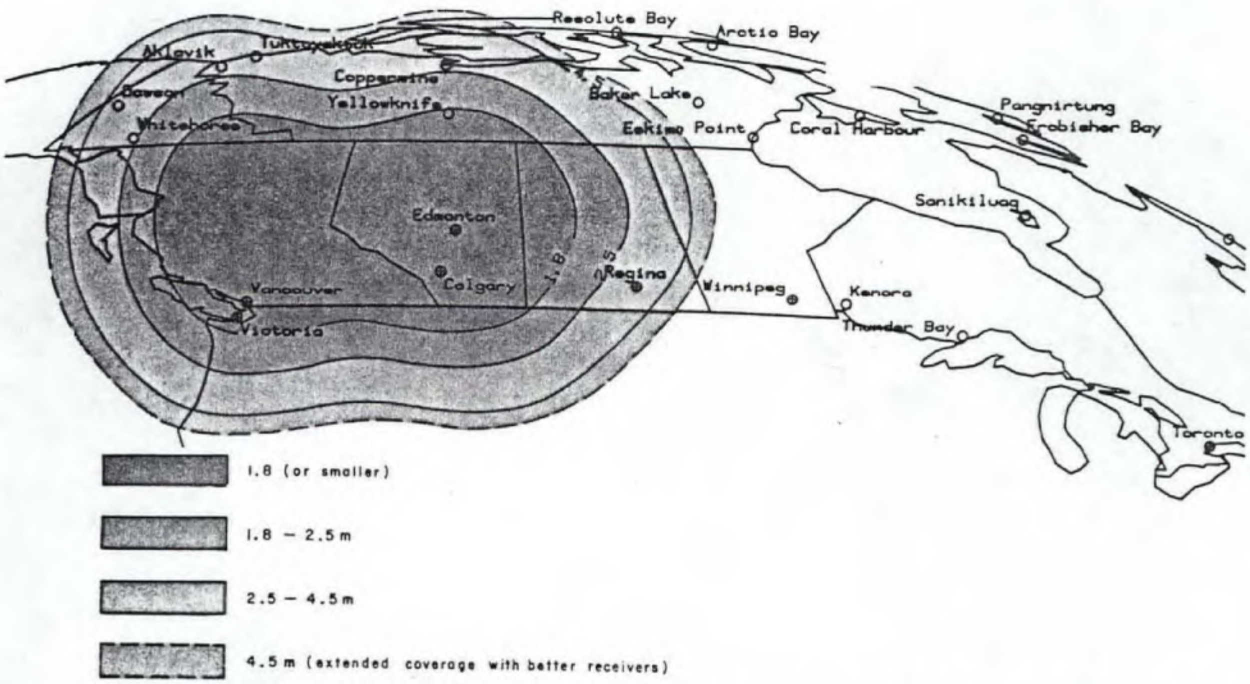

FIGURE 6 ANIK C COVERAGE – WEST QUARTER CANADA BEAM – 0.25° TILT 2 TV PER RF CHANNEL

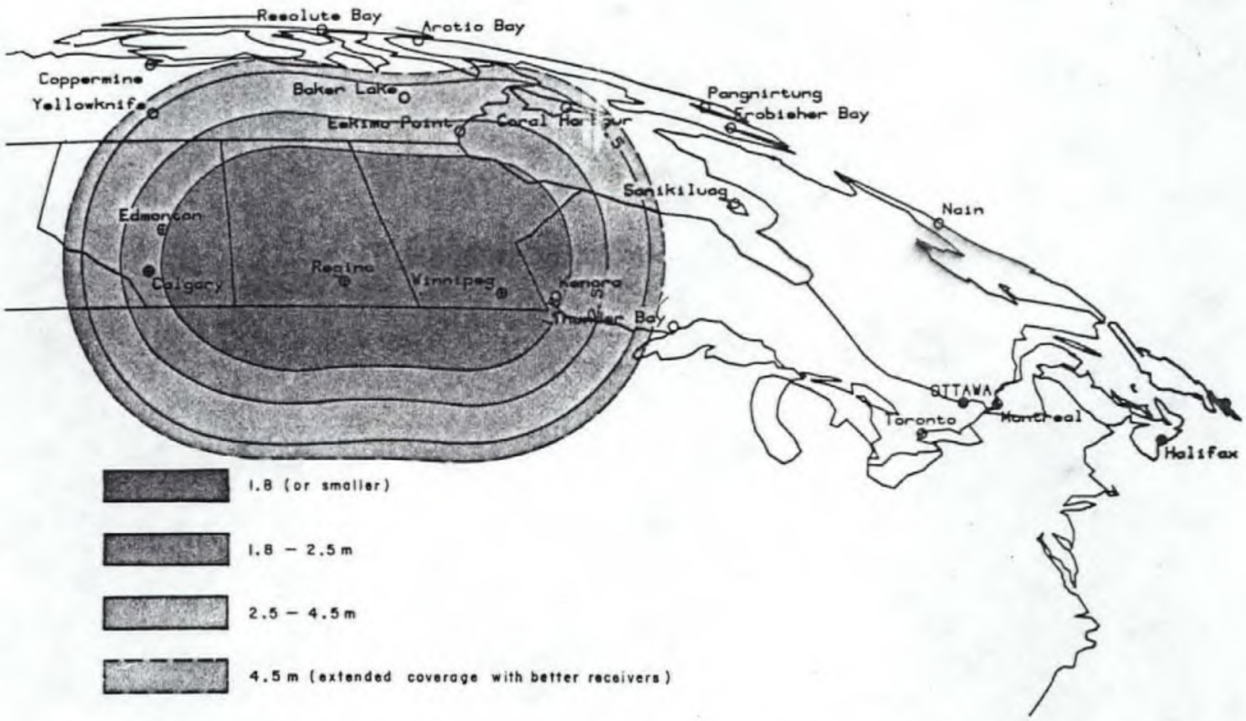

FIGURE 7 ANIK C COVERAGE – WEST CENTER QUARTER CANADA BEAM–0° TILT 2 TV PER RF CHANNEL

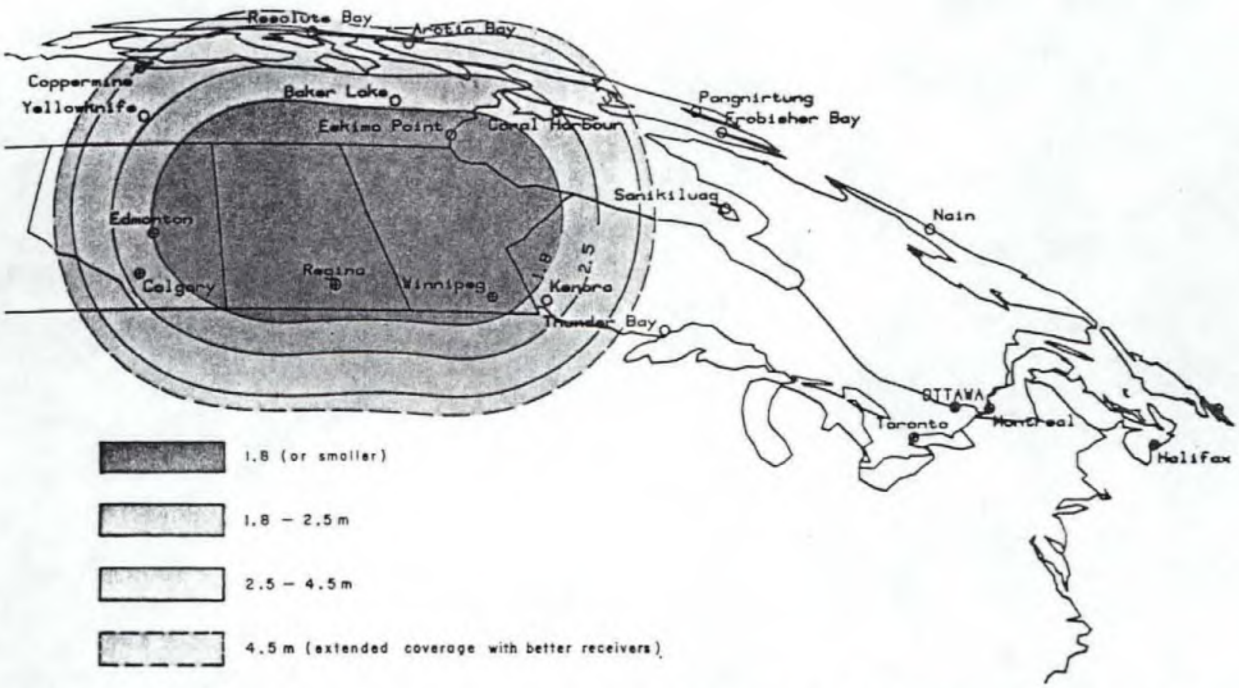

FIGURE 8 ANIK C COVERAGE – WEST CENTER QUARTER CANADA BEAM–0.25° TILT 2 TV PER RF CHANNEL

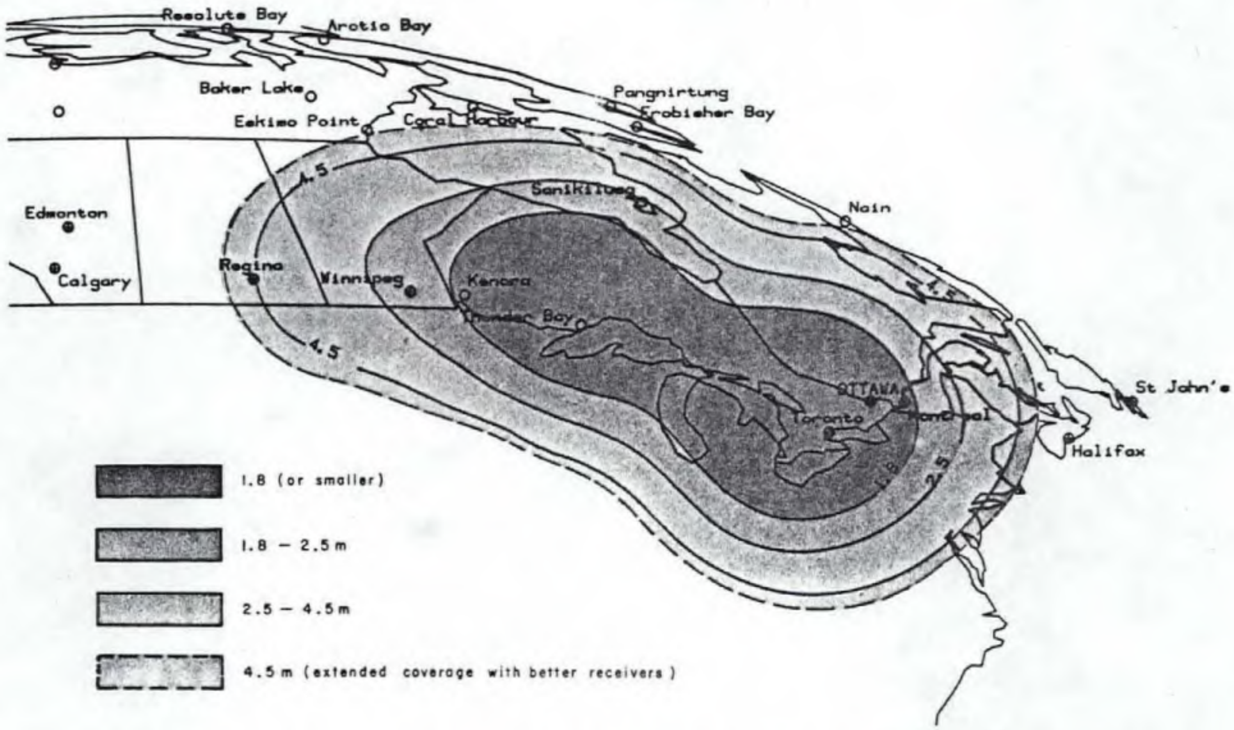

FIGURE 9 ANIK C COVERAGE – EAST CENTER QUARTER CANADA BEAM – 0° TILT
2 TV PER RF CHANNEL

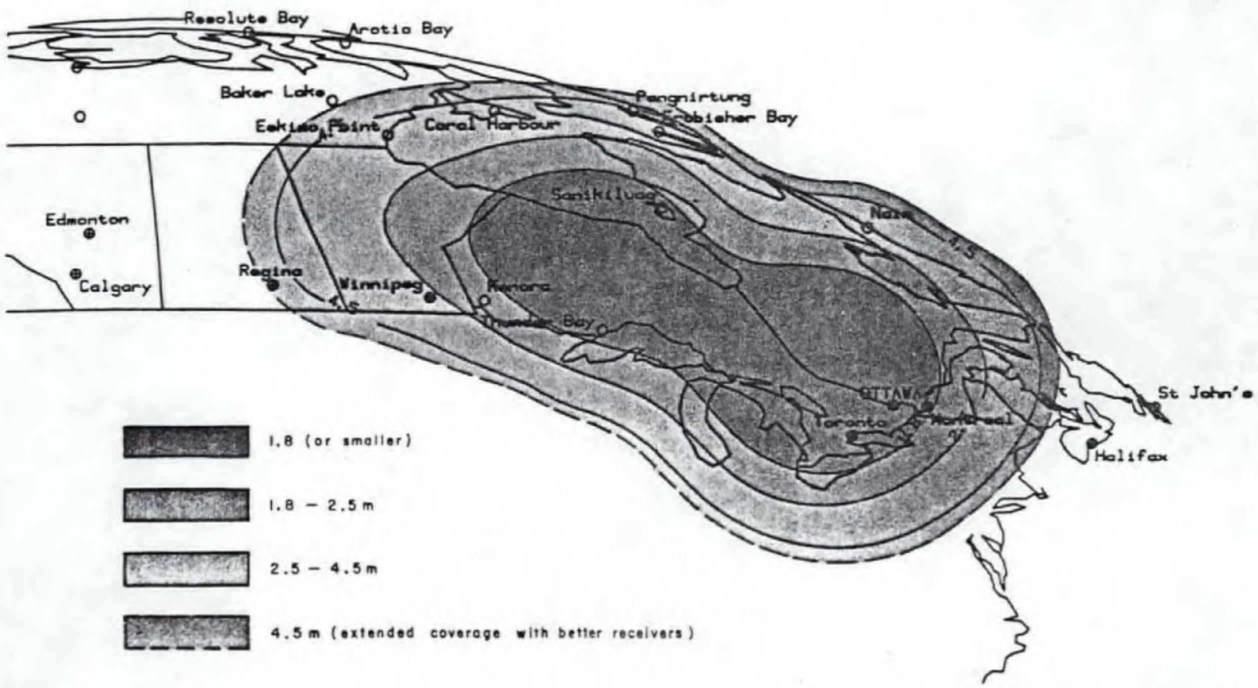

FIGURE 10 ANIK C COVERAGE – EAST CENTER QUARTER CANADA BEAM – 0.25° TILT
2 TV PER RF CHANNEL

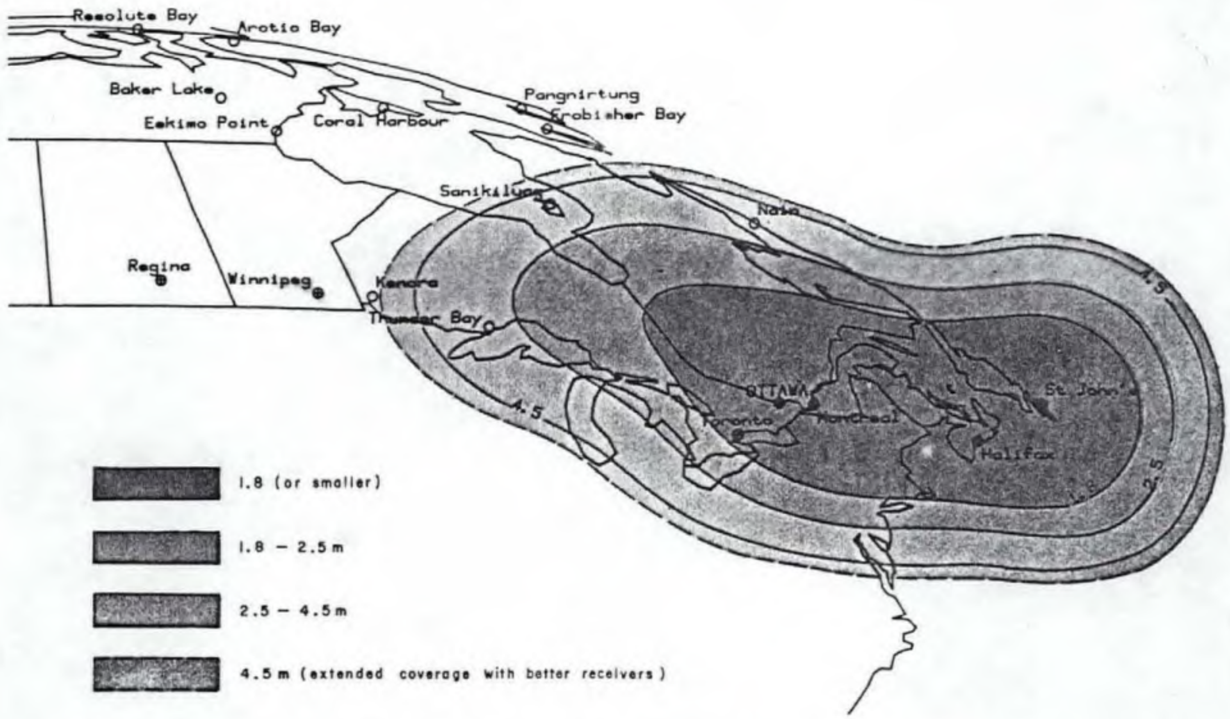

FIGURE 11 ANIK C COVERAGE — EAST QUARTER CANADA BEAM — 0° TILT
2 TV PER RF CHANNEL

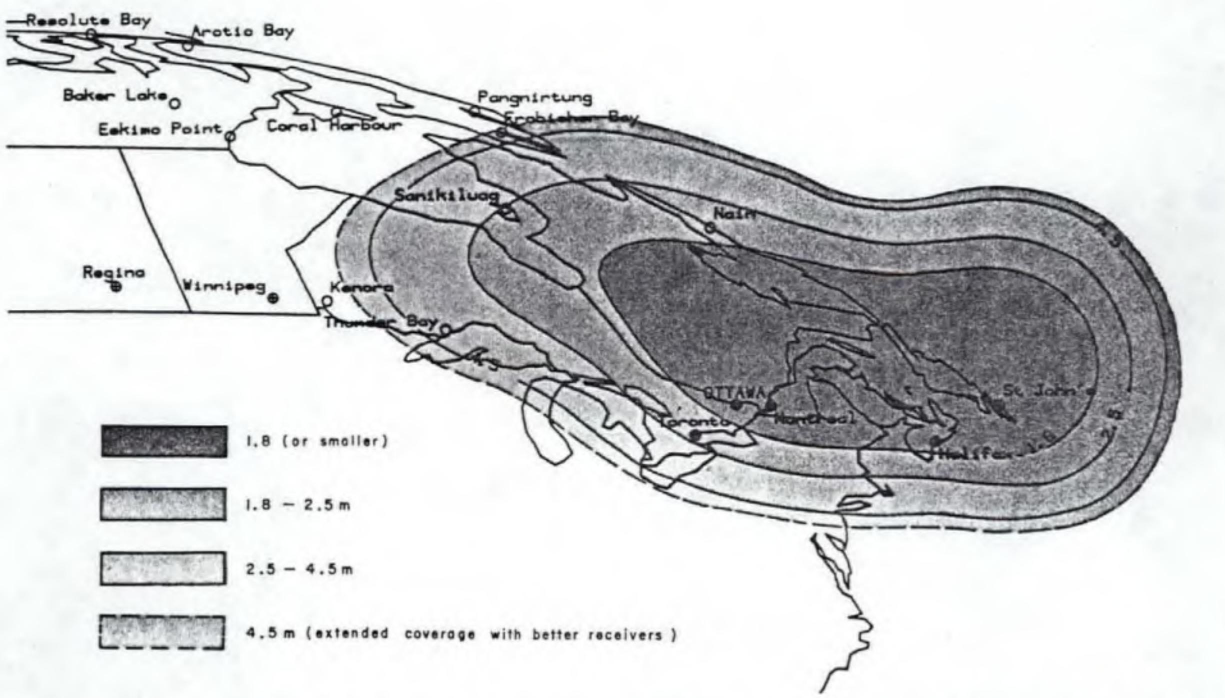

FIGURE 12 ANIK C COVERAGE — EAST QUARTER CANADA BEAM — 0.25° TILT
2 TV PER RF CHANNEL

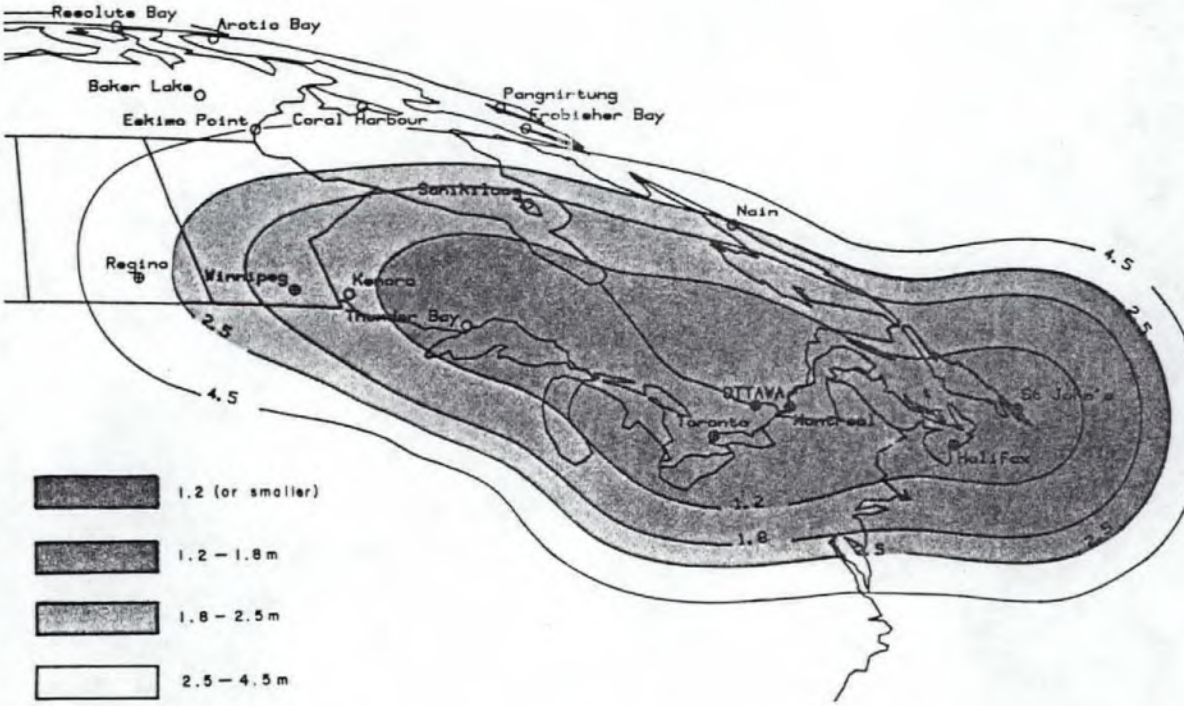

FIGURE 13 ANIK C COVERAGE – EAST HALF CANADA BEAM – 0° TILT
1 TV PER RF CHANNEL

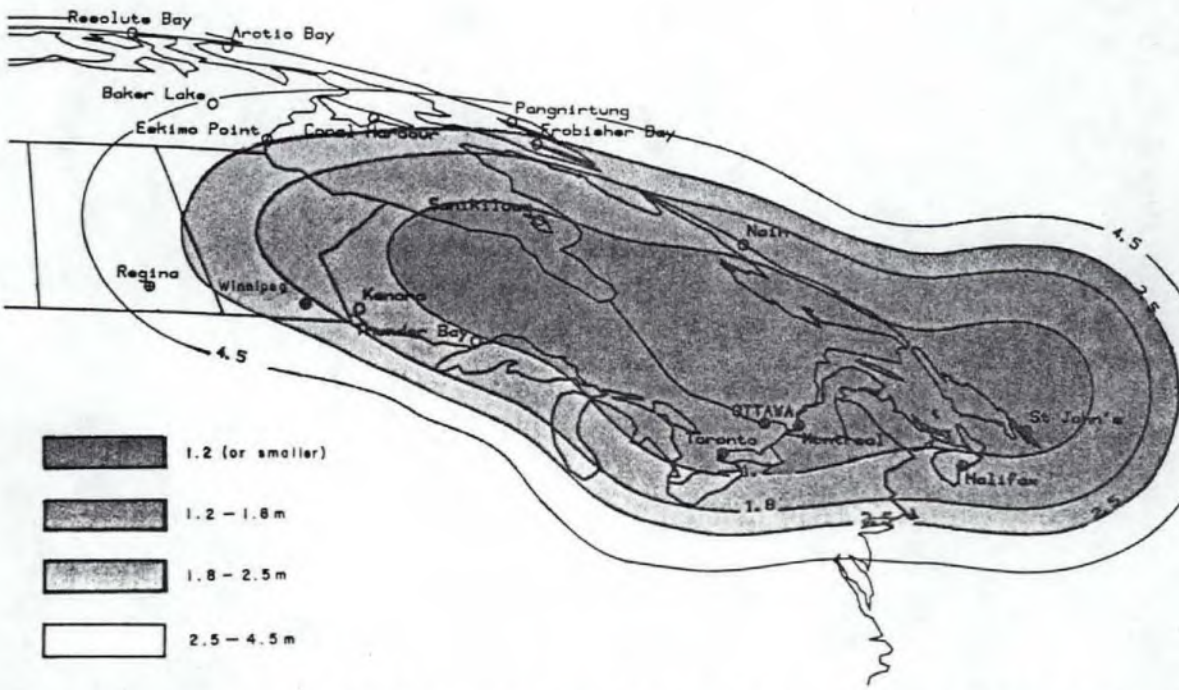

FIGURE 14 ANIK C COVERAGE – EAST HALF CANADA BEAM – 0.25° TILT
1 TV PER RF CHANNEL

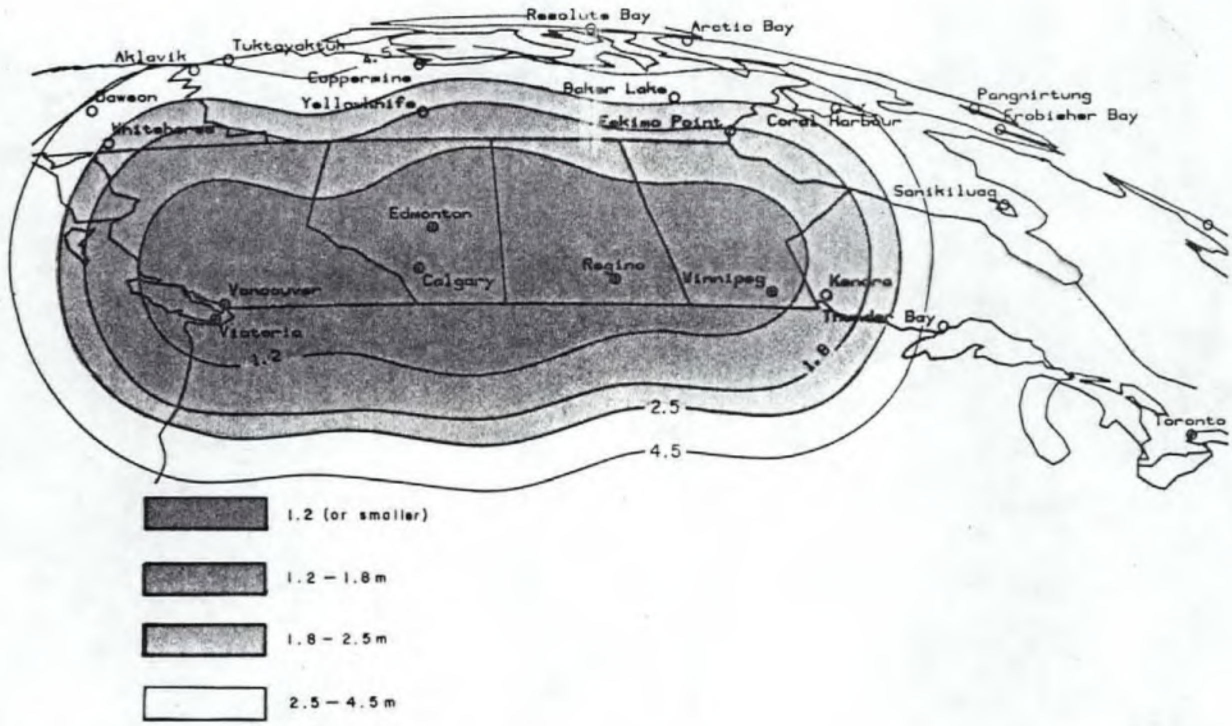

FIGURE 15 ANIK C COVERAGE – WEST HALF CANADA BEAM – 0° TILT
1 TV PER RF CHANNEL

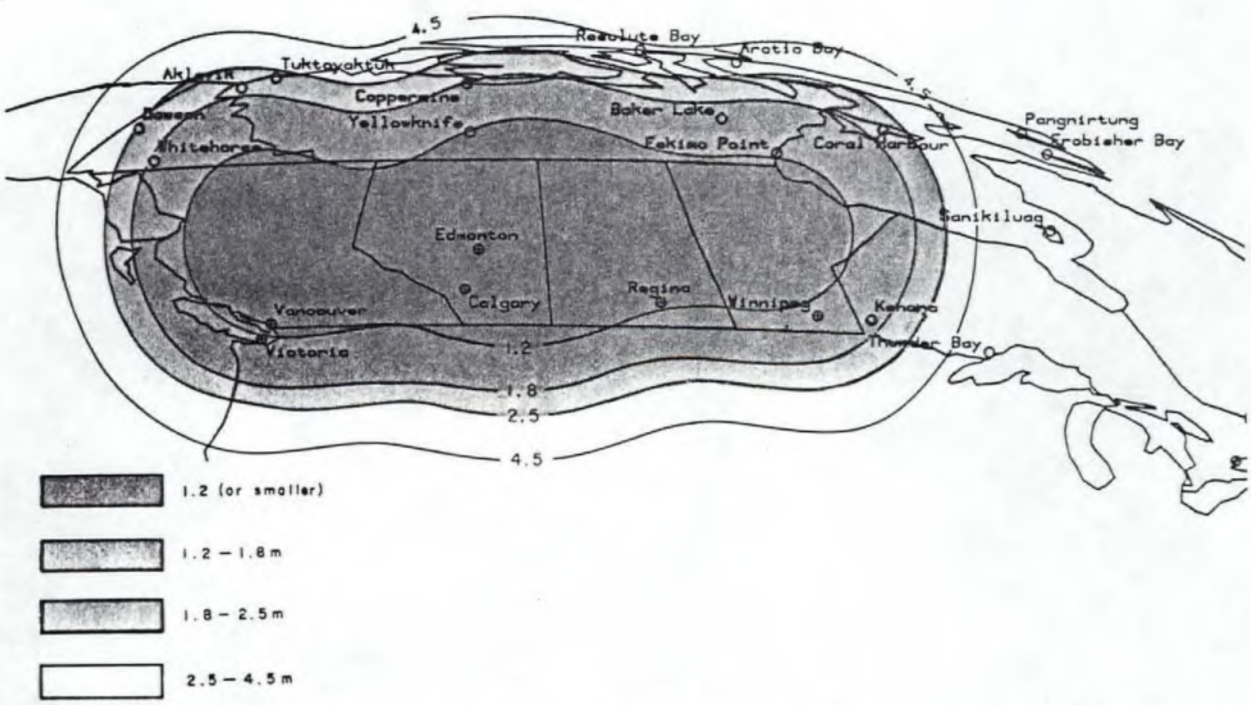

FIGURE 16 ANIK C COVERAGE – WEST HALF CANADA BEAM – 0.25° TILT
1 TV PER RF CHANNEL

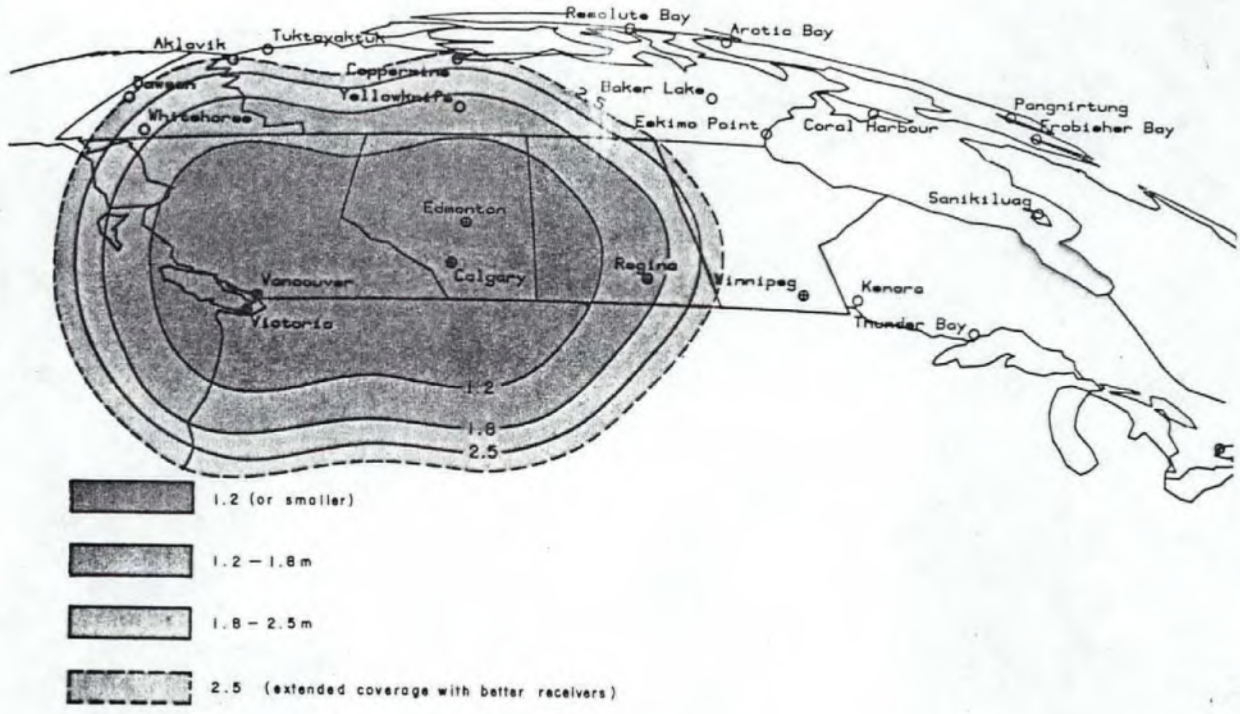

FIGURE 17 ANIK C COVERAGE — WEST QUARTER CANADA BEAM — 0° TILT

I TV PER RF CHANNEL

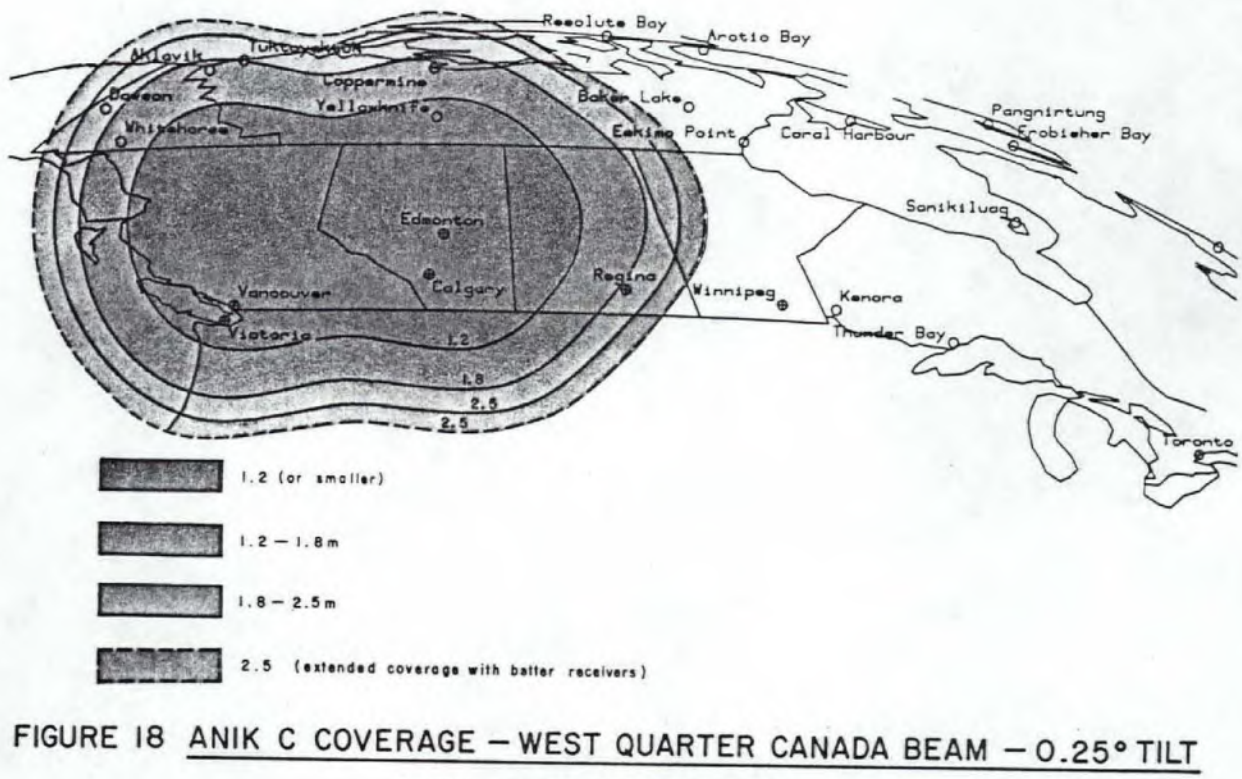

FIGURE 18 ANIK C COVERAGE — WEST QUARTER CANADA BEAM — 0.25° TILT

I TV PER RF CHANNEL

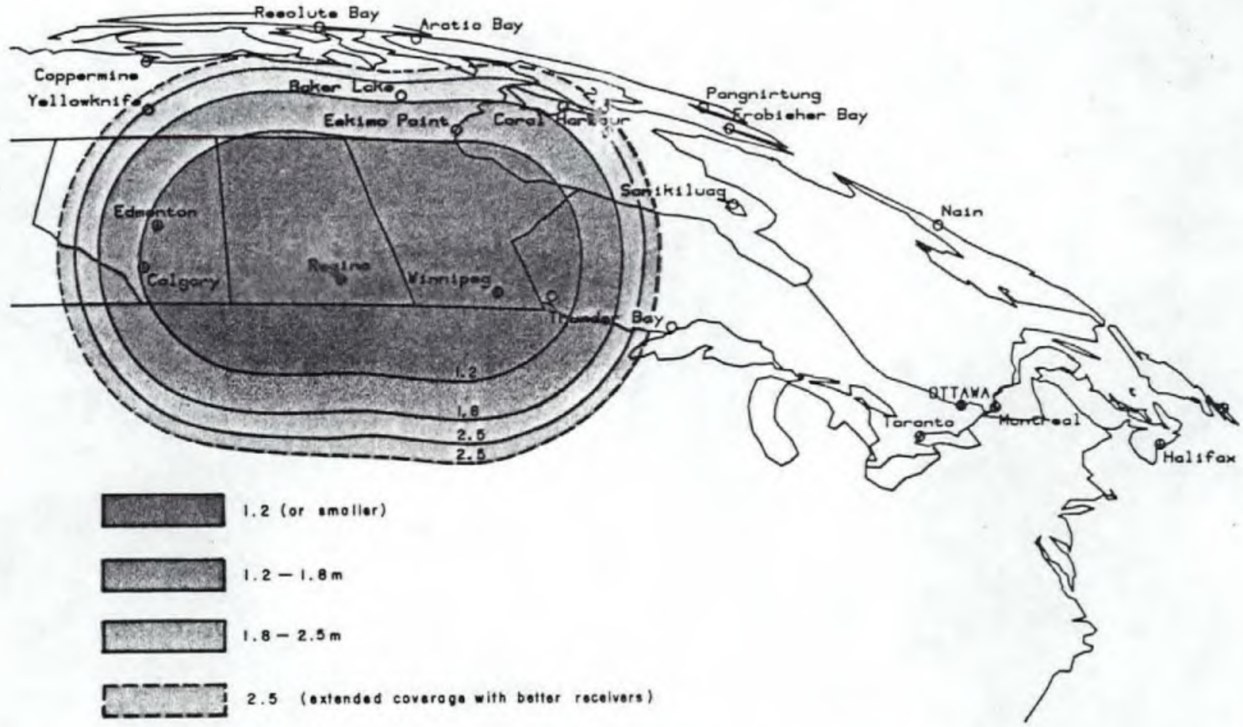

FIGURE 19 ANIK C COVERAGE — WEST CENTER QUARTER CANADA BEAM — 0° TILT
1 TV PER RF CHANNEL

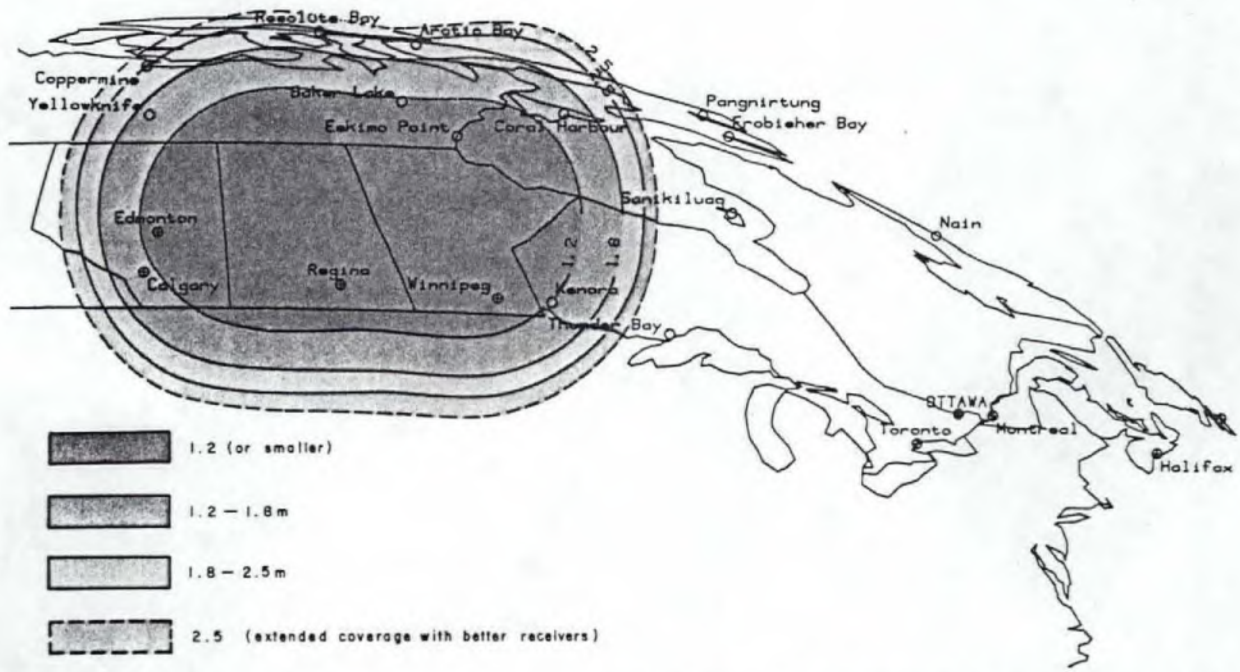

FIGURE 20 ANIK C COVERAGE — WEST CENTER QUARTER CANADA BEAM — 0.25° TILT
1 TV PER RF CHANNEL

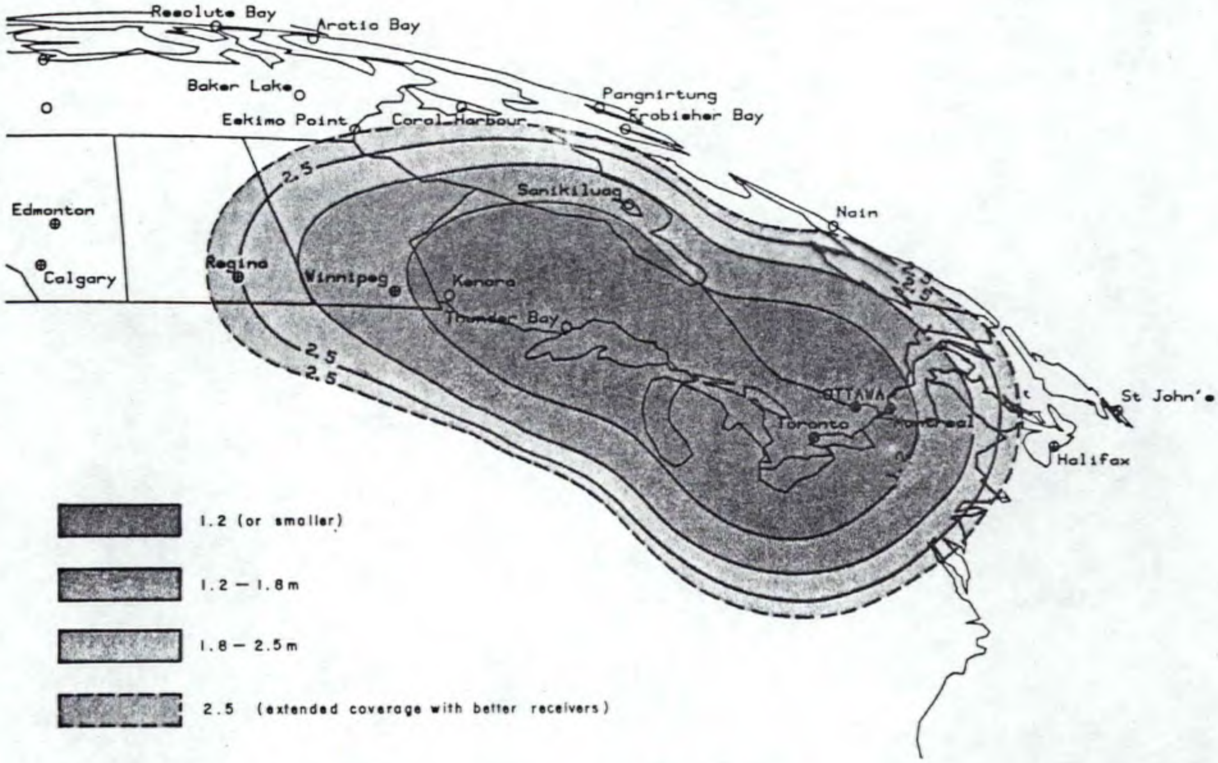

FIGURE 21 ANIK C COVERAGE — EAST CENTER QUARTER CANADA BEAM — 0° TILT

I TV PER RF CHANNEL

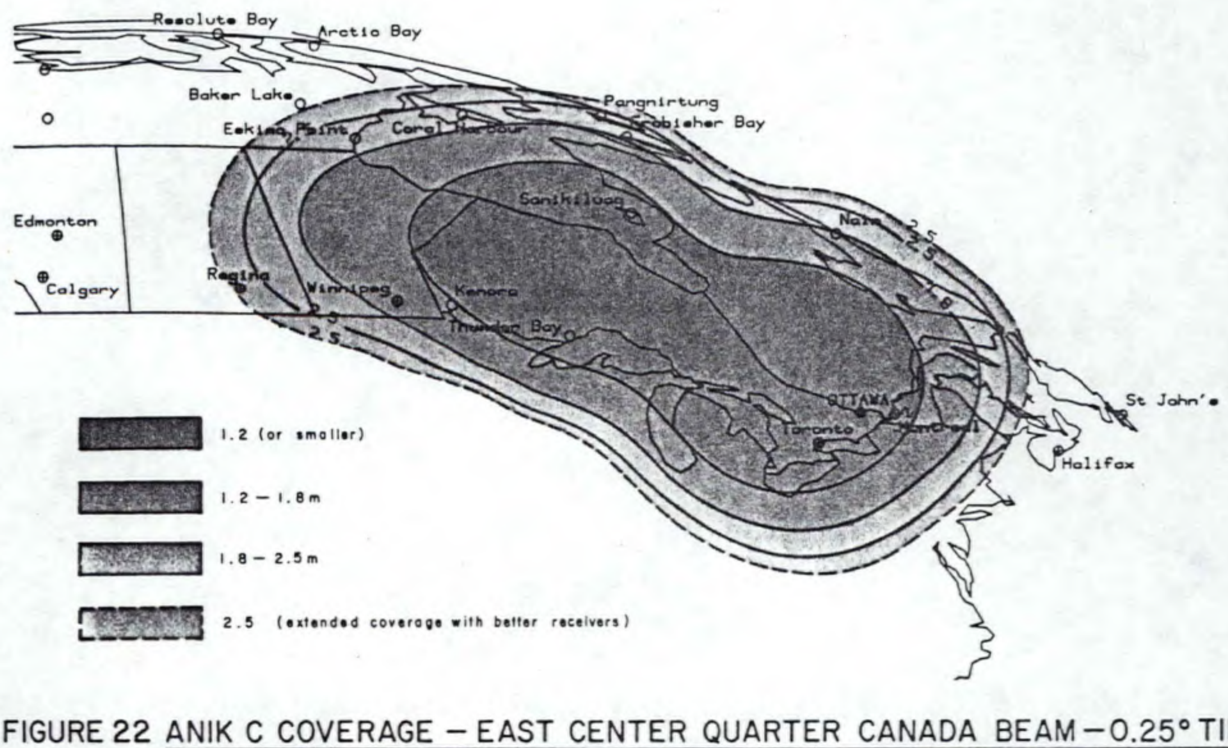

FIGURE 22 ANIK C COVERAGE — EAST CENTER QUARTER CANADA BEAM — 0.25° TILT

I TV PER RF CHANNEL

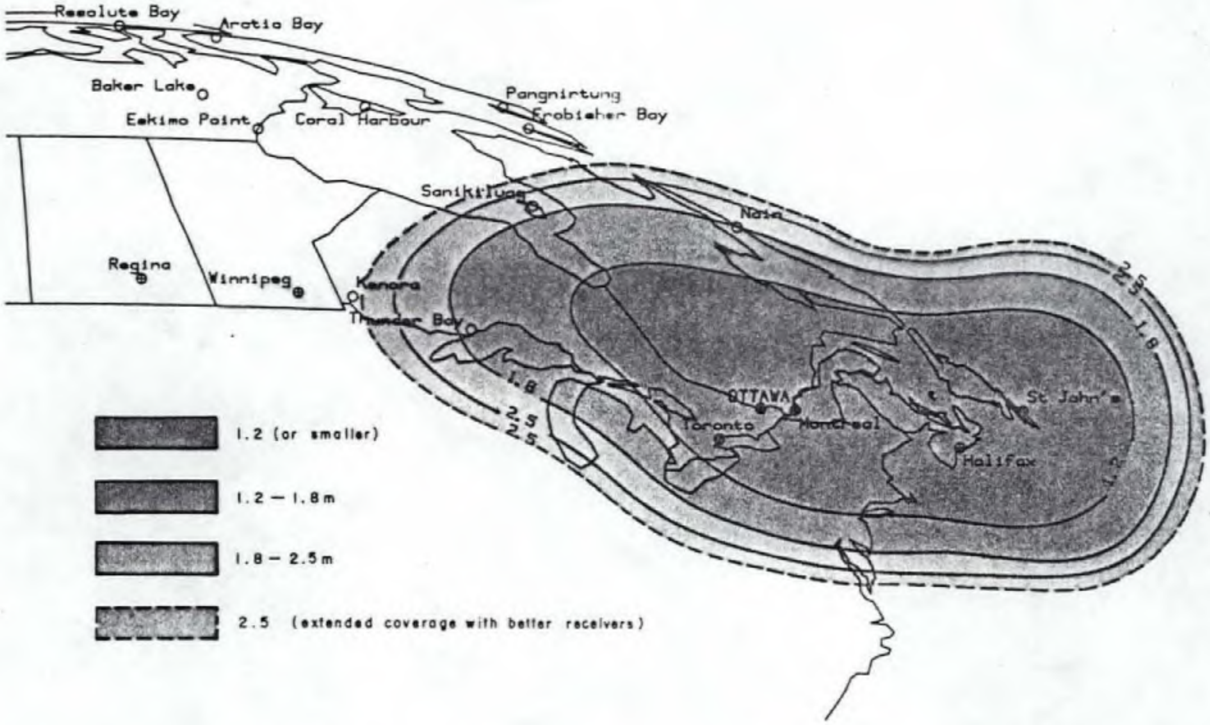

FIGURE 23 ANIK C COVERAGE – EAST QUARTER CANADA BEAM – 0° TILT
1 TV PER RF CHANNEL

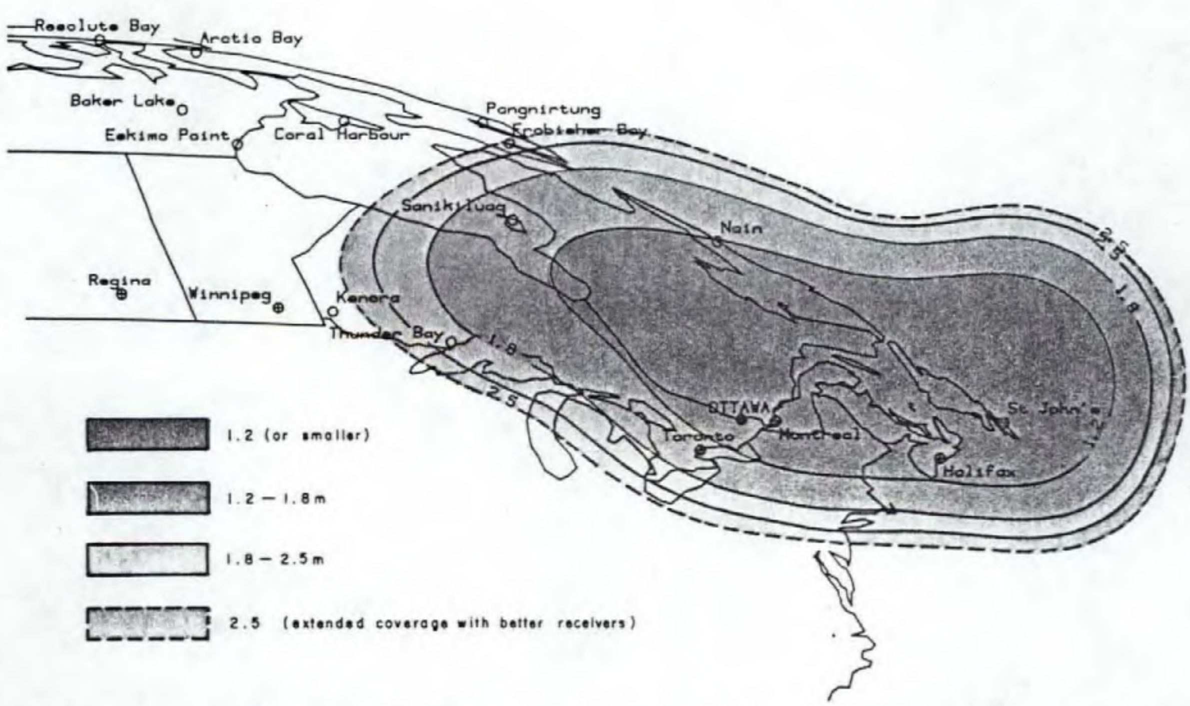

FIGURE 24 ANIK C COVERAGE – EAST QUARTER CANADA BEAM – 0.25° TILT
1 TV PER RF CHANNEL

Appendix D
To Section 2
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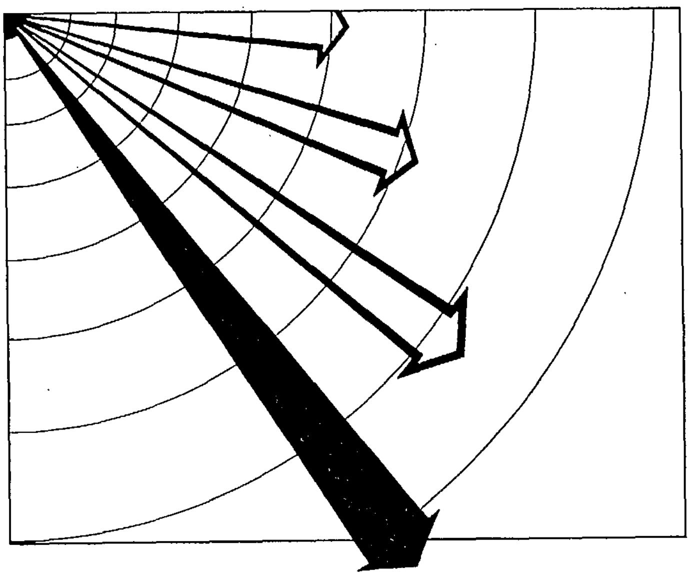
6. "Preliminary Laboratory Evaluation of Sound Program Service for HACBSS", DOC/CRC/SCOPO, 1980

Section 3 –
Economic Analysis



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3.0 Introduction and Methodology

The purpose of Section 3.0 is to determine the most cost effective means of using Anik C as an interim direct broadcasting satellite. Further to this, it provides a baseline design concept for future direct broadcasting satellite systems. The Canadian telecommunications environment is very complex from both a technical and regulatory point of view. The assessment of new technologies is as much a job of defining a role in this environment as overcoming physical barriers. This usually involves proving a need exists for the service and secondly, demonstrating the technical and economic feasibility. Section 1.0, Marketing Report, has determined the immediate primary need for a DBS as one of extending television services to the under-served areas of Canada. Section 2.0, Technical Report, has determined the technical feasibility of Anik C as a DBS in a range of different modes of operation. Section 3.0 will determine which of these modes is most cost effective.

The methodology used in the analysis is described in Figure 3-l. The capital costs of the DBS terminals have been sensitized to quantity in order to provide supply data. The demand data is taken directly from Section 1.0 in the Marketing Report. This supports a supply/demand analysis which determines the lowest terminal price and greatest market penetration for each of the following service categories:

(a) Basic;

(b) Basic and Extended; and

(c) Basic and Extended and Pay TV.

The distribution costs associated with each of the above service categories, when compared to the market penetration, provides a measurement of unit cost of distribution. This measurement determines which service category and mode of operation of Anik C is most cost effective.

A detailed description of the methodology is contained in Figure 3-2.

Figure 3-1 Methodology – General Outline

Input	Process	Output
Earth Segment Capital Costs		
Space Segment Rates	Supply vs Demand Analysis for Small Terminals	Most Cost Effective Role for Anik C as DBS
Market Information Task 1	Cost of Satellite Distribution Analysis	

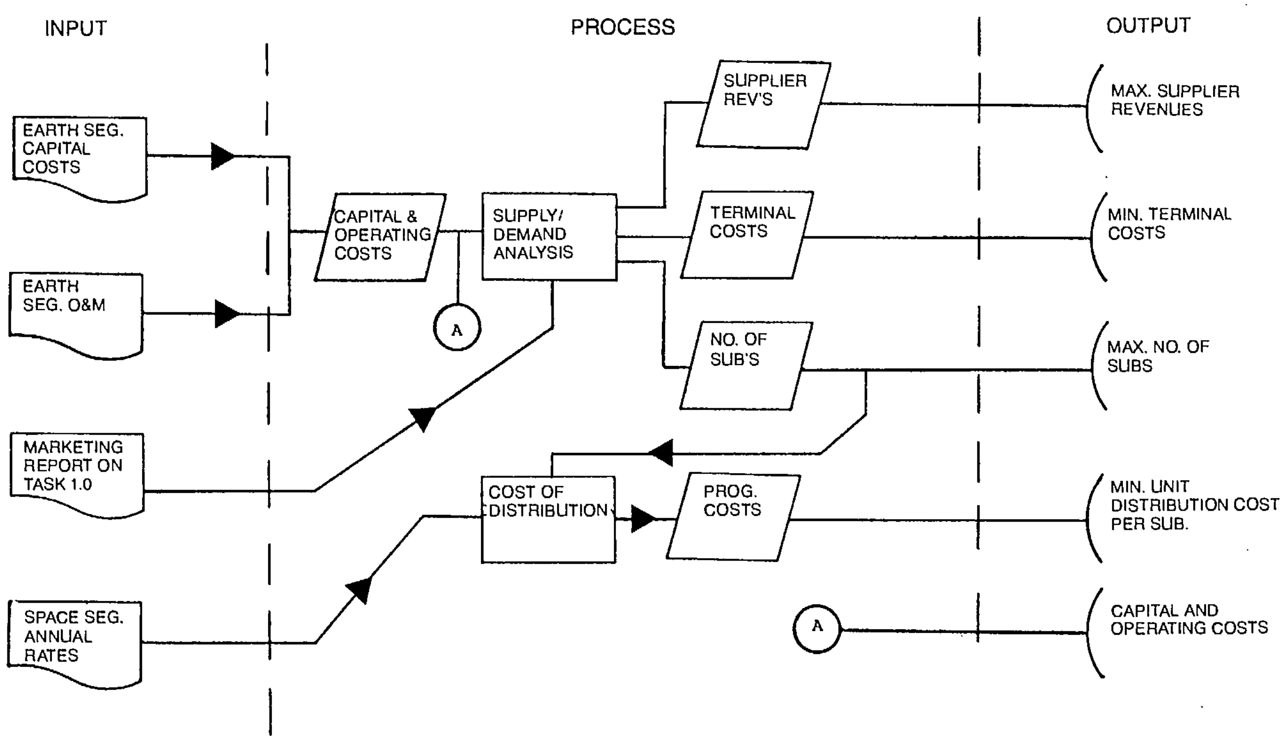


Figure 3-2 Methodology – Detailed Outline.

3.1 Economic Analysis of Anik C for DBS Service

The purpose of this section is to assess the economic viability of using Anik C for DBS service. The methodology used will be a supply-demand analysis to determine the viability of Direct-to-Home service. This refers primarily to the use of small low-cost terminals intended for private households. Secondary to this application, a cursory examination of the criteria for community antennas and local distribution systems is provided. The underlying assumption here is that a Direct-to-Home service must prove to be economically viable as a prerequisite for DBS to community service. Further to this point, it is assumed that community service will materialize using the most available technology. If that technology is a l4/l2 GHz DBS system, then community services will be provided, at least in part, accordingly.

The examination of community antennas and local distribution systems is intended to provide criteria for their application. For example, some communities are more suited to cable TV distribution as compared to TV distribution via low power broadcast transmitters.

The following is an outline describing the subsections contained in Section 3.1:

- 3.1.1 DBS Terminal Equipment Definition
- 3.1.2 Service Demand and Terminal Cost Sensitivity
- 3.1.3 Capital Costs
- 3.1.4 Supply/Demand Analysis
  - (1) Supply/Demand Relationships
  - (2) Possible Market
  - (3) Terminal Cost and Market Penetration
  - (4) Unit Distribution Costs
  - (5) Market Penetration Rate
- 3.1.5 Criteria for Community Service

3.1.1 DBS Terminal Equipment Definition

DBS terminal equipment refers to the low-cost Direct-to-Home terminal which is intended for use in individual households. This equipment will vary in design depending on which mode of operation the satellite is operating in (l/2 or l/4 Canada, l or 2 TV/RF channel), and also the geographic location of the terminal. Both of the above factors affect the EIRP at the point of reception. The required antenna size as a function of EIRP will vary accordingly. The assumption is made that the electronics, (i.e. the indoor unit and the outdoor unit) will be common for all DBS terminal equipment configurations.

Due to the variation in EIRP, it is not possible to assign one antenna size to serve the whole country without exaggerating the requirement, (i.e. 4.5 m antennas would suffice; however, this does not qualify as what is commonly thought of as a DBS terminal). This necessitates determining nominal antenna sizes for each mode of operation of the satellite. For the purposes of economic analysis of low-cost Direct-to-Home terminal equipment, markets to the south of the 60th parallel are dominant. Nonetheless, the importance of service to the North is recognized by providing for a 0.25° northward tilt of the Anik C antenna to provide all-Canada coverage.

The rationale for focusing attention regarding DBS earth terminal equipment upon the area below the 60th parallel is two-fold: households in the North tend to be located in settlements (which, as for the south, are more suited to community distribution systems), and greater than 99.5% of the remote and rural population live below the 60th parallel*.

*Based on antenna contour maps contained in Section 2 and their relationship to Table 7 of the report "Television Network Coverage in Rural Canada Compared with that in Census Metropolitan Areas", G.D. Cormack, DOC, 78-08-28

Based on the antenna contour maps of Section 2, the following nominal antenna sizes have been chosen.

(a)	l/4 Canada coverage l TV per transponder	1.2 m Antenna
(b)	l/4 Canada coverage 2 TV per transponder	1.8 m Antenna
(c)	l/2 Canada coverage l TV per transponder	1.2 m Antenna
(d)	l/2 Canada coverage 2 TV per transponder	1.8 m Antenna

The antenna sizes chosen are intended to be representative of the mean requirement. There are fringe areas requiring somewhat larger antennas and central areas adequately served by smaller antennas.

It is interesting to note that the antenna requirements for l/4 Canada and l/2 Canada spot beams are the same for a given number of TV signals per transponder. This is due to the concentration of the remote and rural population in the southern area of Canada as demonstrated in the Marketing Report, Figure 1-3.

The costs associated with these antennas are contained in the section on capital costs. Operations and maintenance costs are excluded for this type of service as it is assumed that the user will manage this function. It is also assumed that suppliers will be retailing directly to the user, therefore the costs provided in the previous sections will be representative of end-user costs.

3.1.2 Service Demand and Terminal Cost Sensitivity

Service demand and terminal cost sensitivity is defined in Tables 1-8A and 1-8B of the Marketing Report. These tables identify the probable market for each type of service offering. (i.e. Basic, Extended, Pay TV). The probable market is further sensitized to terminal cost. This provides sufficient information to determine demand for DBS service as defined in the next section; however, in order to determine the overall cost of service, the space segment and the number of uplinks associated with each type of service must be assessed. Table 3-1A and Table 3-1B provide the number of RF channels required for both the maximum and minimum scenarios provided in the Marketing Report.

The following assumptions have been made in the derivation of the RF channel requirements.

(a) Basic and Extended services are provided using I/4 Canada spot beams. These services are defined as regional in nature.

(b) Pay services are provided using I/2 Canada spot beams. These services are more universal in nature; therefore it is reasonable to expect that broadcasters would want to maximize the coverage area. There is little penalty with respect to antenna requirements when using I/2 Canada spot beams as the nominal antenna sizes remain the same.

The service groups are ordered to provide a "value added" progression with respect to program quantity, i.e. 2-4-6-8 programs. This facilitates comparison between service groups by incremental levels of service.

Each service group will also have an associated number of uplinks as shown in Table 3-2.

Table 3-1A RF Channel Requirements(1) Maximum Scenario

Service Group	Number of Programs: Basic	Ext.	Pay	Total	Number of RF Channels For All-Canada Coverage: 2 TV per Transponder	1 TV per Transponder
Basic	3	—	—	3	6	12
Basic and Extended	3	3	—	6	12	24(2)
Basic and Extended and Pay TV	3	3	2	8	14	28(2)

Notes (1) Based on All-Canada program coverage being provided.
(2) Anik C has a 16 channel capacity and therefore capacity is exceeded for this application.

Table 3-1B RF Channel Requirements(1) Minimum Scenario

Service Group	Number of Programs: Basic	Ext.	Pay	Total	Number of RF Channels For All-Canada Coverage: 2 TV per Transponder	1 TV per Transponder
Basic	2	—	—	2	4	8
Basic and Extended	2	1	—	3	6	12
Basic and Extended and Pay TV	2	1	1	4	7	14

Notes (1) Based on All-Canada program coverage being provided.

Table 3-2 Uplink Requirements(1)

Service Group	Number of Uplinks Required(2): Maximum Scenario	Minimum Scenario
Basic	12	8
Basic and Extended	24	12
Basic and Extended and Pay TV	28	14

Notes (1) All Canada program coverage provided.
(2) The number of uplinks is independent of the number of programs per transponder; however, there is an impact on the cost of the uplink as additional transmit power is required in a 1 TV per transponder mode. The uplinks can be provided at single or common user stations and this is addressed in Section 3.1.4 (4).
Appendix A provides a derivation of Tables 3-1A, 3-1B and 3-2.

3.1.3 Capital Costs

Telesat has a vast source of capital and operating cost information derived from discussions with suppliers, service provisioning and maintenance experience. Although much of this information describes systems operating at 6/4 GHz, many of the cost elements apply at 14/12 GHz service.

Existing satellite communication systems at 14/12 GHz are mostly for experimental purposes and initial systems have included significant non-recurring costs. For the purpose of this study, it has been assumed that earth station quantities will be sufficiently large and that the 14/12 GHz technology will have matured so that non-recurring design and manufacturing costs are not a significant element.

The following is a description of the different uplink and downlink earth stations under consideration.

1. Uplink

(a) Multiple user uplink capable of transmitting 1-8 programs using *1 TV* program per transponder*

(b) Multiple user uplink capable of transmitting 1-8 programs using *2 TV* programs per transponder*

(c) Single user uplink intended to transmit one program from the point of origin using *1 TV* program per transponder*

(d) Single user uplink intended to transmit one program from the point of origin using *2 TV* programs per transponder*

2. Downlink

(a) Commercial TVRO intended for community distribution; and

*Different uplink power requirements result for 1 or 2 TV programs per transponder.

(b) Low cost terminals intended for private residential use.

Tables 3-1 and 3-2 provide the capital costs associated with each of the above. The uplinks are costed on an incremental basis in that additional uplinks are treated as incremental costs to the main station and first uplink. The commercial TVRO's intended for community use are costed on a main station and incremental receiver basis. The small low cost terminals are costed on a unit basis and sensitized to quantity. This costing approach was taken to enable the reader to estimate almost any given network configuration.

The higher cost of the multiple uplink station, as compared to the single uplink station, is due to the following equipment differences:

(a) The multiple uplink station requires a complex RF combiner.

(b) A more sophisticated monitor, alarm and control system is associated with the multiple uplink station.

(c) A dual polarized antenna feed is required with the multiple uplink station.

The capital costs developed here are used in subsequent sections of this report.

Table 3-3A Uplink Earth Station Costs* ($ 1981 × 000) Common User Site – 1 TV Per Transponder

Terminal Description		Costs		
Antenna Size (M)	5.0	Cost Component	Main Stn & First Uplink	Each Additional Uplink
HPA (KW)	1.0			
Program Capacity:		Antenna	40.0	129.0
Transmit	1-8	Com. Equip	211.0	
Receive	1-8	Test Equip	20.0	
		Spares	25.0	5.0
Quantity	1-4			
		Subtotal	296.0	134.0
		Engineering	15.0	10.0
		AFC	16.0	3.0
		Total Capital	327.0	147.0

* Support facilities, foundations and prime power not included and are assumed to be provided by the customer.

Table 3-3B Uplink Earth Station Costs* ($ 1981 × 000) Common User Site – 2 TV Per Transponder

Terminal Description		Costs		
Antenna Size (M)	5.0	Cost Component	Main Stn & First Uplink	Each Additional Uplink
HPA (KW)	0.5			
Program Capacity:		Antenna	40.0	119.0
Transmit	1-8	Com. Equip	201.0	
Receive	1-8	Test Equip	20.0	
		Spares	25.0	5.0
Quantity	1-4			
		Subtotal	286.0	124.0
		Engineering	15.0	10.0
		AFC	16.0	3.0
		Total Capital	317.0	137.0

* Support facilities, foundations and prime power not included and are assumed to be provided by the customer.

Table 3-3C Uplink Earth Station Costs *($ 1981 × 000) Single User Site – 1 TV Per Transponder

Terminal Description		Costs	
Antenna size (M)	5.0	Cost Component	Main Stn & First Uplink
HPA (KW)	0.5		
Program Capacity:		Antenna	30.0
Transmit	1	Com. Equip	165.0
Receive	1	Test Equip	10.0
		Spares	20.0
Quantity	1-10		
		Subtotal	225.0
		Engineering	10.0
		AFC	12 0
		Total Capital	247.0

* Support facilities, foundations and prime power not included and are assumed to be provided by the customer.

Table 3-3D Uplink Earth Station Costs *($ 1981 × 000) Single User Site – 2 TV Per Transponder

Terminal Description		Costs	
Antenna size (M)	5.0	Cost Component	Main Stn & First Uplink
HPA (KW)	0.5		
Program Capacity:		Antenna	30.0
Transmit	1	Com. Equip	160.0
Receive	1	Test Equip	10.0
		Spares	20.0
Quantity	1-10		
		Subtotal	220.0
		Engineering	10.0
		AFC	12.0
		Total Capital	242.0

* Support facilities, foundations and prime power not included and are assumed to be provided by the customer.

Table 3-4A Downlink Earth Station Costs *($1981 × 000) Commercial TVRO's for Community Use

	Capital Cost of Main Station and First Receiver			Each Additional Receiver
Antenna Diam.	**3.0 meters**	**3.7 meters**	**4.5 meters**	**All sizes**
Quantity 500	5.5	6.7	8.5	1.4
Quantity 1000	4.2	5.6	7.3	0.9

* Includes allowance for Test Equipment, Spares, Engineering and AFC
– Support facilities, foundations and prime power not included

Table 3-4B Downlink Earth Station Costs *($1981 × 000) Low Cost Home Terminal – 1.2 M Antenna

	Equipment Configuration		– LNA N.F. = 3.0 dB – G/T = 16.4 dB/K	
			Capital Costs*	
Quantity	Antenna	Outdoor Unit	Indoor Unit	Total
100	1.2	2.4	2.2	5.8
500	0.6	1.2	1.1	2.9
1,000	0.4	0.8	0.7	1.9
10,000	0.2	0.5	0.5	1.2
100,000	0.1	0.3	0.3	0.7
1,000,000	0.1	0.2	0.2	0.5

* Supplier & FST

Table 3-4C Downlink Earth Station Costs *($1981 × 000) Low Cost Home Terminal – 1.8 M Antenna

	Equipment Configuration		– LNA N.F. = 3.0 dB – G/T = 20 dB/K	
			Capital Costs*	
Quantity	Antenna	Outdoor Unit	Indoor Unit	Total
100	1.6	2.4	2.2	6.2
500	0.9	1.2	1.1	3.2
1,000	0.6	0.8	0.7	2.1
10,000	0.4	0.5	0.5	1.4
100,000	0.2	0.3	0.3	0.8
1,000,000	0.2	0.2	0.2	0.6

* Supplier & FST

Table 3-4D Downlink Earth Station Costs *($1981 × 000) Low Cost Home Terminal – 2.5 M Antenna

	Equipment Configuration		– LNA N.F. = 3.0 dB – G/T = 22.8 dB/K	
			Capital Costs*	
Quantity	Antenna	Outdoor Unit	Indoor Unit	Total
100	2.6	2.4	2.2	7.2
500	1.8	1.2	1.1	4.1
1,000	1.4	0.8	0.7	2.9
10,000	1.4	0.5	0.5	2.4
100,000	0.4	0.3	0.3	1.0
1,000,000	0.3	0.2	0.2	0.7

* Supplier & FST

3.1.4 Supply/Demand Analysis

The purpose of this section is to determine the relationship between supply and demand for DBS service.

(1) Supply/Demand Relationships

The supply data is derived from the capital cost information of Section 3.1.3. The demand data is derived from the service demand and terminal cost sensitivity data of Section 3.1.2.

This information has been plotted as the cost per terminal vs the number of terminals for both the maximum and minimum scenarios. The supply curves for 1.2 and 1.8 meter antennas have been plotted to correspond to service being provided on either a one or a two TV signal per transponder basis. Figures 3-3A and 3-3B demonstrate the results. It can be seen that the demand increases by substantial increments for different service categories. This indicates that market saturation has not been attained even with the addition of Pay TV to Basic and Extended services.

The points of intersection of the supply and demand curves represent the "best" possible market scenarios (i.e. the maximum number of terminals for the minimum cost). For example, the demand for a full complement of services (i.e. Basic, Extended and Pay TV) in the maximum scenario intersects the supply curve for l.8 m antennas at a market of 250,000 households and a terminal cost of $720. It is not possible to increase the market for 1.8 m antennas further as they cannot be supplied at a lower cost.

The information contained in this graph is further analyzed in Section 3.1.4 (3).

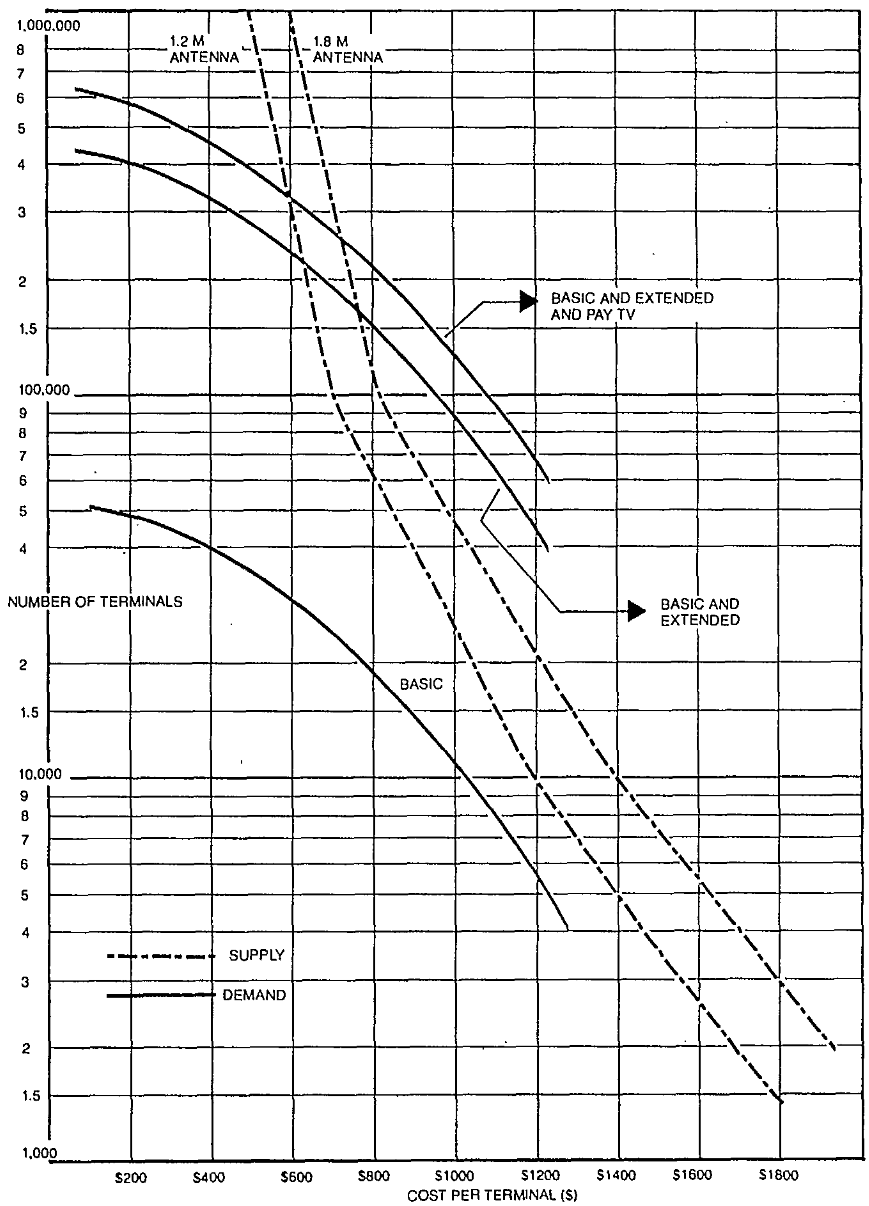


Figure 3-3A Supply/Demand Relationship Maximum Scenario

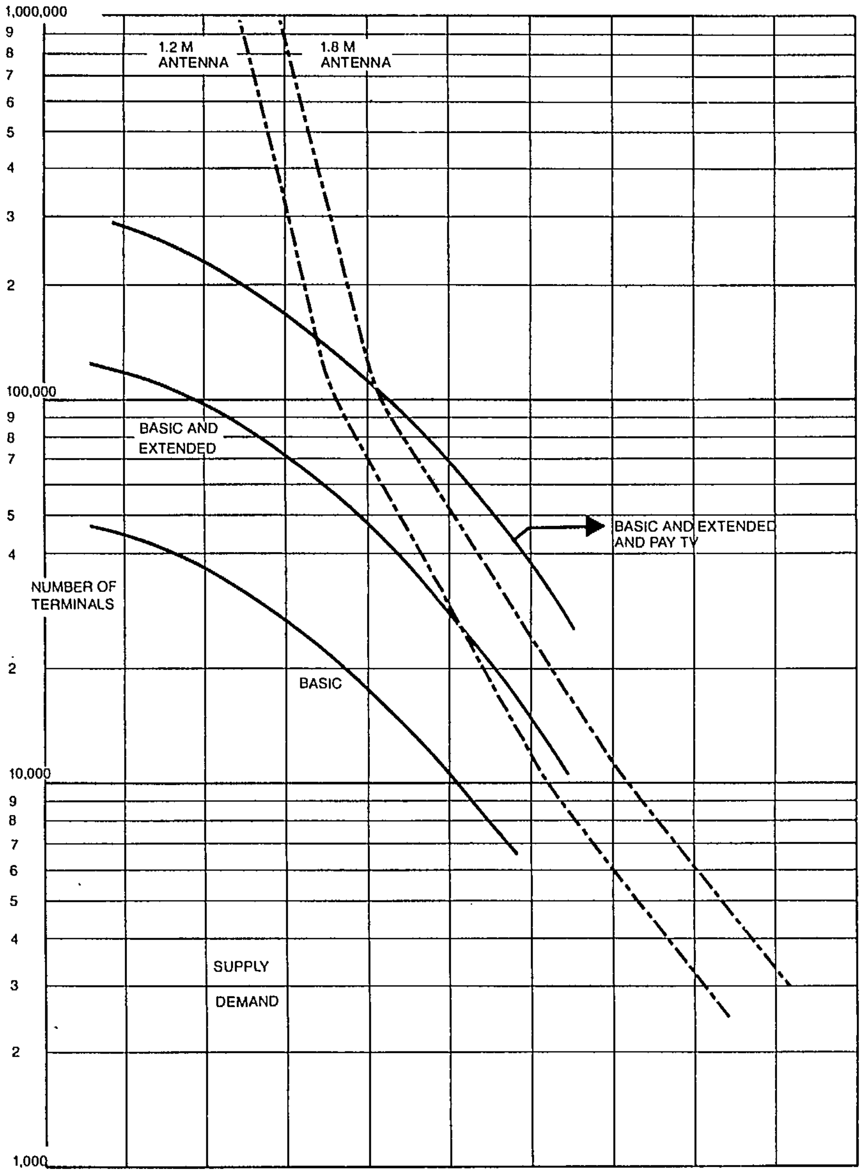


Figure 3-3B Supply/Demand Relationship Minimum Scenario

(2) Possible Markets

The supply/demand relationship also provides an indication of the possible markets as demonstrated in Figure 3-4. This Figure represents a full complement of services (i.e. Basic, Extended and Pay TV) being provided to DBS terminals of normal size 1.8 meters.

Coordinates within the shaded area represent possible market scenarios, however, the "optimum" is the point of intersection of the two curves. This optimum, as discussed before, represents the maximum market penetration at the lowest terminal cost.

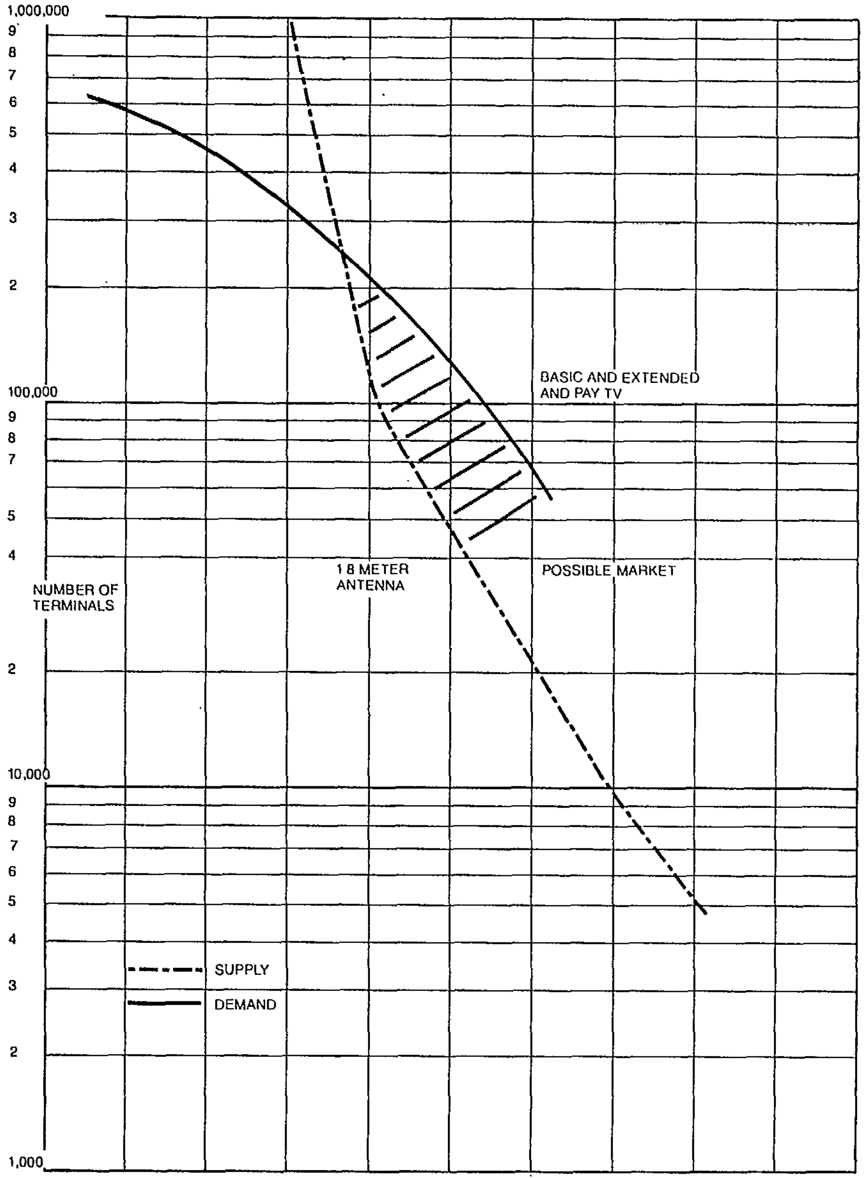


Figure 3-4 Supply/Demand Relationship Example of Market Definition

(3) Terminal Cost and Market Penetration

The supply/demand analysis provides the best-case terminal cost and market penetration for each service group. This has been summarized in Tables 3-5A and 3-5B.

Each service group has been analyzed for nominal antenna sizes of l.2 and l.8 meters which corresponds to satellite services being provided in a l or 2 TV per transponder mode. The following conclusions may be drawn.

(a) Basic services alone do not have sufficient market penetration to warrant further consideration.

(b) As stated previously, some service categories exceed the capacity of the satellite using the l TV per transponder mode. For this reason, these scenarios will not be considered further.

(c) Earth station supplier revenue projections indicate that the greatest market penetration generates maximum revenues, providing an incentive to manufacturers to keep prices low (their market is elastic).

(d) A full complement of services as defined in the maximum scenario, distributed in the 2 TV per RF channel mode (l.8 m antennas) represent the best case with respect to market penetration, (i.e. 250,000 households).

(e) A full complement of services as defined in the minimum scenario, distributed in the l TV per RF channel mode (l.2 m antennas) represent the best case with respect to terminal cost, (i.e. $660 per terminal), but a market penetration of only 145,000 households.

The choice of the most cost effective scenario is based on further analysis taking into account distribution costs as presented in the next subsection.

Table 3-5A Terminal Costs and Market Penetration, Maximum Scenario

Service Group	Terminal (1) Size (m)	TV Signals Per RF Ch	Lowest Terminal Cost ($) A	Greatest Market (Households) B	Supplier Revenue A × B
Basic	1.2	1	Insufficient Demand		—
	1.8	2	Insufficient Demand		—
Basic and	1.2	1	Note (2)		
Extended	1.8	2	$770	160,000	$123 M
Basic and Extended	1.2	1	Note (2)		—
and Pay TV	1.8	2	$720	250,000	$180 M

Notes (1) 1.2 and 1.8 m antennas correspond to service being provided using 1 TV and 2 TV per RF channel respectively.
(2) The capacity of a single Anik CR(2) The capacity of a single Anik C is exceeded for this application.

Table 3-5B Terminal Costs and Market Penetration, Minimum Scenario

Service Group	Terminal (1) Size (m)	TV Signals Per RF Ch	Lowest Terminal Cost ($) A	Greatest Market (Households) B	Supplier Revenue A × B
Basic	1.2	1	Insufficient Demand		—
	1.8	2	Insufficient Demand		—
Basic and	1.2	1	Insufficient Demand		—
Extended	1.8	2	Insufficient Demand		—
Basic and Extended	1.2	1	$670	145,000	$97 M
and Pay TV	1.8	2	$810	105,000	$85 M

Notes (1) 1.2 and 1.8 m antennas correspond to service being provided using 1 TV and 2 TV per RF channel respectively.
(2) The capacity of a single Anik C is exceeded for this application.

(4) Unit Distribution Costs

The purpose of this subsection is to determine the cost of program delivery as applicable to each service group. As a figure of merit, the following has been chosen.

Annualized Unit Cost = $ Dollars/Program/Household /year of Distribution

The unit cost of distribution represents the cost of each program allocated to each household, and facilitates comparison of the service groups by bringing all costs to common ground.

The unit cost of distribution depends on cost of satellite distribution, i.e. the space segment rates for Anik C and the cost of uplinking the programs.

With respect to the cost of uplinking programs, it is assumed each uplink is provided via a single user earth station, i.e. one earth station for each program being uplinked. The alternative to this is to assume the use of common user earth stations, (i.e. multiple uplinks per earth station). The rationale for this is as follows:

(a) The service groups consist of programs provided by different broadcasters and agencies. The points of origin of these programs are quite different and the cost of terrestrial backhaul to a common user site may preclude this approach.

(b) The common user site would require at least three users to be viable. DBS services would probably be introduced over a 2 - 3 year period; therefore, the likelihood of bringing together three broadcasters in the same time frame whose programs have points of origin within close proximity of a common user earth station is very small.

Using the above assumption and the capital costs contained in Section 3.1.3, the cost of the uplinks associated with each service group has been assessed. The costs are expressed as annual rates as shown in Table 3-6B.

Tables 3-6A and 3-6B provide a summary and detailed information related to the cost of distribution. It is quite evident, based on unit cost of distribution as a figure of merit, that a full complement of services (i.e. Basic, Extended and Pay TV, 8 programs) distributed using the 2 TV per RF channel mode presents the best alternative. This result is in agreement with the previous section.

Also of interest is the total cost of each service group expressed as a yearly and monthly amount. This is done on a per-subscriber basis to facilitate comparison between groups. Table 3-7 provides this information. Again a full complement of 8 programs provides the lower per-subscriber cost.

Table 3-6A Unit Distribution Costs – Summary

Service Group	Antenna Diameter	TV Per RF Channel	Total Satellite Costs ($ M/Year) (1)	Total Uplink Costs ($ M/Year) (1)	Total Market (Households)	Unit Cost of Distribution ($/Program/Household/Year)
Maximum Scenario Basic and Extended	1.8	2	$26.4	$1.97	160,000	$29.55
Maximum Scenario Basic and Extended and Pay TV	1.8	2	$30.8	$2.30	250,000	$16.55
Minimum Scenario Basic and Extended and Pay TV	1.2	1	$30.8	$1.17	145,000	$55.12
	1.8	2	$15.4	$1.15	105,000	$39 40
			A	B	C Reference Figs. 3–3A & 3–3B	(A + B) ÷ C / No. of Programs

Notes (1) Derivation shown in Table 3-6B – Unit Distribution Costs – Detail.

Table 3-6B Unit Distribution Costs – Detail

Service Group	No. Of Progm	Description: Ant Dia	Description: TV PER RF CH	Number of RF Channels Required	Annual Rate ($M/YR)	Total Satellite Costs ($M/Year)	Number of Uplinks Required	Annualized Cost Per Uplink ($/K/Year)	Total Uplink Costs ($M/Year)
Max. Sc. Basic and Extended	6	1.8	2	12	$2.2 M	$26.4 M	24	$81.90 K	$1.97 M
Max. Sc. Basic and Extended and Pay TV	8	1.8	2	14	$2.2 M	$30 8 M	28	$81 90 K	$2 30 M
Min. Sc. Basic and Extended and Pay TV	4	1.2	1	14	$2.2 M	$30 8 M	14	$83 65 K	$1.17 M
		1.8	2	7	$2.2 M	$15.4 M	14	$81 90	$1 15 M
Reference:				A Table 3-2	B Task 4.0	A × B	C Table 3-4	D	C × D

Table 3-7 Distribution Costs

Service Group	TV Signals Per Transponder	No. of Programs	Cost Per HSE Per Year	Cost Per HSE Per Month
Maximum Scenario Basic and Extended	2	6	177.31	14.78
Maximum Scenario Basic and Extended and Pay TV	2	8	132.40	11.03
Minimum Scenario	1	4	220.48	18.37
Basic and Extended and Pay TV	2	4	157.62	13.13

(5) Market Penetration Rate

The DBS terminals are assumed to be supplied over a 5 year period for the quantities stated. The introduction of services takes place over a 3 year period as shown in Figure 3-5. Based on this staggered introduction of services, the following penetration rates have been developed.

Year	% Penetration
1983	40 %
1984	20 %
1985	15 %
1986	10 %
1987	10 %
1988	5 %

The penetration rate is relatively high in the early years as a large portion of the market, some 72,000 homes, have no alternative service. This information is shown graphically in the lower portion of Figure 3-5.

The slope of Figure 3-5 is a matter of some debate. It can be argued that due to consumer conservatism, growth will be made slower, and will tend to increase with time rather than saturate. On the other hand, it should be noted that the 220,000 household maximum corresponds to 100% of the expected market at year 5, and this is only a fraction of the total potential market which may be tapped in later years.

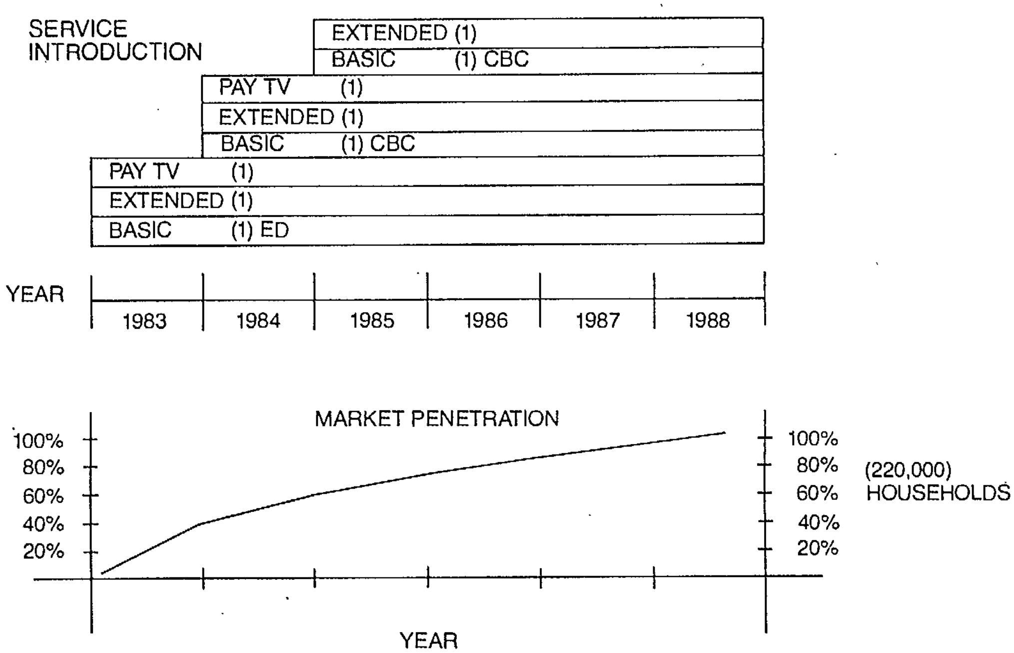


Figure 3-5 Market Penetration

3.1.5 Criteria for Community Services

In many locations, the clustering of the households is such that providing service through a common community antenna is more practicable and economical than through individual DBS terminals. The criteria for this type of service lies within the demographics of the community in question.

The cost of local redistribution is high relative to the cost of the common earth station. The two most common types of local distribution systems are listed below.

(a) Cable Distribution

(b) Low Power Broadcast Transmitter

The low power broadcast transmitters can provide only unprotected service to communities with unallocated channels. It is assumed that service is provided in the UHF band, as the VHF band would be nearly impossible to frequency-coordinate 4 - 8 channels. Clearly, cable distribution was an advantage.

The following is extracted from a report done by K.J. Easton, P. Eng., Cable Consulting Services Limited*

* "Options for local distribution from Satellite Earth Stations, A feasibility study for North Start Home Theatre", November I980.

Cable distribution has an application to communities which are lineally distributed. This is cost effective where the lineal density exceeds 20 homes/mile and the commmunity contains at least 200 homes. Communities of less than I00 homes qualify if the lineal density is 50 homes/mile or greater.

Low-power broadcast transmitters have application to communities which are not distributed in a lineal fashion. Criteria for this system depend on the areal density and the number of homes within the coverage area. For example, cost effectiveness can be achieved with 800 homes having an areal density down to 2I homes per square mile.

3.2 Results — Anik C as a DBS

The purpose of this section is to summarize the findings of the economic analysis of Anik C as DBS. Results and comments are provided below.

Results

(a) DBS service on Anik C is most cost effective if an 8 program package consisting of Basic, Extended and Pay TV services is provided in a 2 TV per satellite RF channel mode.

(b) The above service can be provided to DBS terminals with a nominal antenna size of I.8 m. The projected cost of such a terminal is $720. The projected market penetration is 250,000 households which does not include those served by common community antennas.

(c) The monthly cost of the full 8 program package is approximately $11.00 per subscriber. This is a cost of distribution for study purposes, and should not necessarily be taken as the total monthly charge to the subscriber.

(d) The spot beam configuration is proposed as follows:

Basic Services	—	1/4 Canada
Extended Services	—	1/4 Canada
Pay TV Services	—	1/2 Canada

Appendix A
to Section 3
RF Channel and Uplink Requirements – Detail

Table A-1A RF Channel Requirements – 2 TV Per Channel

Service Group	¼ Canada Spot Beam W	WC	EC	E	½ Canada W+C	E+EC	Total RF Channels
Basic							
1 Program	½	½	½	½	—	—	2
Extended							
1 Program	½	½	½	½	—	—	2
Pay TV							
1 Program	—	—	—	—	½	½	1

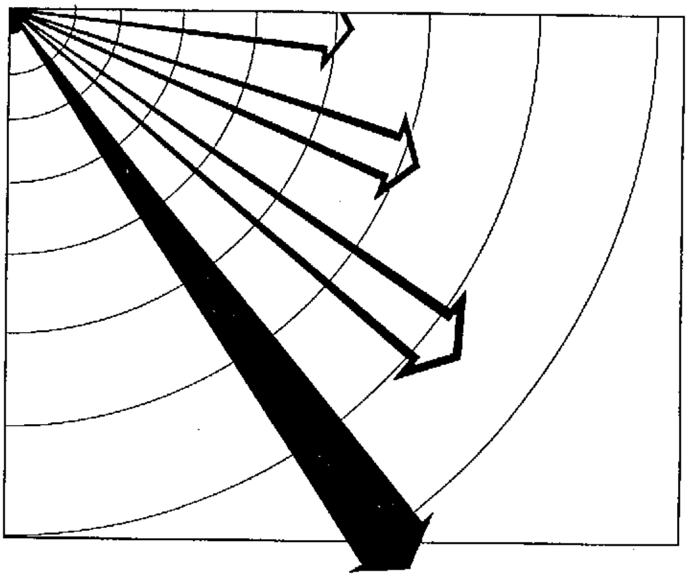
Table A-1B RF Channel Requirements – 1 TV Per Channel

Service Group	¼ Canada Spot Beam W	WC	EC	E	½ Canada W+C	E+EC	Total RF Channels
Basic							
1 Program	1	1	1	1	—	—	4
Extended							
1 Program	1	1	1	1	—	—	4
Pay TV							
1 Program	—	—	—	—	1	1	2

Table A-2 Uplink Requirements

Service Group	Number of Uplinks Accessing ¼ Canada Spot Beam	Number of Uplinks Accessing ½ Canada Spot Beam	Total Uplinks
Basic			
1 Program	1 × 4	—	4
Extended			
1 Program	1 × 4	—	4
Pay TV			
1 Program	—	1 × 2	2

Section 4 – Social, Political, Regulatory, Rates and Service Offerings Analysis



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4.0 Social, Political and Regulatory Considerations

This section of the study explores some of the more important political, social and regulatory features associated with the introduction of a commercial satellite as a means to broadcast services, either for conventional television or for the introduction of specialized vertical services which are defined as new program services such as subscription services, premium services and social services catering to targeted and, in some cases, mass audiences.

4.1.0 International Considerations

4.1.1. DBS – International Regulatory Developments

In the thirty-five years since Arthur C. Clarke wrote of a system of geostationary satellites beaming program signals throughout the world, advances in technology have brought us into the television age, the satellite age, and now into the realization of Clarke's vision by the introduction of satellites broadcasting programs for a direct-to-home reception on DBS.

The DBS technology is based on high power satellites transmitting program-carrying signals to homes or communities equipped with small, relatively inexpensive receiving antennae.

4.1.2. WARC 1971

The practical and technical feasibility of applying DBS technology has been fairly well demonstrated through the experimental programs discussed in the Annex. This actualization resulted from the 1971 World Administrative Radio Conference (WARC) which determined portions of the 14/12 GHz band to be allocated for satellite service and laid down procedures for their use without imposing regulatory limits on permissible satellite power. This international regulatory decision provided designers the motivation and incentive to experiment with high power satellite emissions.

Prior to the 1971 WARC decision, the emphasis had been on developing low power satellites associated with large and powerful ground stations. After the 1971 Decision, with the emphasis now towards powerful satellites, it became feasible to design satellites for the purpose of broadcasting directly to individual or community TV sets.

At the WARC Conference, a Broadcasting Satellite Service (BSS) was defined as a radio communication service in which signals were transmitted for the intended direct reception of the general public. Direct reception was to encompass both individual reception and community reception. This definition was incorporated into the Radio Regulations of the ITU.

Individual reception was defined as "... the reception by simple domestic installations and in particular those possessing small antennae". Community reception was defined as "... reception by receiving equipment which in some cases may be complex and have antennae larger than those used for individual reception and intended for use by a group of the general public at one location or through a distribution system covering a limited area".[1]

During the Conference a sharp distinction was made between the Broadcasting Satellite Service (BSS) and the Fixed Satellite Service (FSS). At this stage of satellite design, the technical development of the FSS systems consisted of fairly large and expensive earth stations working directly with low power satellites for the transmission and reception of signals. Equivalently, it was generally understood that a BSS system would work in converse, i.e., relatively small and inexpensive ground stations associated with powerful broadcasting satellites. This technical distinction was used to develop the ITU regulatory framework to distinguish between both bands of services.

This clear demarcation was acceptable based on the belief that low power satellites would continue to service proprietary signals requiring high quality technical performing equipment. The costs associated with this equipment were considered high enough to act as an economic barrier to entry by individuals for personal enjoyment.[2]

However, hands-on experience has changed this technical distinction. The fixed satellite Anik B is demonstrating successfully that there are such striking similarities between a "fixed" satellite and a "direct broadcast" satellite, that the same spacecraft can be used in both roles.

As a result of extensive worldwide satellite development, the real difference between FSS and BSS has, for the most part, become administrative and legal rather than technical or economic.[3] Notwithstanding the practical experience gained, the ITU regulations continue to be based on this strict distinction of power and size between fixed and broadcasting satellite services.

4.1.3. WARC 1977

At the 1977 WARC, the ITU adopted a plan for all regions except Region 2 (the Americas) on the use of DBS.

The plan allotted a minimum of five satellite TV channels to almost every country (as of January 1979). It laid down details of the coverage area, the positions on the geostationary orbit and other technical characteristics of each allotment.

The plan envisaged the use of very small, low cost receiving stations with antennae of one metre diameter for individual reception. Additionally, to ensure that the satellite signal was of excellent quality under the worst propagation conditions, the specification called for an EIRP from the spacecraft of about 65 dBW.

Additionally, it specified that the satellite 11.7 - 12.2 GHz band was to be divided between FSS and BSS by what was called orbital segmentation, i.e., the geostationary orbit was divided into sectors designated exclusively for one service or the other.[4]

4.1.4. WARC 1979

The 1979 WARC (as it applied to DBS) could be considered as another integral part of a succession of international events leading to a final definitive regulatory framework under which administrations would be permitted to operate direct satellite-to-home broadcasting systems.

For Region 2 in which Canada is located, WARC expanded the 14/12 GHz satellite band, as follows:

i) 11.7 - 12.1 GHz for Fixed Satellite Service

ii) 12.1 - 12.3 GHz shared band between FSS and BSS

iii) 12.3 - 12.7 GHz for Broadcasting Satellite Service

However, the Conference failed to decide the method by which orbital slots and frequency channels would be assigned, leaving this crucial issue to be decided at the Regional Administrative Radio Conference (RARC) in 1983.

To the final acts of the Conference were appended a myriad of footnotes, most of which were exceptions to or unilateral interpretations of the general agreements. An important footnote was applied to the 11.7 to 12.1 GHz band. In this band it would be permitted for Region 2 to operate satellite RF channels in the FSS category for broadcasting satellite services, provided that these emissions did not exceed an EIRP of 53 dBW per channel and did not cause greater interference or require more protection than that accorded to fixed services. Included in the footnote was a caveat specifying that the 11.7 to 12.1 GHz band should be used principally for fixed services.

It would appear that the uncertainty of an authoritative position in this footnote renders the application tenuous and quite risky. In view of the lack of a final decision on how the orbital slots and frequency channels are to be assigned and quite conscious that participating countries (in Region 2) at the RARC '83 Conference will be demanding priority assignments irrespective of whether or when they will be used, many informed observers are of the opinion that there are too many undecided key variables to risk huge sums of money in a pure DBS operating in the assigned frequency band prior to the RARC '83 determinations.

4.1.5. Outstanding International Political Issues

The subject of DBS first appeared as an international issue during the 1963 international radio conference in Geneva.[5] Since then this topic has been debated in many international forums following a course marked with proposals, counterproposals and impasses.

The impasse stems chiefly from potential spillover effects. Satellites, by their inherent nature, cover large areas in their transmission footprint. While engineering sophistication can design coverage patterns, it is inevitable that emissions will enter into other countries since signals know no boundaries. The threat of this spillover has compelled many nations to view this DBS technology as an instrument by which one country can exploit another by broadcasting propaganda and thereby attacking their cultural foundations.

This fear of cultural imperialism is twofold, involving both the fear of the influence from consumer-oriented programs such as U.S. broadcasting and the fear of losing the cultural identity of a nation after exposure to outside ideas and lifestyles.[6]

Through years of discussion, debate, and attempted compromise, three rigid positions have emerged on the issue of DBS:

1. Rule of Prior Consent:

The Soviet Union, Eastern European Bloc Nations and several Third World Nations are very aware that the potential exists to have DBS satellite transmissions employed in a manner that could politically subvert or culturally disrupt a nation's state of equilibrium.

Based on the principle of national sovereignty, these nations insist that the rule of prior consent be incorporated in any DBS regulatory framework. Thus with a failure to receive a prior consent ruling, nations would consequently be permitted to protect themselves against broadcasting intrusions by whatever means were available.

2. Free Flow of Information:

The opposition to the restrictive regulatory approach has been led by the U.S. which argues that consideration of a prior consent regulation would be quite premature since no one country could precisely determine the legal, economic and political problems likely to arise prior to a DBS system becoming operational. Additionally, excessively restrictive policy would stifle the initiatives required to develop and implement DBS. Thirdly the U.S. argues that a regime of prior consent and program control would violate the principle of free flow of information as contained in the Declaration of Human Rights.

3. Bilateral Prior Consent Agreement

Sweden and Canada have attempted to sway certain nations to accept an intermediate position which recognizes the need to incorporate both the free flow of information and the protection of national sovereignty and cultural identity. This position calls for international cooperation expressed in an agreement between broadcasting and receiving countries. Program content, therefore, would be predetermined by a bilateral prior consent agreement.

Resolution of these international political problems is desirable if the benefits of DBS are to serve nations of the world. While there may be some shifts in positions by various nations, the debate has endured some sixteen years with no apparent compromise on the horizon.[7]

4.2.0. Domestic Application

4.2.1. Regulatory Framework for DBS

At the outset one must be aware that no policy determination as yet exists indicating to what degree DBS will be regulated. Currently in the U.S. the FCC staff has urged a "hands off" policy towards DBS, although the FCC has sought public comments on staff recommendations[8]. In contrast, the CRTC publicly has remained quite silent apart from working with the DOC on committees to develop an acceptable policy and technical framework for DBS to be considered and negotiated at the RARC '83 Conference.

4.2.2. U.S. Regulatory Framework for DBS

Although the U.S. participated in DBS experiments and was very active in the United Nations and WARC Conferences related to DBS, by its own admission (at that time) it had no firm plans for the implementation of a direct-to-home broadcasting satellite system and, in fact, refused to conduct procedural determinations on how to best use the 12 GHz band after the WARC '71 Final Acts.[9]

However, with the WARC '79 establishment of proposals, it became apparent that the U.S. regulatory climate would be more receptive to a direct-to-home satellite broadcasting system, coupled with the FCC action to deregulate licencing requirements for receive-only earth stations.[10]

Perhaps based on Comsat's intention to pursue commercially a direct-to-home broadcasting satellite system and acknowledging that this proposal, if received, would precipitate comprehensive consideration as to the effects on existing regulatory policies, the FCC elected through a Notice of Inquiry to seek public views and comments.

Released at the same time were two staff studies, one on regulatory policy and the other on technical aspects related to DBS system (the latter study was not examined in reference to this section because of the technical focus).[11]

While the policy study report urges the FCC to exercise as low a regulatory profile as possible in its relationship with DBS, it is also noteworthy that the FCC Commissioners accepted the report as a starting point for discussion.

The unveiling of the staff studies together with the issuance of a Notice of Inquiry clearly points out that the FCC wishes to resolve and arrive at a regulatory and technical policy framework for DBS.

By their own admission the staff found no substantial basis for the Commission to regulate DBS, and could not conclude that traditional types of regulations (broadcasting or common carrier) were necessary to assure that the public interest was being protected. Rather, they suggested that to impose conventional broadcasting regulations or common carrier regulations on DBS while the Commission was in the throes of deregulating other services, "would be to ignore the lessons of recent years and create yet another service in need of deregulation at some later date".[12]

Furthermore, the report emphasized it had considerable evidence of a large demand for video programming unmet by conventional VHF and UHF television stations. It was concluded DBS had the potential to provide a service the public would want. The expectation was that DBS would probably provide several channels of video programming, likely on a subscription basis, which would enter the home via a small size terminal and other receiving equipment attached to a conventional television set.

Cable television, subscription TV, multi-point distribution service (MDS), video discs and video cassettes were other video services that would compete with DBS for customers since they produced the same product as far as viewers were concerned. The staff noted that DBS should be in the position to compete on an even basis with these services.

As a result of the abundance of different kinds of programming that would come from such varied sources, it was felt enough competition would exist to force DBS operators to meet consumer preferences without regulatory requirements that they do so. Furthermore, in view of this variety of competition and recognizing the high financial investment required to start up a DBS service, the FCC staff recommended that DBS operators be permitted to retain full control over content of programming transmitted to subscribers.

Finally, the staff concluded that based on content control, a DBS service would be included under broadcasting and broadcasting-related services. However, the FCC's consistent regulatory approach has been to subject the content of subscription radio and television to minimal regulatory scrutiny. Moreover, the FCC's General Counsel indicated a direct-to-home satellite service could be classified as a hybrid broadcasting communications service and, consequently, receive discretionary exemption from regulations that apply to conventional broadcasting.

The report ended on a surprising note by suggesting the FCC would face a tough task in determining allocations for DBS operators and recommending the Commission should settle on an auction process (lotteries or paper processing could also be utilized).

In promulgating the staff studies and Notice of Inquiry (NOI) the chairman of the FCC stated, "DBS may not fly. I believe the point ... is that the question of whether there should be such a service should be decided by consumer demand and the capability of the technology ... not by the (actions) of the regulator."[13]

The FCC, in April 1981, through a Memorandum of Opinion and Order accepted the free market approach to DBS. Furthermore, the FCC indicated it would accept interim DBS applications noting that these applications, while considered experimental, would be of great assistance to setting up the U.S. final policy position for RARC '83. As a result, the COMSAT (or STC) application was accepted; two additional entities (DBS Inc. and Hubbard Broadcasting Inc.) have submitted letters of intention wishing to establish direct broadcasting services.

4.2.3 CRTC View on DBS

The CRTC has neither hinted nor suggested publicly that it is giving thought to establishing regulatory policies and procedures related to a direct-to-home broadcast satellite service; apparently, this is viewed as entirely premature at this time. Staff have mentioned that the premature establishment of a domestic DBS regulatory policy could foreclose the possibility of rational and objective decision making, and could potentially undercut and distort Canada's position at the RARC '83 Conference.

In light of this uncertainty and prematurity, it is suggested by some members of the CRTC staff that no benefits could be gained from a pre-RARC regulatory policy framework or a pre-RARC interim authorization of DBS.

The technology of almost every major component of the DBS system has been moving ahead rapidly. It now seems evident many of the technical parameters adopted at WARC '77 and '79, for example uniform 6° orbital spacing between satellites, satellite power, flux density, may be outmoded and subject to revision. The decisions to be made at RARC '83 could become so fundamental and have such far reaching effects that it appears from comments received the Commission would rather defer any decision-making related to commercial DBS until after RARC '83.

In discussions with Commission staff, the idea has been put forth that authorizing a commercial interim DBS operation could inhibit the DOC's flexibility in arriving at an appropriate Canadian position at the RARC '83 Conference. An example is given to illustrate this contention: should an interim system be licenced at a particular power level, antenna pattern, modulation technique and channel bandwidth, the ability of the Canadian negotiating team to press for different standards might be compromised since it may be urging a different standard, which if adopted, would necessitate an early shutdown of the commercial interim system and cause a substantial loss of revenue.

Similarly, some CRTC staff suggests that interim authorizations could bias the development of permanent DBS policies. Should the DOC decide, after RARC '83, to allocate portions of the satellite broadcasting spectrum to non-entertainment DBS services, the introduction of a newly conceived plan might be difficult to implement and be subjected to many delays if an interim system were using this spectrum totally for entertainment services.

Furthermore, they suggest that, in the management of spectrum by the DOC, once an interim system becomes operational, it eventually becomes entrenched. Consequently, it becomes very difficult to take effective action to roll back the situation because of the allocated investments in the interim systems and the disruptions to service that would result to existing consumers.

4.2.4 Commercial DBS – Just Around the Corner?

Broadcasters who have been concerned with added competition from superstations or pay-TV, now, no doubt, have another concern — the potential of a commercial DBS system.

Until recently, direct reception of broadcasting from satellites to the home was thought of as unlikely considering the on-going international debates to resolve major political differences and the fact that no nation had a DBS system in service or planned.

From the time WARC '71 dedicated appropriate satellite spectrum to satellite broadcasting services, the concept of program signals transmitted via satellite to low-cost domestic and small community receivers has been the subject of much study and planning throughout the world. The great advantage of DBS, particularly as demonstrated in Canada, is that every part of the country, no matter how remote, can receive good quality programming signals.

Studies have shown that satellite distribution is a very cost-effective means of providing broadcasting entertainment services in the U.S.[14]

In spite of pre-operational experimental DBS successes, it was essentially Comsat's announcement, in August 1979, that it would shortly ask the FCC for permission to establish a commercial direct-to-home subscription entertainment service, which hurtled DBS into a pressing issue.

Comsat's announcement gave respectability to the idea of commercial satellite broadcasting. It is one thing for politicians and scientists to look at the success of controlled DBS experiments and to prophesy that direct broadcasting is at hand; it is quite another story when a large commercial entity, like Comsat, reports that the state of the art regarding technical feasibility is no longer a concern and, therefore, plans to launch a commercial DBS service.

Furthermore, the Comsat announcement removed any consolation broadcasters might have had regarding the start-up difficulties of a commercial satellite-to-home system. The Comsat announcement escaped the "chicken and egg problem" by seeking authority for a subscription system rather than an advertiser-supported system.

On December 17, 1980 Satellite Television Corporation (STC), a subsidiary of Comsat, filed with the FCC a request for permission to construct a commercial DBS system to be used for the delivery of premium subscription television service to homes, communities or cable systems.

Commercial DBS is now just around the corner, and with it many hard and difficult domestic policy decisions will have to be made by the regulators and/or politicians.

4.2.5 Comsat's DBS Application: Summary[15]

The application filed with the FCC by Satellite Television Corporation (STC), requests a permit to construct an experimental commercial DBS system to be used for the delivery of premium subscription television service to homes, communities or cable systems.

The system designed for satellite broadcasting, in its full implementation, will utilize four operating satellites; will be spaced 20 degrees apart along the geostationary arc; will provide nation-wide coverage including Alaska and Hawaii by means of shaped beams and accordingly, the signals will unintentionally spill over into Canada, particularly along the populated portion along the east-west border. The proposed plans are to have satellite transmissions in the 12.2 - 12.7 GHz band which has been temporarily allocated for Broadcasting Satellite Service in Region 2. Uplink transmissions will occur from an 11 m antenna in the 17 GHz DBS band. The three proposed broadcast-encoded RF channels per satellite would be transmitted directly from the satellite to a receiving antenna approximately 0.75 metres in diameter. Each channel would have 185 watts of power with an EIRP of 57 dBW. In addition, the proposed DBS system would be capable of providing closed captioning for the hearing-impaired, stereophonic sound, teletext and a second language sound track.

STC expects to charge approximately $14 to $18 per month for the three channel program service with subscribers having an option to either purchase the receiver at approximately $100 or lease the home receiving equipment from STC, or purchase the equipment from an outside supplier.

The application requests permission to begin construction on the first phase of the application calling for an operating satellite to be located at 115° W longitude. The phasing-in of this proposal is necessitated due to the huge financial requirements and to reflect the experimental nature of this application. It is experimental to the extent STC wishes to observe the operation before attempting to adopt permanent standards for commercial DBS services.

STC intends to devote considerable resources to the development and acquisition of a diverse mixture of high quality and imaginative programs and to the design of flexible program schedules to satisfy a broad cross-section of consumer tastes. This intention is predicated on the applicant being permitted the three RF channel broadcast service per satellite. The program diversification will occur by means of an active effort to "counter program" differing types of material on each of the three channels and to "narrowcast", i.e. to develop special interest programs to satisfy program preferences of relatively small audience segments. Without the three channel service, the applicant foresees adverse consequences. For the most part, it predicts commercial DBS service would be confined to movies and general entertainment with substantial duplication of programs and, therefore, inevitably be doomed to failure.

The success of a commercial DBS system, according to STC, must be rooted on presenting an attractive, broadly diversified and flexible program schedule with full control of content by the operator.

The applicant requests the FCC to render a decision expeditiously in the form of an "ad hoc authorization" i.e., the FCC is requested to utilize a form of adjudication procedure without in fact determining final regulatory policy and procedures for a regular or permanent framework for satellite broadcasting services. It is suggested that this "ad hoc authorization" will generate the data and experience necessary to conduct comprehensive and meaningful evaluations in the process leading to a determination of long-term policies to govern satellite broadcasting services. It further states that the system design is consistent with international provisions governing DBS systems and furthermore is sufficiently flexible to accommodate any reasonable DBS plan devised at RARC '83.

Finally the applicant closes on the note that the proposed system would not cause a substantial diversion of audiences away from conventional television to TV satellite subscription services and, moreover, such a diversion would result in an insignificant loss in revenue among broadcasters. It strongly suggests the principle of evaluation should be based on the question of whether a broadcasting satellite service would result in a net loss of overall service to the public and not whether the proposed entrant will affect the revenues and profits of existing conventional broadcasters.

4.3.0 Canadian Broadcasting – As It Is

Policymakers have viewed Canadian broadcasting as having a special significance. This view is rooted in the belief that consuming Canadian originated programs, Canadians then would be more in touch with that which is Canadian and would be able to see how ideas and issues, new and old, relate to the social-cultural fabric of Canada.[16] To this end the Canadian Broadcasting Act states that broadcasting should help "... safeguard, enrich and strengthen the cultural, political, social and economic fabric of Canada ... "; that the programming provided by broadcasters should be "... of high standard, using predominantly Canadian creative and other resources ..."[17] In general, it is viewed that the Canadian cultural sovereignty and Canadian entity is intimately bonded in the continuous development and reinforcement of the Canadian socio-cultural fabric with both of these elements becoming actualized when Canadians consume their own messages.[18]

Unfortunately, it has been judged that the attainment of these broadcasting goals has proved elusive due to the massive viewing, by Canadians, of American content on both Canadian and American stations received via cable television or off air.

Moreover, Canadian private television broadcasters achieve higher profitability purchasing and airing American entertainment programs than by engaging in costly domestic productions.[19]

The problem boils down to economics — program production is undertaken in a competitive environment, subject to great risk involving pilot acceptance, scheduling, counter-programming, programming trends, changes, (most of which are beyond the control of the program producer). Equally important is the observable fact that production costs are constant and, consequently, the size of the audience has no influence or control.

Recognizing these risks and economic difficulties in program production, Canadian private broadcasters, while producing their own news, public affairs and sports programming, have tended to purchase their entertainment programs from American production companies at prices well below the cost of producing comparable quality Canadian programs. As an added incentive, the American-purchased programs have established a sufficient viewing popularity to provide far greater advertising revenues than could be expected from Canadian-produced programs.[20]

The outcome has been a paucity of Canadian entertainment programming and virtually a void of Canadian-produced programming during peak viewing hours (8:00-10:30 PM) on the English private networks or on independent stations. This is due, in part, to the unsurprising fact that advertisers, not viewers, financially compensate broadcasters. The propensity of broadcasters is to evaluate the ability of programs to sell goods by holding the viewing audience during commercial messages. As a result the broadcaster schedules programs in a manner that attracts mass audiences and, correspondingly, receives large advertising revenues.

Canadian private broadcasters, in general, have achieved excellent financial performance due in part to their innovation, ingenuity, creativity and craft to achieve success and, in part, to the existing regulatory framework. According to a study prepared by Babe and Slayton for the Department of Communications, profits earned by private Canadian broadcasters have been consistently well above the competitive rate of return (defined as the cost of attracting new capital to the industry) with revenues increasing steadily to an average annual growth rate of over 15 per cent.[21] In their report, the authors calculated a rate of return on net assets plus working capital before tax for the period 1969 to 1978 to range from a low of 25.6% in 1971 to a record high of 55.1% in 1978. All of this has been earned despite the apprehensions Canadian broadcasters have expressed regarding cable television's threat of fragmenting viewer audiences with U.S. imported television networks and thereby siphoning revenues.

The CRTC has been given the mandate and authority by Parliament to supervise the Canadian broadcasting system in such a way as to achieve the goals established for broadcasting as delineated in the Broadcasting Act. However, the Act does not say what the regulations should be.

The regulator's authority is directed at the programming provided to the viewers and not to the viewing patterns. The Commission has neither rewarded nor penalized broadcasters on the basis of how well it attracted audiences to Canadian programs. Conversely, there are no obligations to require viewers to watch Canadian programs.

The two principal means by which the Commission has regulated the Canadian broadcasting system has been through introducing Canadian content quotas and the requirement to submit Promises of Performance.[22]

4.3.1 CRTC Regulations: Television[23]

Canadian content television regulations require Canadian broadcasters to provide 60% Canadian content from 6 AM to midnight and 50% from 6PM to midnight with the CBC subject to a more stringent requirement of 60% between 6 PM and midnight. However, the Canadian content regulations are diametrically contrary to the financial interest of private broadcasters who are in business for profits.

Relatively it costs more to produce Canadian programming than it does to procure American programs and because the former attracts smaller audiences and decreases advertising revenues, supplementary measures were introduced by the regulator:

1. Program substitution on cable systems was granted to Canadian broadcasters to substitute for similar programs on cable systems their programs, thus augmenting the audience for the local broadcaster and accruing additional advertising revenues therefrom;
2. Restrictions on the introduction of new and innovative services on cable systems, for example superstations, pay-TV, so as to maintain a relatively stable viewing audience for broadcasters to sell to advertisers;
3. Priority carriage of Canadian signals on cable systems; and

4. Restrictions on the use of advertising (or other commercial services) on cable system's local community channel.

By examining the Babe/Slayton rate of return to broadcasters, the measures of protection appear to have been very effective, while the goals set in the Broadcasting Act seem not to have been achieved.

4.3.2 CRTC Regulations – Radio[24]

The emergence of television in the late 1950's, forced radio to redefine its role and traditional characteristics. Radio entrepreneurs were able to adapt successfully to the revised needs of the marketplace; Canadians now have an increasingly wide range of choice between AM and FM stations. As a derivation of this choice variety, the resulting audience fragmentation has led to a substantial degree of specialization in the radio format.

AM Radio

Prior to 1970 most of the radio programming consisted of a mixture of records and talk. While most of the talk was Canadian, most of the music was not — the range of Canadian music was from 4 to 7%.

Beginning in 1970, the Commission issued new regulations requiring that at least 30% of musical compositions broadcast between 6 AM and midnight be Canadian and scheduled reasonably through this period. However, it was left to each broadcaster through the Promise of Performance to schedule programs to meet this regulatory requirement.

FM Radio

With FM radio, the Commission has adopted a different regulatory approach. The Commission did not introduce a regulation but rather specified, as a condition of the FM broadcasting licence, different levels of Canadian content for different types of stations on the basis of availability of Canadian music material. This approach was undertaken to stop immediately the simulcasting of programs i.e., FM stations and AM stations with the same programs and program scheduling.

By introducing this type of regulatory policy, the Commission was seeking to achieve FM program diversity. The Commission felt it had the right to proceed in this manner since the Broadcasting Act, while not specifically addressing the issue of diversity, requires that services provided by the broadcasting system be varied and comprehensive. The Commission's decision to seek diversity constituted a direct entry into the general management of FM radio services, substantially reducing the operator's flexibility. Perhaps more importantly, it was felt that the Commission, through this action, was becoming involved in the creative programming process.[25]

In general, broadcasters do not want to have program formats imposed by outsiders, particularly a regulator. They wish to have planning flexibility and appropriate incentives to respond to changes that are considered to be within their purview of providing service.

In summary, there are no existing regulations either in AM radio or FM radio that would preclude the regulator from considering the application of extending radio services beyond their natural boundaries.

4.3.3 Promise of Performance

The other major tool by which the CRTC has attempted to regulate performance is through Promises of Performance. Each broadcaster (radio or television), either when applying for a new licence or seeking a renewal of an existing licence, submits the programming plan for the term of the licence. Because the Commission views itself, when dealing with broadcasting items, as an administrative tribunal, it consciously minimizes its judicial role and, consequently, has been reluctant to permit cross-examination, financial disclosure and competitive licencing. The Commission has generally relied on an informal approach to fact-finding and licencing determination. As an outflow of this process, the Promises of Performance, while enforceable in law when attached as a condition of licence, have often not been fulfilled, and equally, have not been effectively enforced.[26]

4.3.4 Commercial DBS Impact on Broadcasters: Substantial or Insignificant?

In a submission to the CRTC on Canadian content, the Canadian Association of Broadcasters stressed the challenge broadcasters must face in Canada. Not only must they serve with a first-class array of programming in both French and English a population of less than twenty-three million spread over six and one-half time zones and a vast land mass of 4,700 miles (east/west), but also broadcasters must attempt to provide programming comparable to that of the U.S. network stations. Notwithstanding this continual challenge (as pointed out in the submission), broadcasters currently believe they are now facing an even greater challenge: that of technological change. Broadcasters have had to contend with the introduction of cable delivery systems, home video recorders, video cassettes, video discs, video games and now must grapple with the possibility of a direct-to-home broadcasting satellite.

As discussed in many broadcasting journals, each and every one of these new technologies represents a potential contraction in viewing time devoted to conventional television. However, private broadcasters depend entirely upon revenues derived from the sale of air time to advertisers. Those sales and the value they represent in revenues are entirely dependent upon the size of audience attracted to its programming. Consequently, it has been viewed by the regulator that the introduction of new program services should add to and not cause undue damage to the existing local broadcaster.

The structure of current broadcasting is based on the existence and operation of local broadcasting stations attuned to and serving local community needs by providing to its viewers (radio and television) a blend of national and international programs with local and regional coverage of news, public affairs and local programming. The introduction of a direct-to-home broadcasting satellite service would necessarily by-pass local broadcasting stations, and accordingly it is believed would impose improper financial pressures on local broadcasters that they could not meet.

Hence, broadcasters argue strongly against a direct-to-home satellite broadcasting service which, in their view, would duplicate or be in direct competition with their services, thus fragmenting their audience and causing undue harm and reducing the positive effects accruing to communities from local broadcasting services.

Broadcasters point out that the CRTC has consistently prohibited introduction of new services that endanger the vitality of the local broadcaster. They cite the CRTC's negative decisions regarding the introduction of pay-TV and of superstations, the requirement of cable systems as a matter of priority to carry local stations, the prohibition of commercial advertising on community or special programming channels and the provision for simultaneous program substitution in favor of the local broadcaster.

The Babe-Slayton report, however, suggests quite strongly that private television broadcasters have failed to achieve the goals set out in the Broadcasting Act and their performance within this framework has been poor. As noted previously, the private broadcaster's goal is to generate profits by providing and scheduling programs that sell advertising by attracting large audiences. To this end they have done their jobs well earning rates of return that have been classified by the consultants as "supra normal". Thus private broadcasters in spite of their concern, and protest, appear not to be suffering unduly so far from competitive alternatives. Additionally, broadcasters have received substantial regulatory protection while, according to Babe-Slayton, contributing minimally towards achieving the goals of the Broadcasting Act.

In general, broadcasters are interested in reducing competition not only for reasons that have become apparent but more importantly for control of the system. With a lack of competitive alternatives, advertisers must seek the highest viewing audience. However, advertisers and program producers (writers, artists, performers, etc.) would rather have increased competition in order to have more outlets which would have the potential effect of lowering the price charged for ad time and allowing more variety in program production. More broadcasting outlets would allow for target advertising to groups most likely to purchase a given product and equally would allow creative freedom for program originators to produce programs with contents, structure and tone in an innovative and flexible manner without fear of imposed restrictions.

It is in this context that the espoused principle of content-carriage separation receives substantial support. In having each segment specialize in what it knows best, it is felt that greater efficiency will occur which would in the long run effectively contribute to diversity and the public interest. Thus it is viewed from the content side that telvision would specialize for targeted audience much like magazines and Canadian radio have done. As a result the total focus would become oriented to establishing program content to favor targeted audiences and consequently reduce the propensity of having narrowcasted specialized programs discriminated in favour of mass programming vis-a-vis the delivery system.

In summary, the fears of audience fragmentation and economic damage put forward so vigorously by broadcasters has not been empirically upheld. In fact, quite the opposite has taken place. Studies for the Comsat DBS proposal conducted by Arthur D. Little Inc. clearly[28] indicate that an optimistic *sixteen percent level* of audience penetration would direct only *three percent* of the audience from conventional television where cable TV and STV/MDS systems are not yet available. The FCC has determined, through empirical analysis, that undue harm to local broadcasters would commence where audience fractionalization is above the computed ten percent level.

In light of these impact statistics, a direct-to-home satellite broadcasting service appears prima facie not to threaten the financial survival of local broadcasters particularly if the intended satellite services would be supported by customer subscriptions rather than advertising revenues.

4.3.5 Social Considerations

The Broadcasting Act stipulates, among other things, that programs should be varied and comprehensive and should provide a reasonable, balanced opportunity for the expression of different views. This implies, a supply of programs across the various program types which would be imaginative and of such quality to attract the general audience and, as well, programs catering to specialized viewers.

In this regard, audiences would like to exert some control or influence over programming content that they view. It has convincingly been demonstrated that allowing audiences to choose from a wide range of program alternatives (mass appeal to narrowcasting) increases their power over television content. Babe and Slayton conclude that audiences wish to have increased competition in programming and, furthermore, have demonstrated this requirement in the marketplace through action by subscribing to cable services and purchasing new video technologies.[29]

The proliferation of unauthorized earth stations receiving program signals illegally from U.S. satellites is another illustration of the degree to which the consumer will pursue the need for alternative programming choice and diversity. Inasmuch as the development of cable television has resulted in an increase of television channels, it has, at least initially, given the consumer an opportunity to select specialized programs or services reflecting his particular interest (e.g., PBS). From a practical viewpoint, the U.S. television industry has successfully demonstrated that, while there are many viewers receiving conventional television, there are as many paying for vertical services (such as sports channels, children's programming, etc.) supporting the case for diversified and specialized programming. A symbiotic relationship has evolved benefiting the consumer in terms of program diversity and choice.

Overall, the public is demanding more choice in the strongest possible terms. The means by which the diversified programs would be delivered is not of as much concern as is the expected price for the services, the assurance of service continuity and the flexibility to use whatever hardware is required with potential alternative programming suppliers.

In addition, consumers are wanting not merely more entertainment but, in addition, access to information. In achieving this, some have proposed that the satellite broadcasting services should be oriented to benefit the public in terms of providing social services. In their view, medical, educational, informational and other public services should be treated equally and not discriminated in favour of entertainment.

4.3.6 Program Content

The Broadcasting Act declares all Canadians are entitled to varied and comprehensive programming. Accordingly, broadcasters have interpreted this as a means of balancing their services among information, entertainment and enlightenment categories while maintaining their financial performance. More and more consumers are expressing their dislike of existing conventional services and are seeking out alternatives.

While some are in disagreement with the current television fare, others are forcefully complaining that they are entitled to current broadcasting services. During the Therrien Committee meetings held in April 1980, it was confirmed that many population pockets located in rural and remote areas were substantially underserved. In its report, the Committee strongly emphasized that extension of existing broadcasting services should occur immediately using satellite technology.

To this end the CRTC addressed at a public hearing the question of extending conventional broadcasting services to northern and rural communities. While the Commission expressed confidence that "....innovative and imaginative use of new technology....would be used for this purpose", proposed applicants were made aware that their proposed entertainment program packages had "....to be identical or similar to that currently offered by broadcasters in other parts of the country". In calling for these applications, the Commission was mindful of consumers' special needs and, although not wishing to jeopardize the operations of existing broadcasters, noted that the onus was being placed on them to prepare and demonstrate the extent to which consequential damage to their programming capability would be impaired by the licencing of new services. This promulgated position is quite a turn of events in Canadian broadcasting and has given rise to the expectation of introducing program diversity in the form of specialized vertical services catering to targeted and mass audiences.

Notwithstanding this new position, it should not be anticipated that the Commission would free applicants from the constraint of Canadian content. Rather, the prediction is the Commission would attempt to achieve the Broadcasting Act's goals by challenging the imagination and entrepreneurial risk takers to program more Canadian productions on an entertainment format oriented for vertical specialized services.

Before any new services are licenced by the Commission, applicants no doubt will have to clearly demonstrate that their proposed new services are real and distinct, will offer an alternative to existing conventional services and will not significantly fragment audiences. In an address to the Commission on the application of CBC-2/Télé-2, the President of the CBC, A.W. Johnson, indicated that these specialized vertical services are not considered a concern to cause substantial fragmentation because it was felt that the proposed new services would appeal "primarily to those who currently watch little television....we think it is mainly those who watch little television who will be drawn to CBC-2/Télé-2....because they will find these more of interest....than they do on the....conventional television services".[30]

It is this specialization in programming that is anticipated to dominate in the l980's, since it is believed that this approach in programming will give new life, new hope and new optimism to the Canadian broadcasting system.

4.3.7 Program Delivery: Satellites

The Honorable David MacDonald's (former Minister of Communications) objectives and guidelines in the uses of satellites called for the extension of broadcasting services to inadequately served areas and, furthermore, the offering of a broad range of program services responsive to viewer preferences.[31] In this context there are in effect two focuses:

- extension of existing broadcasting services to underserved areas
- offering of new program services to all Canadians regardless of location for both mass and specialized audiences.

However, in the framework and subsequent discussions of direct-to-home satellite technology, there are some who do not make this distinction of usage. The principles of direct-to-home satellite broadcasting, among other things, assume the satellite signals are intended for general reception by the public. With regard to the deliberations on the extension of services, the Commission pointed out quite clearly that proposed applications should merely duplicate what is currently available and in special cases accommodate the indigenous requirements. Many believe that these extended program signals will not be made available to all Canadians simply because the mere duplication of similar programming would have the potential of directly harming the local broadcasters.

It is felt, therefore, that the carriage of program signals for extension of services will be assigned to fixed services. Furthermore, it is anticipated these signals will be restricted from being redistributed by existing cable systems in order to protect the local broadcaster's revenue base should there be duplication of signals. On April 14, 1981 the Commission granted the extension of service network licence to CANCOM supporting the above statements and contending that the public interest will be protected in that all Canadians will be in a position to receive similar conventional broadcasting services without unduly jeopardizing the existing broadcasting infrastructure as it pertains to conventional services.

In conjunction with the second focus i.e., offering of new program services, specialized vertical services such as subscription services, premium pay-TV services, social services and others are deemed to be appropriately applicable to a direct-to-home satellite broadcasting service. Whether the program signals are received directly by homeowners, distributed by community services, cable systems or retransmitted is of no consequence, as long as all Canadians have the potential of receiving these programming signals. It is felt that these proposed services will have a much better chance of succeeding in being authorized if their proposals are not contingent on revenues received from advertising.

4.3.8 DBS and Anik C

Theoretically, a direct broadcasting satellite would operate in geostationary orbit, would transmit high power signals for reception at individual residences by small and inexpensive earth stations. These transmissions could cover an entire time zone or be directed by spot beams to cover a smaller area. The receiver package (antenna, amplifier and converter) could cost in the range of $100 to $1,000.

The numerous benefits in implementing a DBS include:

- satisfying consumer demand for diversified video services and other social services;
- stimulating and augmenting the program production industry;
- equalizing video services to rural and remote areas of Canada;
- promoting economic activity and employment opportunities; and
- preserving Canadian leadership in satellite communications.

While acknowledging these five potential benefits, questions have been raised about the use of ANIK C for interim DBS services vis-a-vis the ITU Radio Regulation. This concern is based on an interpretation of the WARC '79 footnote which states "... transponders on space stations in the fixed-satellite service may be used additionally for transmissions in the broadcasting-satellite service ... (but) ... this band shall be used *principally* for the fixed-satellite service ..."[32] Accordingly, it is argued that only some ANIK C channels might be used for DBS services but not a full satellite. Telesat is not in consonance with this opinion. Rather, the Company believes that an ANIK C satellite can be dedicated to DBS services in the FSS band as long as such usage neither causes greater interference nor requires more protection from interference than another ANIK C used strictly for fixed-satellite services. The use of a single ANIK C for DBS services cannot reasonably be construed as resulting in the 12 GHz band being used *principally* for broadcasting satellite services, particularly in view of the number of foreseen American FSS systems.

In reviewing the footprint patterns of Anik C, opponents maintain that the potential DBS role of Anik C would have to be confined in view of the assumption that the 14/12 GHz satellite would be of little practical use for northern Canadian communities to receive proposed DBS services. Even with the satellite beams tilted, the Therrien Committee reported it was not satisfied the tilt would satisfactorily solve the problem, a view disputed by Telesat (see Section 2, Appendix C).

In addition, DBS is based on the anticipation homeowners would own their own earth stations. It is expected Anik C will operate as a fixed satellite service, with the associated receiving earth stations licenced only to carriers, governments, broadcasting undertakings and acceptable institutions; homeowners are currently excluded. However, this restriction is currently under review by the DOC.

Furthermore, the power of Anik C is moderate in comparison to the U.S. approach — Comsat intends to use high-powered satellites in the order of 180 watts per channel. Therefore, the effects of spillover along the Canadian east-west corridor is inevitable. Given the high risk and huge investments of a DBS undertaking, potential users of DBS would want some type of assurances that Canadians would not redirect their earth stations in favour of receiving DBS programming from American DBS satellites.

Notwithstanding these concerns, some of the major applications for extension of services to rural and remote areas proposed to have their programming signals carried on Anik C. In particular, the thrust of one applicant's proposal, Northstar Home Theatre Inc., was based on using this satellite. In this application they submit that misinformation led to mistaken conclusions regarding Anik C coverage. The application contends that Anik C will provide effective service to all of Canada and goes on to conclude that Anik C is "... the best possible choice for this country, in terms of coverage, reliability, channel capacity, time zones, regional efficiencies, protection of the broadcasting system, prevention of piracy and cost effectiveness."

In planning a broadcasting satellite, Lloyd Ludwig, the former manager of direct broadcasting systems for Hughes Aircraft and now a DBS consultant, strongly points out that the first thought must be given to service area and the capability of the earth terminals. It is these two factors that dictate how powerful the channels on the satellite must be to deliver a quality signal in the home, and it is precisely in this area of trade-off where experts disagree.

In a speech delivered at the International Institute of Communications by Mr. Alex Curran, Assistant Deputy Minister Space Program, entitled "Direct Broadcasting Satellite – Myth or Reality" he discusses the drawbacks of employing high power satellite systems.[33]

"The satellite with such large transponders and correspondingly large power supplies are expensive to build, costly to launch and are less reliable than moderate power satellites... It is equally interesting that cost studies also support the use of lower power levels... Thus there are advantages to the use of lower powers in the broadcast satellites....the very high power satellites proposed at 1977 WARC have not yet been demonstrated to have the reliability normally associated with operational systems. It has been shown, however, that acceptable quality of reception can be achieved with much *lower* powered satellites, while maintaining the advantages of low cost, small earth stations. Both the satellite and the earth stations are available for these power levels."

Northstar Home Theatre Inc. fully supports the position taken by the DOC that the 14/12 GHz configuration of Anik C produces the most reliable and cost-efficient satellite-to-home system on any design board anywhere at the present time.

It is pointed out that Anik C is extremely well suited for the applicant's broadcasting requirements because the:

- footprint covers all Canadians in rural and remote regions;
- system has flexiblity for providing regionalized programming to cater to regional needs;
- four spot beams can accommodate the different time zones;
- earth stations can be located wherever there is an unobstructed signal line with the satellite;
- reception from 14/12 GHz will alleviate (or at least not increase) piracy on the 6/4 GHz system; and
- earth stations will be relatively small and inexpensive to purchase.

4.3.9 Conclusion

While the direct broadcasting satellite is a technology to be reckoned with, it is nothing more, however, than an alternative method of program distribution. Insofar as broadcasting satellites are used for the distribution of programs broadcasters fear its perceived impact in fragmenting audiences and diluting advertising revenues. However, it should be remembered that the cause for audience dilution is program diversity, not satellites. Audience dilution is unaffected by the means by which programs are delivered to television households. Furthermore, the study by Arthur Little Inc. and the analysis by the FCC suggest that the fear of audience fragmentation and the fear of economic damage caused by the introduction of new broadcasting services are not empirically upheld.

While RARC '83 will have a substantial thrust in the long run framing of a Canadian broadcasting satellite system, the current regulatory movement, particularly as it applies to extending basic broadcasting services to the underserved communities, is one of permissive flexibility. Noting that the burden of proving harm had been shifted on to the broadcasters, the Commission has indicated it will consider innovative approaches in order to provide basic television services to these underserved areas. While the Commission has authority to exercise whatever flexibility might be required to assist start-up operations, nevertheless it is expected to proceed in a manner that will cause minimum disruption to current broadcasters.

Once it can be stated that all Canadians have the potential to receive basic broadcasting services, the Commission has given appropriate hints that it will consider new programming initiatives that respond to consumers' special needs. Whether the program signals are received directly by homeowners, distributed by community services, cable systems or retransmitted is of no consequence as long as all Canadians have the potential of receiving these new programming initiatives. It is felt that these vertical services would have a much better chance of succeeding in being authorized if their proposals were not contingent on revenues received from advertising. Moreover, it is felt that the long-term thrust of satellite broadcasting services lies in developing this potential market with vertical services for both mass and specialized audiences.

In order to enjoy these Canadian broadcasting potentials, Canada must act *now* and preempt the United States in the introduction of *Direct Broadcasting Services directly from satellites.*

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4.4 Rates and Service Offerings

In this activity we have developed the "ballpark" annual rates that would be applicable for an interim DBS (IDBS) service using the AnikC series of satellites. Annual rates for the television transmit earth segment and the space segment are presented in Section 4.5. These rates, along with the related definitions of service, and terms and conditions are incorporated into a "Strawman Tariff".

To accomplish this, we have drawn on the results of sections 1.0, 2.0, and 3.0. Section 1.0 provided market information which was used in determining the projected loading of the available space segment capacity. Section 2.0 provided the technical descriptions and specifications which were further incorporated into the definitions of service for applicable groups of services. Section 3.0 contained the estimated capital and operating costs which are two of the major cost components required in determining the service costs for the IDBS services.

In order to meet the Company's corporate objectives, rating objectives and principles, the rating process must examine the total system implications of the proposed IDBS services and must ensure that rates for such services do not confer an undue advantage to some customers at the expense of others. Therefore, the IDBS rates are derived in a manner that is fair and just to all of Telesat's customers.

The design of the "Strawman Tariff" contained in Section 4.5 is future oriented and takes into consideration both internal and external factors. The service definitions have been drafted with sufficient flexibility to allow some latitude in future interpretation. To define these service offerings on a refined basis would impose an unnecessarily rigid framework to accommodate for unforeseen developments in the IDBS market and technology. The rates are based on future expected costs and market demands.

Finally, in developing the rates and service offerings, consideration was given to the business risk inherent in a project that contains certain elements of uncertainty. These uncertainties concern the market forecast. We have attempted through the provision of a range of annual rates to include these risks in our consideration surrounding the rate and tariff design.

4.4.1 Rating Principles and Objectives

(1) Sources

Telesat's rating principles and objectives were set out in the Memorandum on Rates and Related Issues, filed in Exhibit No. Telesat-80-10 with the Commission on January 16, 1980. In summary, these principles and objectives are:

(2) Rating Principles

(a) Recognition of Costs

The rate structure should result in charges sufficient on a segment basis (space and earth) to generate revenues that cover total operating and administrative costs and provide a fair rate of return to investors. Telesat's view is that, in general, costs associated with each segment should be recovered through revenues generated from each segment.

(b) Value of Service

In developing space segment rates, the first step was to account for the overall service costs required for an integrated space segment network configuration. Furthermore, in order to meet the customer's demand for a multi-type and multi-class of service offerings, the "value of service" principle is used in establishing a series of value factors which represent the true values of these services.

(3) Rating Objectives

(a) Optimize Plant Utilization

To maximize the domestic satellite telecommunication traffic, Telesat's space rates are distance-insensitive and not related to the number of earth stations involved in the reception or transmission of the said traffic.

(b) Meet Competition

In order for Telesat's services to be attractive to a customer, rates must reflect the discipline of the overall telecommunications marketplace.

(c) Simplicity

Telesat's Strawman Tariff has been arranged in such a way that it is simple to interpret and to apply.

(d) Provide Appropriate Revenue

Rates are designed to generate sufficient revenues in order to allow the Company to continue to provide its services and to be able to attract additional capital investment.

4.4.2 Telesat's Standard Rating Methodology

Since Telesat's rating methodology is cost-oriented, the Discounted Cash Flow (DCF) method was used to arrive at the future service costs for the services. In addition, due to the uncertainty involved in the nature of satellite business activities, the range of rates was introduced in order to quantify the risks. The incidence of risk is analysed independent of the DCF method and is characterized by estimated probabilities.

(1) Component of Cash Flow

The DCF method takes into consideration the cash outflows and inflows and the timing of these cash flows associated with the provision of a specific service. Cash outflow consists of capital investment, and operating and administrative expenses. Cash inflows consist of revenues and salvage. Telesat passes on to the customer the tax savings resulting from the capital investment.

(2) Service Cost Components

Service costs which form the basis of Telesat's rates and charges are derived through application of the DCF methods. The two components of the service costs are:

(a) Recovery Component

The discount rate used to arrive at the service cost for each capital investment is Telesat's cost of capital. This provides an upper limit of recovery component which determines an appropriate return expected by the Company. The amount includes recovery of capital investment, cost of capital and corporate income taxes.

(b) Expense Component

This component identifies the requirements for on-going operating and maintenance expenses, and general administrative expenses.

4.4.3 Space Segment Rating Methodology

In order to ensure that the rate structure for the IDBS services complies with current and future services and meets the demand of the current and future customers, the space segment rates covered in this report are developed based on the following:

(a) Telesat's Tariff CRTC 8001

The general terms and conditions to be offered for the IDBS services should be consistent with the general terms and conditions applicable for the services specified in Telesat's Tariff CRTC 8001, filed with the Canadian Radio-television and Telecommunications Commission on September 20, 1979.

(b) Telesat's Plans Pertaining to the Pre-Launch Anik C 14/12 Tariff

The "ballpark" rates and associated service offerings for the IDBS services should be compatible with the rate offerings to be included in the future Tariff filing of Anik C 14/12 GHz services.

The summary of the space rating information is:

(1) Recognition of Costs

The total capital investments for each satellite include satellite costs, associated Telesat Engineering costs, launch costs, insurance premiums, Allowance for Funds used during Construction (AFC), and incentive payments. In addition, there are allocated and dedicated capital investments for Telemetry Tracking and Command (TTAC) facilities, allocated operating and administrative costs. Since the principle costs for space segment services are fixed and must be incurred in "lumps" at each launch time rather than in smooth annual increases, the weighted average cost pricing method was used to arrive at space segment rates.

(2) Study Period

In light of the fact that the physical life of a satellite is approximately eight years, a study period of eight years covering 1983 to 1990 inclusive is used in the space segment rate design of this report.

(3) Service Costs

The service costs for each satellite are calculated based on the actual and expected total costs incurred. The following in-service dates are assumed:

Satellite	In-Service Date
Anik D1	October 1982
Anik C1	January 1983
Anik C2	May 1983
Anik D2	July 1984
Anik C3	February 1986
Anik E1	April 1990
Anik F1	December 1990

For each satellite, the service costs are analysed on a yearly basis by summing the annual recovery components of each satellite and the allocated portion of the operating and administrative costs.

(4) Loading of the System

A percentage loading factor representing the potential market utilization for the IDBS services was incorporated in the space rate design.

(5) Unit of Service used in Space Rating

One unit of space segment service is defined as one "Television Channel Service" which includes one video and associated audio program. Based on the recommendations summarized in Section 3.2 of the Economic Analysis in this report, rates per unit given under item 4.5.4 are developed on the assumption that two "Television Channel Services" would be provided on one transponder of the Anik C satellites. It should be noted that the rates given under item 4.5.4 could be increased by as much as 80% to 90% for the service furnished with a requirement of one transponder per "Television Channel Service".

(6) Annual Rate per Unit

Table 4.5A provides the range of annual rates per "Television Channel Service" developed for the IDBS services.

(7) Price Changes with Respect to Changes in Quantity Demand

In order to provide DOC the flexibility of reviewing the Strawman Tariff towards various policy applications, the price effect was analysed based on the marginal increase or decrease of one "Television Channel Service" per year from the weighted average forecasted market utilization per year. The above price effect could be expressed as follows:

For each incremental demand for the "Television Channel Service", the annual rates will be reduced by $15 000 per unit of service. For each decremental demand for the Television Channel Service", the annual rate will be increased by $28 000 per unit of service.

4.4.4 Earth Segment Rating Methodology

The methodology used in rating the IDBS earth segment services are the same as those Telesat has currently employed in rating the existing 6/4 GHz earth segment services.

(1) Recognition of Costs

The rates for the television transmit services were derived directly from the capital investment in the earth station facilities required to provide the services and from the related annual operating and administrative costs. The capital costs consist of communications equipment, Telesat Engineering, and Allowance for Funds used during Construction. These costs, along with the annual operation and maintenance costs, were developed in Section 3.0. The administration costs consist of a portion of the overall corporate administration overhead which is allocated to services based on a percentage of capital investment. This allocation principle is the same as that used to develop the rates for the comparable 6/4 GHz services.

(2) Study Period

Since the physical life of the Anik C series of satellites is expected to be approximately eight years, the planned service life of the IDBS earth segment should also be approximately eight years. This service life was used to determine the period for recovery of the capital investment.

(3) Service Costs

As described previously, the recovery component of the service cost is derived from the amount of capital investment using Telesat's cost of capital. The expense component of the service costs, which is adjusted for forecasted inflation, is derived from the estimated annual operation and maintenance costs and the allocated general administrative costs.

(4) Rates

Based on a system providing two "Television Channel Services" per transponder, the appropriate television transmit services were selected from Table 3-3B and 3-3D in Section 3.0 for rating. The results are shown in Table 4.5B. These rates assume that support facilities, foundations, and prime power will be provided by others at no cost to Telesat. All the maintenance will be the responsibility of Telesat at the transmit locations.

4.5 Strawman Tariff

4.5.1 Application of Tariff

The Strawman Tariff applies to "Television Services" furnished by the Company and contains applicable regulations, conditions, and "ballpark" rates.

"Television Services" are furnished via the satellite telecommunication system and consist of "Television Channel Service" (space segment), and "Television Transmit Services" (earth segment). The general description and the distribution of annual rates applicable for "Television Channel Service" and "Television Transmit Services" are shown separately hereunder. No rates are presented for television receive - only service, since it is assumed that this will be provided by others, hereby through sale rather than lease.

4.5.2 Definitions

The definitions covered under Items 2.2 to 2.21 in Telesat's Tariff CRTC 8001 also apply to this Strawman Tariff.

4.5.3 General Regulations

The General Regulations covered under Item 3.0 of Telesat's Proposed Tariff CRTC 8001 also apply.

4.5.4 Television Channel Service

(1) General Description of Service

"Television Channel Service", furnished by the Company, consists of a one-way monochrome or colour video channel and an associated audio channel. "Television Channel Service" is provided via satellite beam or beams which furnish service on 1/4 Canada or 1/2 Canada coverage basis.

(2) Full Period Television Channel Service

(a) Description of Service

"Full Period Television Channel Service" is dedicated to the customer's use twenty-four hours per day, seven days per week. The service is unprotected in the event of service interruption. The Company will not provide a protection video and associated audio channel. If a service interruption occurs, the Company may at its discretion substitute another video and associated audio channel.

(b) "Full Period Television Channel Service" is available on the 1/4 Canada or 1/2 Canada coverage basis. Coverage is described in Section 2.0. It is intended that the future tariff will specify precise service areas in terms of geographical references and associated EIRP's.

(3) Rates for Full Period Television Service

The annual rates per television service are:

Table 4.5A Distribution of Annual Rates per Television Channel Service

Lower Significant Amount	Upper Significant Amount
$1 050 000	$1 160 000

(4) Operating Term

The operating term is a minimum of one year.

4.5.5 Television Transmit Service

(1) Service Description

"Television Transmit Service", furnished by the Company, provides the capability of transmitting one monochrome or colour video channel and an associated audio channel from a terrestrial designated location. The service is provided in two modes:

i) single user service
ii) common user service

The single user mode permits only one such uplink service at each designated location. The common user mode permits up to eight such uplink services at each designated location.

(2) Rates for Television Transmit Service

Table 4.5B Distribution of Annual Rates

Service Description	Annual Rates Lower Significant Amount	Annual Rates Upper Significant Amount
TV transmit at a common user site:		
– main station with first transmit	$115 000	$125 000
– each additional transmit	50 000	55 000
One TV transmit at a single user site	90 000	95 000

(3) Operating Term

The operating term is eight years. It should be noted that the above annual rates for the television transmit services are established based on the assumption that the service life for such services be eight years. However, Telesat would entertain offering the service with an operating term reflecting a longer or shorter period, should the need arise.

(4) Customer's Responsibilities

In order to enable the Company to furnish service on the commencement date and thereafter during the operating term, the customer shall grant or furnish in a manner approved by the Company, the following:

(a) transportation for the earth station facilities and personnel to and from the site, meals, lodgings, transportation, construction tools, and non-technical personnel at the site,

(b) the site, primary power at the site and civil works,

(c) the legal right to locate the earth station on the site, and to use and occupy the site,

(d) access to the earth station whenever such access is deemed necessary by the Company or its agent, and

(e) maintenance of customer's facilities furnished to the Company by the customer.

Annex

Historical Review of the Emergence of DBS

Introduction

As early as 1945, the concept of communication via satellite was being hypothesized. In the following decade, the hypothesis became a reality when the first man-made communication satellite was launched. In the ensuing years, literally dozens of satellites were designed and launched with varying degrees of success. The results of each endeavour, whether positive or negative, have formed a base on which to advance so that now, only 23 years later, tremendous strides have been made in satellite technology and new ground is being broken with the emergence of satellites designed to operate in the 14/12 GHz frequency bands capable of providing both fixed satellite service and broadcast satellite service.

While direct broadcasting is undoubtedly another milestone in technical advancement, its greater impact may be on social and cultural development which would, in turn, affect the political and economic climate of any country or region introducing such a service.

This portion of the study presents a brief historical review of the emergence of direct broadcasting satellites (DBS).

In satellite telecommunications generally, the fifties may be characterized as a decade of speculation, the sixties a decade of experimentation and the seventies a decade of realization.

The Seventies – Realization

With the launch of Anik A on November 9, 1972, Canada became the first country in the world to have an operational geostationary domestic communications satellite system. In 1973 Intelsat was formally established to promote usage of a global communications satellite system. Its first satellite, EARLY BIRD, went into commercial service in June 1965. By the end of the 70's at least a score of countries had domestic satellite communications facilities. Some countries own and operate their own systems; others operate regional satellite systems or lease facilities from Intelsat. All of these countries use the television broadcasting capability of the satellite to distribute television service or to augment existing microwave television facilities.

The Eighties – Innovation

Based on the experience of distributing television signals via satellite many countries, hampered by geographical conditions, are focusing attention on DBS.

A review of the literature reveals that because of the development of small earth station technology, direct broadcasting is recognized as a feasible solution to communication needs which cannot be met even with 6/4 GHz satellite coverage: e.g., remote area coverage and increased demand on congested broadcasting frequencies. Nevertheless, while there is enthusiasm for the theories and principles of DBS, in practice definite commitment to its introduction has evolved slowly.[1] The principal reasons for the high interest but low involvement are:

- Radio frequency spectrum allocations for DBS service
- Politics
- Economics
- Technology Development.

1. Use of the Radio Frequency Spectrum

The use of the radio frequency spectrum is determined by the International Telecommunications Union (ITU), an association established to promote international cooperation and foster scientific progress and technical development worldwide.[2] From time to time the 150 member countries of the ITU meet at Administrative Radio Conferences (ARC) to discuss their concerns and agree on RF spectrum usage.

For ITU purposes the globe is divided into three regions:

Region 1 – Africa, Europe and Northern Asia

Region 2 – North and South America and the Caribbean

Region 3 – Southern Asia and Australia.

Since 1959, four conferences have been held to determine in which part of the RF spectrum direct broadcasting satellites would operate.

In 1959 a General Administrative Radio Conference allocated the frequency band 11.7 to 12.7 GHz to fixed service, mobile service (except aeronautical mobile) and broadcasting service.

In 1971 a World Administrative Radio Conference (WARC) on Space Telecommunications modified the 1959 frequency allocations to accommodate space service, including direct broadcasting service (and also including fixed satellite service in Region 2).

WARC 1977 established the sharing criteria between broadcasting satellite and fixed satellite service for the 11.7 to 12.2 GHz bands in Regions 2 and 3, and 11.7 to 12.5 GHz bands in Region 1. Orbital segments were assigned to one or the other service for all countries in Regions 1 and 3. A Regional Conference in 1983 will attempt to reach agreement on segmenting the orbit in Region 2.

WARC 1979 rewrote all existing Radio Regulations and included therein the Final Acts of WARC '77 and a revised Table of Frequency Allocations.

DBS frequency allocations and orbital placements have only recently been determined in Regions 1 and 3 and are still in question in Region 2. The uncertainty surrounding this very important aspect of DBS has been reflected in the lack of DBS planning.

2. Politics

Governments try to ensure they have all the facts pertinent to any situation before formulating policy decisions. In the case of DBS, some of the national implications to be considered are: cultural erosion, programming content and language, the effect on established microwave and broadcasting networks, excess channel capacity, and financing. International issues such as interference with other satellites, spillover, and copyright infringement must also be studied.

Industry is naturally reluctant to commit the large amounts of money involved until they know the parameters of their situation.

3. Economics

Financing of the satellite system itself from conception through design, testing, launch and operation is a major economic consideration. Small and/or developing nations cannot in all probability afford their own satellite systems. While their interest and needs may be great, they must either depend on larger nations or Intelsat to lease them capacity, or enter into joint agreements with other small countries to share regional satellite systems. Any country embarking on widespread usage of DBS with its resulting cultural impact must also consider the economic ramifications which would be inevitable.

4. Technology Development

Research and development funds and facilities, high technology expertise and capability do not exist in many countries; this presents an obstacle to DBS planning. Some countries are awaiting the results of experiments being conducted in Canada and Japan before committing themselves.

Community Reception Experiments

Many governments have recognized the benefits of better communications to and from isolated areas to provide medical and educational services and radio and television entertainment. Despite the problems to be faced and overcome, some countries have undertaken experiments to prove the feasibility of direct broadcasting satellite for these applications.

ATS-6

ATS-6 was the only Applications Technology Satellite in the NASA series with television broadcasting capability. NASA established the mission goals:

- demonstrate and evaluate, through experimentation, satellite applications and required technology;
- test the feasibility of small (3 m), simple to operate, inexpensive terminals for television reception

The ATS-6 DBS experiment operated in the 2.5-2.69 GHz frequency band and could provide one video signal with four audio channels. It was not designed to broadcast conventional television to the user, although 3 of its 27 experiments were intended to demonstrate the possible uses of a broadcasting satellite. These were

1. HET - Health/Education Telecommunications Experiment (U.S.A.)
2. SITE - Satellite Instructional Television Experiment (India)
3. TRUST - Television Relay Using Small Terminals (U.S.A.)

SITE is generally recognized as the first use of a satellite for television program reception incorporating all the elements associated with direct broadcasting.

1. HET

The HET experiment [3] was sponsored by the U.S. Federal Department of Health, Education and Social Services in cooperation with state governments, educational and medical resource centers, public broadcasting networks and performing artists, as a test of satellite distribution of education, remote medical diagnosis and treatment, and teleconferencing for scattered populations living in remote areas not served by terrestrial microwave systems. Three sections of the country were selected as representative of the above mentioned types of areas which could benefit from satellite distribution of television programming: Appalachia, the Rocky Mountains and Alaska. Three-metre, solid state earth station receivers were installed in community centers, schools and hospitals in the selected regions for a one-year period. The average cost of the receive-only stations was $6,400. Approximately one-half of the receivers had voice transmit added.

Six sub-experiments explored different aspects of problems in educational and medical supervision of scattered populations. All experiments chosen were social service related to indicate that the satellite was being tested to determine its social benefits.

HET Experiments

A) The Federation of Rocky Mountain States undertook a major role in planning, developing and implementing both hardware and educational software for HET. It persuaded artist unions to permit their members to provide services for the duration of the experiment at relatively low lump-sum rates. It also operated the Network Coordination Center and the uplink terminal at Denver, Colorado. Its 12 public broadcasting stations were supplied with receivers and either delivered the signals live or taped the programs for later transmission.

   The Federation contributed 235 hours of programming to HET including:

   - career counselling for teachers

- related programming for high school students, approximately 15% with voice communication between students and a panel in Denver
- adult programming in the areas of consumerism, cultural heritage and land use
- refresher courses for emergency medical technicians
- taped audio-visual material which the participating schools were allowed to retain.

B) The State of Alaska's Office of Telecommunications undertook an instructional program designed and produced by professionals in consultation with two consumer committees.

Its segment included:

- teacher education
- elementary school courses
- one-half hour per week of native programs
- taped national network programming
- refresher courses in emergency medical aid sponsored by the Federal Indian Health Service
- medical consultation and diagnosis with two-way audio
- medical education in cooperation with the Universities of Washington and Alaska.

C) The Appalachian Regional Commission, while interested, was hampered by a lack of funds and administrative expertise. Nevertheless it did produce:

- two series of educational programming for teachers, one on reading problems, one on career counselling
- live seminars from the University of Kentucky utilizing teletype for two-way communication
- medical programming to Veterans Hospitals in six states:

  seminars
  grand rounds (medical team discussions)
  consultations taped in advance and relayed from Denver three out-patient clinics.

Telephone lines were used for two-way communications.

At the conclusion of the one-year HET experiment ATS-6 was relocated over the Indian Ocean for the SITE experiment. Plans to launch ATS-7 were cancelled by the U.S. government when the Space budget was reduced after the final manned moon flight.

HET Results

1. A major criticism leveled by participants in HET was that ATS 6 was designed for technologists, not with social needs in mind. They felt the HET experiment was a technical success but a social failure. ATS-6 did open the way to techniques that could work with small receivers operated by non-technical people with a minimum of instruction or supervision. With more local involvement in program planning to better serve viewer needs, HET experimenters continued their projects using the DOC/NASA Hermes satellite.
2. The successful use of ATS-6 for rural communications needs led to the creation of the Public Service Satellite Consortium in 1975. It was founded to assist public service organizations to deliver their services more efficiently through use of new communications technologies.

PSSC is an aggregator, arranger and broker of satellite facilities. It provides consultation, arranges networks for video and audio distribution of programming, performs objective studies of communications problems and proposes workable, cost-effective solutions for member and non-member organizations.

2. SITE

India's interest in the ATS-6 stemmed from its history of attempts to overcome the problems of mass communication among its people.[4] India extends over an area of one billion square miles. Almost 80% of its 700 million people live in 600,000 villages situated mainly in outlying areas, isolated not only geographically but also politically, culturally and linguistically. Because of a lack of transport and communication facilities, there was very little contact even with neighbouring villages. The Indian Government had for many years made serious attempts at mass communication but while major cities were fairly well served by All-India Radio (AIR), remote areas were not. The print media was not adequate because of the high percentage of illiteracy. India had, however, achieved a good degree of success with simple educational movies and, therefore, considered that television would also be an effective tool for increasing adult education in agriculture, health, hygiene, domestic science and current affairs. As an instrument of social change and national cohesion, and to give children in primary schools a broader view of geography, science and the arts, television was necessary; distribution by terrestrial means was not feasible.

In 1969 the Indian Government entered into an agreement with NASA whereby ATS-6 would be positioned over the Indian Ocean from August 1, 1975 to July 31, 1976 and would be available four hours a day (1300 hours total) for an instructional television experiment.

The general objectives of SITE were to gain experience in the development, testing and management of a satellite-based instructional television system, particularly in rural areas; to determine optimal system parameters and program requirements; and to stimulate national cultural development.

India presented examples of the type of problems to be faced in introducing satellite television to underdeveloped countries: unreliable electricity supply to power the receiving equipment; lack of maintenance personnel, inaccessibility of earth station sites, suspicion and lack of interest in the intended audience (many of whom were illiterate or semi-literate) and, important to the programming aspect and therefore to the success of the attempt at communication, language barriers. In India, as in many other nations, there are hundreds of local dialects and not all Indians speak or even understand the official language.

The Indian Space Research Organization (ISRO) installed and maintained two central earth stations and 2,400 community receivers. Attempts were first made to establish a number of primary receiving stations linked to the 2,400 selected villages by microwave but this proved too difficult due to the mountainous, forested terrain. However, direct reception in the villages themselves, using a 13 foot diameter chicken wire antenna embedded in mud and stone proved effective and offered an excellent quality of reception.

All-India Radio was responsible for programming with input from government departments participating in the experiment: Agriculture, Health, and Family Planning. ISRO would evaluate the project results.

SITE Experiments

1. One-half hour per day was devoted to children's programs intended to provide general knowledge in science and the arts. A common video channel was used with a different audio channel for each language required.
2. Two and one-half hours each evening was programmed for adults; one-half hour consisted of India's National Integration program in Hindi. The rest of the programming covered agriculture, health, hygiene, nutrition and family planning with the same video/audio arrangement as for the children's programs.
3. A 12-day multi-media training experiment using television, radio and print was offered. 50,000 primary school teachers participated.
4. A series of programs on common agricultural problems was taped on location for farmers.

SITE Results

One year was insufficient to fully evaluate the social benefits of the experiment. Consequently, the Indian Government set up six terrestrial transmitters to continue television transmission to about half the SITE villages after the withdrawal of ATS-6, to enable programming techniques and timing to be perfected. The SITE hardware was a success, but programming seemed to indicate a lack of sufficient planning. However, much valuable information was gained from the one-year experiment.[5]

A. Social and Cultural

1. Evidence from surveys and continuing observation by visiting anthropologists suggested that programming must be of interest to the intended audience. Programs for local viewing, as was found in the U.S. HET experiment, should have been produced by individuals familiar with the interests and needs of the local inhabitants.
2. Children who were exposed to the satellite experiment became more interested in learning and in reading, and showed a marked improvement in the spoken language.
3. Local teachers achieved community respect, not previously accorded them. Teachers also gained a better understanding of children's capacity to learn with modern techniques.
4. Adults learned about self-help. Constructing the community antenna (apart from yielding savings in material and labour over other types of antenna) was a unifying force — people working together to achieve something for the common good. Women became knowledgeable in previously male-dominated areas: health, hygiene, family planning, politics and civil rights.
5. Farmers acquired knowledge of basic techniques to improve their crops.
6. Communal television watching acted as a catalyst to bring various castes together.
7. An unfortunate result of the television experiment in India (and this could apply to other developing countries as well) was the fact that isolated people had an opportunity to view themselves in relation to others in their own country and elsewhere. They gained a new awareness of their deprivation but were unable to improve their standard of living for economic reasons.

B. Political and Economic

1. India took a positive role as a third-world leader in telecommunicatons technology. Indian technologists became sought after because of their experience in solving problems peculiar to emerging nations.
2. India demonstrated that high technology industry was not the prerogative of affluent nations only, but could be achieved by less advanced countries.
3. Receivers for the experiment were TV sets developed in India. The government decision to install six terrestrial transmitters to continue the experimental program provided a continuing market for the manufacturer.
4. India became actively interested in launch plans of countries other than the U.S.A., believing control of satellite launches by one country could have serious political repercussions. Unless other countries develop launch vehicles, the U.S. could control satellite plans of other countries and gain political leverage by offering low cost launches as "development aid" in return for political favours.

India Today

In 1981 India will launch its first domestic communication satellite. Though operating in the 2 GHz band as a fixed satellite service, Insat will provide programs through community receivers for local viewing, and thus could be considered as a quasi-broadcasting service.

3. TRUST

At the conclusion of SITE, ATS-6 was slowly returned to the Western Hemisphere and during its three-month journey, with funding from the United States Agency for International Development, taped and live programs on such diversified subjects as range management, forestry and mining were transmitted to 30 Asian, African and South American countries. This programming accompanied by 2-way audio was intended to demonstrate how a satellite could be used to promote social and cultural development in an emerging nation.

CTS (Communications Technology Satellite) – HERMES

Canada's Federal Department of Communications (DOC) has been involved in space research and development since the early 1960's. The Alouette and Isis satellites were developed by DOC's Communications Research Centre and launched in 1962, 1965, 1969 and 1971 to collect ionospheric data. During this period DOC also used NASA's ATS's to conduct measurement experiments.

The Canadian Government's White Paper "A Domestic Satellite Communications System for Canada" published in 1968, identified the need for a Canadian organization to undertake the development of a domestic satellite system to serve the communication needs of Canadians. As a result of the White Paper, Telesat Canada was incorporated on September 1, 1969 and undertook to fulfill its mandate: establish and operate a domestic communications satellite system.

The launch of Anik A-1 in late 1972 was the first step in extending communication services to remote areas of the country. Notwithstanding the success of the Anik A series of satellites, the cost of the large earth stations required to pick up the signal was excessive for many small communities, and segments of the population remained inadequately serviced. Further reductions in costs for satellite receivers were needed.

Even before the launch of Canada's first operational domestic satellite, the Department of Communications had entered into a joint agreement with NASA to construct and launch an experimental high power satellite to test a communication system using the 14/12 GHz frequency bands and low-cost, small ground terminals.

Canada's participation in the CTS was based on a desire to explore the technical capabilities of a high-powered satellite. The social needs of the remote population provided a unique testing opportunity. By successfully demonstrating the practical uses of this technology, Canada would acquire international prestige.

The Communications Technology Satellite, named Hermes by Canada after its launch in 1976, was an experimental satellite and assisted tremendously toward direct broadcasting satellite development. CTS was designed and built in Canada and launched by NASA.

Canada and the U.S. shared the satellite equally, on alternate days conducting communications experiments such as tele-education, telemedicine and teleconferencing.

The United States' time was used by former participants in the ATS-6 HET experiment who wished to continue their projects beyond the initial one-year period allotted to them, as well as by other groups who wished to experiment with various satellite applications.[6]

Canada chose 37 experiments, 22 of a social nature: 15 in education, 3 in medicine, 5 in community interaction, 4 in administrative services and 3 in television and radio broadcasting. By conducting a wide range of experiments DOC intended to determine whether a high power satellite would be an effective means of serving the educational, medical and social needs of isolated communities, at a reasonable cost.

HERMES Experiments[7]

Some typical examples of the social experiments follow.

1. The University of Quebec, a network of 18 graduate and post-graduate institutions, initiated 12 projects using 300 satellite hours from October 1976 to March 1977. An omnibus network linked 10 small towns to four teaching centers. Two-way video with voice links by community radio and telephone were used. In some areas community cable systems received the signal for rebroadcast to one and two metre antennae at more distant locations.
2. The British Columbia Government in cooperation with provincial universities, technical institutes and community colleges, a hospital, the public health association, library associations, the Indian Cultural Centre, the National Film Board and a remote logging camp, produced 64 hours of colour television forums and workshops on law, social science, public health, medicine, forestry and library science. Six locations received the programming from October to December 1977 via community cable systems and receivers installed in community centers. Audio links were by radio and telephone.
3. Western University and the University Hospital collaborated on a telemedicine experiment using 250 hours between October 1976 and February 1977. Community health programs, seminars and diagnoses were televised between London, Ontario and Moose Factory, a small northwestern Ontario town, using one-way video, two-way audio.
4. Memorial University, in cooperation with DOC and the Newfoundland Department of Social Service and Health, conducted a similar experiment from March to June 1977. A total of 134 hours of live programming with two-way audio was produced.
5. Saskébec was a joint community interaction project sponsored by the University of Regina and the Quebec Department of Education. It involved

cultural exchanges between a small Quebec town and a francophone town in Saskatchewan with two-way audio and video links. Local people provided much of the programming content.

6. The Alberta Native Communications Society produced two-way audio exchanges between Edmonton and three northern Alberta towns. A video tape recorder at the northern sites enabled the native population to produce material for Edmonton viewers. This project ran from August to October 1977.
7. The Federal Public Service Commission carried out a staff training experiment to evaluate the possibility of providing developmental courses to decentralized employees using a one-way video transmission to multiple receivers. The 16 hour experiment took place in May and June, 1977.
8. The Ontario Government offered on alternate days three hours of environmental, natural resource, legal and educational information services using both point-to-point and broadcast delivery. One 3 metre terminal and one TVRO were tested in Northern Ontario locations as part of the experiment.

Of the 15 technical experiments on HERMES, three were designed specifically for terminal evaluation.

1. The CBC used a 2 metre antenna to test direct reception through a window in a metropolitan office building.
2. Three types of small terminals, Canadian, Japanese and European, were loaned to remote households to test direct reception of 14 GHz signals.
3. A demonstration of a 0.6 metre prototype TVRO in Lima, Peru in 1978 stimulated interest in using HERMES for direct broadcasting tests. In the first six months of 1979 DOC, CBC and OECA cooperated in a simulated DBS experiment. OECA educational programs were transmitted to four remote northwestern Ontario towns each day and CBC entertainment programs were televised in the evening to three Labrador communities.

HERMES Results

A. Political/Economic

1. Hermes outlived its predicted life span by almost two years and functioned at or above expectations, testifying to the reliability of the satellite itself. Canadian-manufactured and imported terminals gave high quality performance in all kinds of weather.
2. A 60 cm terminal developed by Communications Research Center (CRC) was demonstrated in Peru in 1978. This led to what might prove to have been one of the most important results of the HERMES project.[8] To demonstate the terminal's ability to receive signals, HERMES' radiated power was progressively lowered. At its lowest levels HERMES' power simulated the expected performance of the 14/12 GHz portion of Telesat's Anik B, arousing speculation that direct broadcasting might be possible using a satellite with lower power than had previously been considered. DOC decided to utilize their leased 14/12 GHz capacity on Anik B for a DBS Pilot Project to field test this new theory.
3. Canadian industry benefited from the terminal technology developed. DOC purchased 100 terminals from a Canadian manufacturer for use in the Anik B pilot projects.
4. Canada achieved a high degree of international prestige by demonstrating and explaining the advanced technology at scientific and industrial conferences. Prestige, in turn, translates into economic gains for any country which takes the lead in developing and manufacturing a sought-after commodity.

B. Social/Cultural

1. Preparation for and involvement in experiments by the participants offered a hands-on training course in many facets of an operational system. The experimental Omnibus Network in Quebec became fully operational for tele-education in September 1977.
2. In general, the perceived success of the individual experiments varied in direct proportion to the experience and expertise of the participants. For example, medical personnel in Newfoundland had to familiarize themselves with the constraints of live studio broadcasts, northern natives had to learn to cope with the intricacies of a video tape recorder. In spite of the difficulties, the educational value of the projects was positive.
3. Community interaction projects served to promote a sense of national unity.
4. Native groups discovered they could adopt modern methods to serve their communication needs but preserve their culture and heritage from erosion by southern influences, if desired, by involving themselves in program production.
5. The native and non-urban citizens' urgent need for reliable, continuing communication services was recognized by the very wide cross-section of participants in the HERMES experiments, creating pressure for concrete action to satisfy this need as quickly as possible.

Direct-to-Home Reception Experiments

Canada – Anik B

The decision by DOC to use the leased 14/12 GHz portion of Telesat's Anik B for a direct-to-home pilot project had as its objectives:

1. to test the 14/12 GHz technology under actual conditions and to evaluate user reaction to direct-to-home satellite broadcasting;
2. to encourage Canadian industry to manufacture

receiving equipment which could compete in the international marketplace;

3. to provide information to potential users of direct broadcasting satellites; and
4. to assist in determining appropriate government policy regarding direct broadcasting satellites.

Assuming positive results from the pilot project, it could well be a means of addressing some of Canada's unique broadcasting problems:

a. the vastness of the country and the fact that most of its population is concentrated along the southern border,
b. the inaccessiblity and temperature extremes of its northern and mountainous regions,
c. its six time zones
d. the Broadcast Act provision that all Canadians are entitled to English and French broadcasting as public funds become available, and
e. the necessity of providing network access to native groups.

Anik B Experiments

In mid-1980, following a series of tests and demonstrations to reconfirm the reliability of small terminal reception, the field tests[9] began and are still ongoing.

1. In Northern Ontario, approximately 40 terminals were loaned to homes, schools, hotels and a prison for direct reception of television signals from Anik B. In some communities, receiving equipment was loaned to the local cable operator or rebroadcaster who delivered the satellite signal through the local distribution system.

   The OECA provides its educational programming for 12 hours a day Monday to Friday and all day Saturday and Sunday.
2. In British Columbia and the territories similar receiving equipment loans were made. Slightly larger terminals were required because the satellite's power was divided between two TV channels. The entire program schedule of both the CBC and CTV networks is transmitted.

   The user experiments are a cooperative effort of DOC, providing the satellite facilities, Canadian Broadcasting Corporation, the Ontario Educational Communications Authority and British Columbia Television providing the programming and the Governments of Ontario, British Columbia, the Yukon and Northwest Territories handling the logistics in their respective areas.

Anik B Results

A. Social/Cultural

1. User reaction to the DBS pilot project has generally been enthusiastic. Remote communities receiving current news and affairs feel less isolated, and television entertainment programs are welcomed in a setting where social activities are substantially limited.
2. Native people, having used Anik B to operate a native broadcasting service throughout the north, are anxious to continue this service and are actively seeking ways of doing so.
3. The underserved and rural populations are aware that the technology currently exists to permit direct program reception from the satellite. Furthermore, it appears that basic service is no longer sufficient. The facility with which signals are picked up from the U.S. 6/4 GHz satellites has led the underserved and rural population to demand equal rights in terms of program variety. Establishing a Canadian DBS service with programming diversity is an alternative to widespread reception of programming from U.S. satellites.

B. Political and Economic

1. A public meeting to discuss Extension of Services to Remote and Rural Areas took place in early 1980. The CRTC Committee tasked with the inquiry traveled to remote areas to familiarize themselves with local concerns and, among other things, viewed the Anik B field trials. Over three hundred briefs were submitted covering every conceivable point of view. The Committee's recommendation for immediate action to extend television service to remote and underserved areas of Canada has been endorsed by the CRTC and a public hearing to consider license applications took place in February 1981.
2. DOC has exercised its option to extend its lease of Anik B 14/12 GHz capacity and to continue the direct-to-home service until Anik C is in service.
3. Anik C satellites will have a maximum EIRP of just over 50dBW. The Anik B field trials tend to confirm the view expressed as a result of the HERMES experiments, namely that an EIRP ranging around 60 dBW is not required for direct reception of programming. It appears from the field trials that satellite power levels at the high 40 dBW level are adequate for satellite transmission directly to homes. Slightly larger terminals (1.2 m) would be required to compensate for the lower radiated power, but the terminal cost increase over, for example, 60 cm pure DBS terminals would be marginal.
4. Canada was the first country in the world to operate a commercial geostationary domestic satellite communications system. It is also the first country in the world to operate a commercial service in the 14/12 GHz frequency band. One of the DOC channels has been leased back to Telesat for resale to a consortium of Quebec cable companies who are offering television programming from France to the province of Quebec. International cultural agreements were required to permit the French programming to be distributed in Quebec. Satellite Business Systems, a U.S. Company, also leased part of DOC's 14/12 GHz capacity to conduct preoperational testing of its data communications system.

Japan – Introduction

In 1969 Japan formulated its long-term plan for developing communications by satellite. The National Space Development Agency (NASDA) was established to manufacture, launch and operate two experimental satellite projects, a Broadcasting Satellite (BSE) and a Communications Satellite (CS) developed by the Japanese Ministry of Posts and Telecommunications (MPT). Mission experiments were conducted by the Radio Research laboratories of MPT in cooperation with Japan Broadcasting Corporation (NHK) and Nippon Telephone and Telegraph.

The principal experimental feature of the satellites was utilization of high frequency bands (14/12 GHz on the BSE and 30/20 GHz on the CS) for high accuracy performance tests in spacecraft positioning and attitude control. Propagation experiments and broadcasting and communication experiments were conducted in the high frequency bands.

(CS) Communication Satellite

The CS was a hybrid experimental satellite having two 6/4 GHz and six 30/20 GHz transponders.[10] It was launched in December 1977 as a preoperational test of a domestic satellite system. With the exception of two K-band transponder failures, the satellite continues to perform well and results of the experiments have led to a Japanese decision to procéed with an operational domestic system of the same configuration, with the first satellite to be launched in 1983.

This satellite system will fulfill three of Japan's space objectives:

a. Space development for peaceful purposes.

b. A reliable communications system for emergency situations where terrestrial networks could be destroyed.

c. A means of ensuring that increasing demands for communication can be met in an orderly manner.

BSE (Broadcasting Satellite Experiment)

The Japanese Government holds the view that it is important in terms of cultural education that all Japanese people have an equal opportunity to receive television broadcasts.

Japan has extensive, high quality terrestrial television distribution serving 97% of its population but one million Japanese inhabit remote islands and mountainous regions which cannot be served economically by terrestrial means. In addition, within the terrestrial television network there are areas, primarily in urban centers, where signal reception is degraded because of "ghosting" caused by reflections from the numerous tall buildings which often surround residential communities. In an attempt to overcome these problems, in conjunction with the CS experiment, Japan's 15th satellite, YURI, was launched in April 1978 as an experimental direct broadcasting satellite. Its purpose was largely preoperational.

YURI was used to conduct various experiments for perfecting satellite broadcasting technologies as a first step towards an operational satellite broadcasting system operating at 14/12 GHz. Ground facilities included the main transmit and receive stations, transportable earth stations, receive-only and small relay equipment to test the capability of low cost receivers, low power rebroadcasters and various methods of receiving satellite signals for terrestrial relay through radio or cable links to community antennae. For individual reception, tests were made to determine suitable antenna quality and size based on coverage patterns, installation, adjustment and maintenance requirements. Site diversity experiments were conducted to study signal attenuation, interruption and degradation.

BSE Experiments[11]

1. Basic technologies in the broadcasting satellite system: coverage area, television transmission system, radio wave propagation characteristics, frequency sharing, characteristics of the satellite's on-board equipment and characteristics of ground facilities.
2. Experiments on control and operation of a satellite broadcasting system: satellite control techniques, satellite broadcasting system operational techniques, and access of a satellite by multiple transmit earth stations.
3. Reception of radio waves from a broadcasting satellite.
4. One-on-one comparisons of terrestrial and direct broadcasting reception under varying S/N ratios to establish system parameter comparisons between the BSE and Canada's HERMES.
5. Possibilities for a nationwide educational television system.

BSE Results

1. Results of the BSE experiments were positive[12] although the satellite was turned off June 17, 1980 when the last of its three transmitters failed prematurely. Television reception quality was satisfactory and showed no sign of degradation. Sufficient data has been collected to indicate that practical applications of a DBS are feasible.
2. High quality colour television signals were received by simple receiving equipment using 1.0 or1.6 m antennae and by receive-only equipment using 2.5 and 4.5 m antennae.[13] These NHK/NEC receivers have become more or less the standard for 12 GHz reception.[14]
3. Japan has developed a launch vehicle which will be used to put its own satellites into orbit and will provide an alternative launch facility to those of NASA and ESA.
4. In 1983 and 1985 respectively. Japan will launch its first domestic communications satellite and its first direct broadcasting satellite. The Communications satellite will be powered by a 6 Watt TWT for each channel in the 6/4 GHz segment and a 5 Watt TWT

per channel in the 30/20 GHz segment. The direct broadcasting satellite will have a total power output of 200 W — 100 W per channel. Both satellites are under the authority of the Telecommunications Satellite Corporation of Japan (TSCJ), instituted in July 1979 to ensure uniform control and operation of both communication and broadcasting satellites. The satellites will be financed by The Government of Japan (40% of the cost) and Japan Broadcasting Corporation (60%).

5. While there is no concrete evidence on which to determine the effect a direct broadcasting satellite will have on existing commercial broadcasters, two widely divergent schools of thought have been voiced by members of the National Association of Commercial Broadcasters of Japan:

a) since DBS will become a reality, commercial broadcasters should actively participate in the development of broadcasting satellites; or

b) broadcasting satellites should not be used for conventional commercial broadcasting since this is viewed as an economic threat to the existing networks; consequently direct broadcasting satellites should be used only for non-commercial purposes.

The National Association of Commercial Broadcasters has not yet formulated a definite policy on DBS but wants representation on the TSCJ Administrative Council to protect the interests of its members. One proposal being put forward by NACB Study Group is that the principle of regional broadcasting upon which Japan's commercial industry is based, should be protected by the Broadcast Law, guaranteeing that present licensing standards would not be modified without "sufficient" cause. This would obviously lead to lengthy regulatory battles. Present arguments are, however, based on present technology, and may change or even be rendered academic by the time Japan's operational DBS is launched.[15]

Planned Direct Broadcasting Satellite Activity

Intelsat

The ever-increasing volume of international traffic prompted Intelsat's choice of a different satellite design for its Series V spacecraft.[16] A dual-band 6/4 and 14/12 GHz satellite was chosen to provide the increased capacity required while remaining compatible with existing ground stations where necessary. The higher frequencies will be used by countries in the Atlantic Basin which have the heaviest traffic volume and the resources to bear the cost of installing new ground stations to receive the 12 GHz transmissions.

Pacific Region countries will continue to use the 6/4 GHz frequencies and their existing ground stations. Seven Series V satellites have been contracted for. While not specifically designated for direct broadcasting, the higher frequency band could be so used if necessary or desirable. Developed for Comsat/Intelsat by a U.S. primary contractor with subcontractors from four European countries, Japan plus Canada, these Intelsat V satellites will provide opportunity for additional experiments and perhaps actual implementation with DBS thereby establishing the potential to increase knowledge and expertise in this technology.

All Series V satellites are scheduled for launch in the early to mid-1980's.

Europe – Introduction

Germany, France, Sweden and several smaller European countries have been active in satellite research and development since the early 1970's. In 1975 the European Space Research Organization and the European Launcher Development Organization joined forces to participate in space research as the European Space Agency (ESA). ESA members are Belgium, Denmark, France, West Germany, the Netherlands, Italy, Spain, Sweden, Switzerland and Britain. Ariane and Spacelab are two of ESA's widely known projects.

When ESA was formed, Europe's terrestrial communications facilities were well developed; nevertheless studies indicated that by the end of the century increased demands would necessitate greater capacity than would be available in the limited and congested microwave terrestrial frequencies. In addition, an alternative to terrestrial communication for emergency situations and to improve communication with non-contiguous areas was considered desirable.[17]

Satellites were regarded as this alternative method of providing total coverage of the region to be served, at a uniform level of quality. The heavy capital investment required could be shared by ESA members, and offset by the expected diversification of services which would be accommodated.

ESA recommended a multi-purpose satellite as the best way to meet all the requirements of its member countries in a coordinated manner, reducing cost, risk and duplication of effort. ESA now has several satellite programs underway or in the planning stage (e.g., Orbital Test Satellite, European Communications Satellite, Maritime Orbital Test Satellite, known as OTS, ECS and MAROTS respectively).

European Space Agency – H-Sat

ESA also wanted to launch a direct broadcasting satellite as an alternative to terrestrial distribution methods of providing high quality reception of additional program choices to groups of countries linked by common political, cultural or linguistic ties.

ESA members agreed to produce an experimental heavy satellite bus (twice the weight of the OTS) which could carry all its members' communications and direct broadcasting experiments. When Germany and France opted out of the project in 1979 to launch their own direct broadcasting satellites H-Sat could no longer be justified. The project was abandoned.

European Space Agency – L-Sat

Replacing the H-Sat was the L-Sat, a large multi-purpose satellite bus designed to accommodate a variety of communication and direct broadcasting applications.

Seven participating ESA members were to decide by late 1980 whether or not to proceed with this project. At present only Italy appears to have an interest in its broadcasting capabilities. Italy is now conducting communication and propagation experiments at 17/11 GHz with its own satellite, SIRIO, launched in 1978.

Germany/France — TV-Sat and TDF-1

Since 1970 the German government has been encouraging development of satellite technology expertise in order to make satellites one of the country's major export items. Germany wanted to have an operational DBS in orbit as early as possible to demonstrate their expertise. With this demonstrated expertise, the Germans intended to win a major consulting contract for China's domestic satellite system. In addition, H-Sat was proceeding too slowly for Germany's plans. After withdrawing from the H-Sat project, the German government immediately proceeded with its own preoperational DBS.

France's involvement in satellites also dates back to the early 1970's and includes the Symphonie satellite, a joint project undertaken with Germany in 1974; Telecom, the 6/4 and 14/12 GHz hybrid satellites which will replace Symphonie, and the OTS and ECS projects of ESA. France was also interested in the Chinese market and withdrew from the H-Sat venture to enter into an agreement with Germany to co-produce twin satellites, with French and German industry sharing equally in their manufacture.

The French satellite, TDF-1, is intended to cover only France. The German TV-Sat's very high power coupled with its narrow beam width would permit reception in Germany using a 60 cm antenna, and in neighbouring countries using a somewhat larger receiver.

The principal benefits of the French/German DBS are expected to be economic:

1. Promotion of Franco-German technology in developing nations and the resulting market for satellites and receiving equipment.
2. Development of related technologies e.g. stereo-television, pay-television, teletext, etc. to utilize surplus channel capacity.

Two pre-operational satellites will be launched in 1983 (one for each country) with operational versions to be in orbit by 1985.

Luxembourg – Lux Sat

Luxembourg was interested in a DBS to televise programs in the French and German languages to complement its French and German radio service. When H-Sat was cancelled, Luxembourg had four alternatives:

1. lease a transponder on the French or German DBS;
2. establish its own DBS system;
3. participate in ESA's ECS project; or
4. abandon its DBS plans.

Luxembourg offers an example of the problems faced by a small country surrounded on all sides by other countries attempting to introduce direct broadcasting: the extremely high cost of a satellite system, the inevitable spillover, the absence of expertise in high technology.

Luxembourg's main problem appears to stem from spillover. Germany opposed Luxembourg's plan to program commercial television in German which would spill over into Germany. Luxembourg was denied a transponder on TV-Sat. Not wishing to jeopardize its satellite agreement with Germany, France also refused Luxembourg request for capacity on TDF-1.

Luxembourg was to decide early in 1981 whether to proceed with its own DBS system or to include its transponder requirements on an ECS satellite.

Scandinavia – Nordsat

In 1976, a direct broadcasting satellite feasibility study was undertaken by the Scandinavian countries — Sweden, Denmark, Norway, Finland and Iceland.[18]

The study objective was to explore the technical, economic, legal and social aspects of a DBS system to serve Scandinavia. The system envisaged was two or three satellites supplying up to a dozen television channels at very high power (400 Watts).
A regional DBS system seemed reasonable as a means to:

1. strengthen common cultural elements;
2. provide a greater choice of programming in each country;
3. provide high quality reception in all areas of each country; and
4. reduce the cost of providing extended television services in each country.

Results of the study, released in September 1979, indicated some problem areas (which could apply to any group of countries contemplating a regional DBS system). The Nordic governments are now studying ways and means of coming to grips with matters such as:

- cultural erosion of minority groups such as the Laplanders;
- language differences between Finland and the rest of Scandinavia;
- spillover complaints to be expected from Russia:
- division of responsiblity for the system: financing. manufacture, operation and control.

The educational and social advantages and the economic advantages to be gained from entering the world market in high technology are being given equal consideration.

Sweden has been active in space research for many years and is considered to be the driving force behind

Nordsat. Each of the countries involved will announce its government's decision early in 1981. In light of the difficulties to be resolved, early realization of Nordsat is now in doubt. Indications are that further study will be needed before the five countries agree to proceed with a regional DBS system.[19]

Australia

Australia appears to be an ideal milieu for a DBS system. Its eight million square km area is populated by only 14 million people. Its topography lends itself to DBS. It is an island; spillover would not be a problem. It has a common language.

Australia has, until recently, shown little interest in satellites. 80% of the population lives in urban areas well served by terrestrial communication networks. Government policy has consistently been to implement radio and television service as quickly as possible, recognizing it as a unifying force, particularly among the remote population. Literally everyone in Australia enjoys radio service and 95% of the population receives at least one television signal.

Australia's decision to investigate satellite television distribution stemmed from two perceived needs:

1. additional service in remote areas, particularly in the fields of education and medicine; and
2. increased capacity to meet growing demands for new communication applications.

In 1979, the Australian Ministry of Posts and Telecommunications arranged to use Canada's HERMES and five of the 1.2 metre terminals designed for the Anik B pilot project, to test the remote Australian population's reaction to direct reception of television from a satellite.[20]

Australian-produced taped programming was transmitted from Canada to 46 remote Australian locations. The five small terminals were relocated from day to day.

Terminal installation and antenna alignment were simple, reception was excellent, and participants indicated their willingness to invest in receiving equipment for a continuing service. The main concern is the effect of DBS on the established broadcasting system.

Australia has two broadcasting systems — one national and one commercial. The national system provides wide area coverage of radio and TV. The commercial system consists of a large number of independent broadcasters, each owning and operating its own transmitter. Each broadcaster programs for local interests and thereby attracts local advertising revenues.

The Federation of Australian Radio Broadcasters does not oppose DBS in principle but feels that it has no application in radio since the country enjoys 100% coverage now.

The Federation of Australian Commercial Television Stations is violently opposed to DBS. In its view government control of DBS programming will eradicate local interest programming, advertising revenues will be lost and unemployment will result.

Australia has decided to proceed with a 14/12 GHz domestic satellite system operated by the Australian Overseas Telecommunications Authority, a government agency. The decision to bypass 6/4 GHz technology and implement a system capable of direct brodcasting is in line with the government's commitment to give priority to extending a national service to remote areas. Voice and data communications will be secondary uses.

Two satellites are scheduled for launch in 1985 or '86.

The U.S. Situation

COMSAT has applied for a licence to operate a DBS pay-TV service. The FCC issued a Notice of Inquiry and Rulemaking in October 1980 to receive comments from interested parties on potential issues arising from the proposed implementation of DBS. Additionally in April 1981, the FCC ruled to accept applications for interim DBS experimental systems. In addition to COMSAT's application, thirteen other entities have forwarded letters of intention to the FCC for the purposes of pre-briefing them on their respective applications. The DBS issue will be examined in detail in 1981 by the U.S. Government.

Summary

Interest in the Direct Broadcasting Satellite stems from four main needs, all of which are applicable in Canada:

1. communication services in isolated areas;
2. increased capacity to meet the demand for urban communication applications;
3. simple-to-operate, inexpensive ground terminals; and
4. market opportunities for satellite hardware, terminals and technological expertise.

HERMES and ANIK B experiments have established that the 14/12 GHz satellite is both technically feasible and economically viable particularly since a low power satellite such as ANIK C has the potential to be used for direct broadcasting.

The small ground terminals developed in Canada provide excellent reception in private homes and community centers. The terminals are simple to install, operate and maintain and can be sold at a reasonable price.

Canadian demand for terminals will create a market for manufacturers. Development of a Canadian market will lead to export sales. Canada is in an excellent position, having already demonstrated its terminals at many international events.

The international reputation enjoyed by Canada has been enhanced by the successful DBS experimentation and should lead to demand for Canadian expertise by other countries contemplating DBS systems.

The Canadian experiments have produced positive social and cultural results. Educational, medical and entertainment requirements of the isolated population can be satisfied by direct broadcasting. Resource companies will be able to attract personnel accustomed to urban amenities. A Canadian DBS could reduce the pressure for pirating signals from American satellites.

There appears to be no technical impediment to the introduction of a direct broadcasting satellite system. The questionable factors affecting DBS are the institutional and regulatory elements which were discussed in section 4.0.

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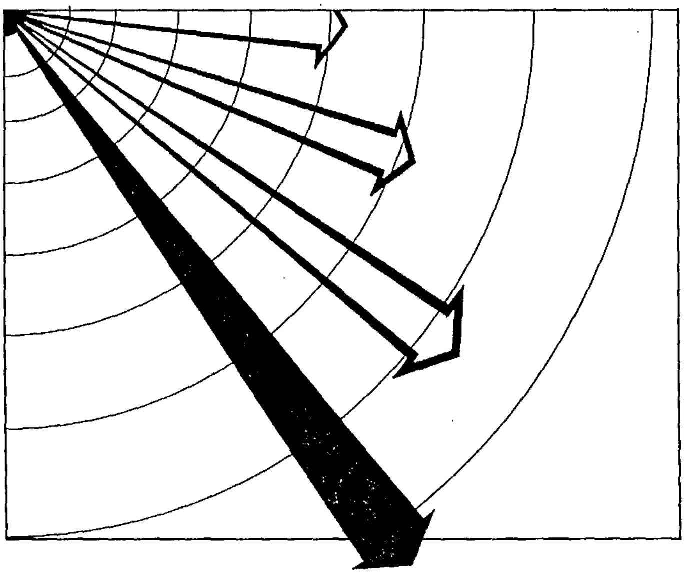
Section 5 – Future Integration Considerations



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5.0 Future DBS System Consideration

In the following sections, a preliminary assessment of the key characteristics of a future DBS system designed for Canadian requirements is presented. The assumed frequency bands are 12.2 - 12.7 GHz (downlink) and 17.3 - 17.8 GHz (uplink), the bands to be used in planning DBS for Region 2 at RARC 83. It should be noted, however, that projecting a future DBS system for Canada, even to the level of detail given here is hazardous when considering the uncertainties relating to future national and international policies for DBS.

5.1 Interim DBS Consideration

5.1.1 Compatibility of Interim DBS with Future DBS

With respect to the conversion of the Interim DBS service on Anik C to a future DBS service using the 12.2 - 12.7 GHz band, two approaches were considered.

In the first approach, the DBS terminals are initially designed to operate on both Anik C and a future DBS satellite using the 12.2 - 12.7 GHz band. This approach was considered not to be attractive for the following reasons:

a) The performance of a DBS TVRO terminal would be significantly inferior if it were designed to operate over a 1 GHz band as opposed to the 500 MHz band assigned either to Anik C or future DBS operation. That is, the LNA's matching circuitry, the input transition as well as the GaAsFET devices and the antenna feed structure can be designed and biased for much better performance in terms of the system noise figure and the antenna characteristics over a 500 MHz operational bandwidth than a 1 GHz bandwidth.

b) The technical parameters of the future DBS service will not be known until after RARC-83. In particular, the selection of the type of polarization (linear or circular) for the 12.2-12.7 GHz band has not been determined and, thus, the antenna feed cannot be designed prior to RARC-83.

In the second approach, however, the DBS TVRO terminals are designed so that they can, at a later date, be readily converted for operation in the 12.2-12.7 GHz band. This approach has the following advantages:

a) It provides for the lowest cost and simplest terminal for the initial service.

b) It permits an optimum design of the terminal for the initial service.

c) It permits the latest technology and hardware to be employed (e.g., LNA's) at the time that transfer to the 12.2 - 12.7 GHz band is made.

d) It permits the "Conversion Kit" to be designed after the system parameters have been selected by RARC-83.

In view of the advantages of the second method (Conversion Kit approach), this method is recommended for an Interim DBS service using Anik C.

In the conversion process of receive stations, the front end (i.e., antenna feed and first down conversion stage) of TVRO terminals seems to be the only major parts which will have to be retrofitted with proper hardware due to the shift in the receive frequency band (11.7 – 12.2 GHz to 12.2 – 12.7 GHz) and possible change from linear to circular polarization. This could be accomplished by either replacing the entire outdoor unit (antenna, feed and first down convertor) or by retrofitting the antenna feed and the outdoor electronics with appropriate hardware. The cost of this conversion from operation with Anik C to operation with a future DBS satellite would, therefore, be considerably less (1/3 or 1/2) than the cost of a new DBS terminal. The uplink stations would, of course, require major modification.

5.1.2 Other Considerations

In this section a number of factors affecting the design of a future DBS system are briefly discussed. Many of these areas will require a much more detailed and in-depth study before any final recommendations on the design parameters can be made.

(a) Satellite's Orbital Slot

The orbital position of the satellite affects the elevation angle experienced by the earth stations. For regions with high rainfall rates (Eastern Canada), the variation in the required propagation margin for loss mechanisms such as rain attenuation and cross-polarization interference, atmospheric absorption and low elevation angle fading as a function of orbital longitude, is quite significant, particularly for a high system availability objective.

Table 5.1.1 shows this variation in Eastern Canada for uplink and downlink frequencies and availability objectives of 99.9% and 99% of the worst month corresponding to 0.1% and 1% exceedance probabilities (these objectives are being considered in RARC 83 planning). As is evident in this table, the closer the satellite's longitude to that of the service area, the less severe are the adverse propagation effects on the system performance. Note that the induced cross-polarization interference is assumed to be co-channel and transmitted from the same location as the co-polarized signal.

A second consideration is that the required battery power to sustain communications during eclipse periods is also dependent on the selected orbital slot. If the satellite is located to the west of the western most edge of the desired service area, the eclipse periods will occur after the local midnight. This can eliminate or significantly reduce the eclipse protection power requirements. A second advantage to locating the satellite to the West (or also to the East) of the desired coverage region is that the coverage area as seen from the satellite is reduced in size, resulting in higher potential satellite antenna gain. However, a westernly located satellite serving a large land mass provides lower elevation angles and, hence, higher propagation losses for the eastern and north eastern edge of the service area.

In view of the cost penalty of providing additional power and eclipse protection in spacecraft, the orbital slot selection process deserves a comprehensive trade-off study in the design phase of a future DBS system for Canada.

Such a study would require, as inputs, the coverage of individual spot beams, and operational constraints like time zone and accessability of an entire province or territory by a single spot beam (if desired).

(b) Beam Shaping

For a fixed system availability objective, the required EIRP of the satellite per RF channel is generally estimated first by determining the minimum required EIRP at the edge of the satellite beam pattern. For simple beams of elliptical shape, the difference between the EIRP level in the center of the beam and the edge is about 3-4 dB. This means that the power made available to the central region is 3 to 4 dB higher than the required level. To avoid this non-uniform power distribution, which results in a wasteful distribution of the satellite's available power, shaped beams can be used. To provide a shaped beam, an electrically over-size reflector antenna, in conjunction with a cluster of horns, is selected to generate a fairly uniform power pattern over the desired land mass and a sharp cut-off characteristic beyond the service area. However, the degree of the uniformity of the beam is generally limited by the maximum tolerable size of the spacecraft antenna, the degree of irregularity and size of the coverage area. Furthermore, if two separate antennas are used for receive and transmit purposes, which is likely to be the case for DBS satellites due to large separation between the uplink and downlink frequencies, the individual antennas can be optimized over a single band. This results in more efficient antennas and a better beam shaping capability. The beam forming advantage over simple elliptical beams may range from a small fraction of a dB to about 1.5 dB, depending on the above factors.

5.1.3 Usable RF Channel Bandwidth

For a future DBS satellite, a channel bandwidth of 20 to 23 MHz seems to be quite adequate to accommodate a video carrier and a limited number of additional sound or radio programming carriers. However, the foreseen market for High Resolution TV (1000 to 1500 lines per frame) and the state of the related-technology, at the time of the design phase of a future DBS system, may make it attractive to equip some of the channels with switchable RF filters and possibly coherent combiners. This would allow for combining the available bandwidth and power of the adjacent channels into a wide-band high-power channel for HRTV for experimentation or commercial purposes. The related system parameters and standards, as well as the most suitable modulation methods, are not yet fully explored.

Table 5.1.1 Rain Attenuation and Induced Cross Polarization Statistics for Eastern Canada (Average Worst Month)

Satellite Longitude		95° West				105° West				115° West			
Frequency GHz		12.5		17.6		12.5		17.6		12.5		17.6	
Average Worst Month Exceedance	%	0.1	1.0	0.1	1.0	0.1	1.0	0.1	1.0	0.1	1.0	0.1	1.0
St. John's	A	5.1	0.7	11.0	1.6	6.5	1.0	13.9	2.3	9.0	1.7	19.3	3.8
	X	21	38	17	35	18	34	14	31	14	29	10	26
Halifax	A	4.9	0.8	10.3	1.8	5.6	1.0	12.0	2.2	7.0	1.3	14.9	2.9
	X	23	39	19	36	20	35	16	32	17	32	13	29
Montreal	A	4.5	0.4	9.6	0.9	5.0	0.5	10.7	1.1	5.8	0.6	12.4	1.4
	X	27	48	23	45	23	43	19	40	20	40	16	37
Ottawa	A	4.5	0.4	9.6	0.9	5.0	0.5	10.7	1.1	5.8	0.6	12.4	1.4
	X	28	49	24	46	24	44	20	41	20	40	16	37
Toronto	A	3.3	0.4	7.0	0.9	3.6	0.5	7.6	1.0	4.1	0.6	8.7	1.3
	X	32	>50	28	48	27	45	23	42	24	41	20	38
Winnipeg	A	3.5	0.4	7.4	0.8	3.5	0.4	7.5	0.8	3.7	0.4	7.9	0.9
	X	49	>50	45	>50	38	>50	34	>50	30	>50	26	47

A = Attenuation dB
X = Cross Polarization C/I dB

5.1.4 Atmospheric Induced Cross Polarization Interference in a Polarization Re-use System

The concept of frequency re-use by means of orthogonal polarization for increasing capacity is briefly studied for the 17.3 - 17.8 GHz uplink band and 12.2 - 12.7 GHz downlink band. The method used for estimating the C/I contribution due to rain-induced cross polarization is based on the available semi-empirical techniques (CCIR, Study Group 5, July 1980). The results generated by the model used for estimation of the cross-polarization statistics at frequencies higher than 12/14 GHz compare with satisfactory results, against a limited amount of measured data. The data were obtained by receiving the Comstar D-3 beacon at 28.56 GHz in Ottawa (CRC-Telesat joint propagation experiment) and the initial results are shown in Figure 5.1.1. More data, however, are being processed to generate statistical information and the experiment will continue by receiving the Comstar D-4 beacon at 28.56 GHz.

The expected C/I ratio due to rain-induced cross polarization for 99.9% and 99% of the worst month are listed in Table 5.1.1. It is assumed that the cross-polarization interference is generated by a *co-channel*, initially orthogonal polarized signal launched from the same site, at an equal amplitude to the wanted signal.

Even though frequency off-set methods and transmit site separation schemes may be used to reduce the rain induced cross-polarization interference, nevertheless, the high level of interference suggests a more detailed study should be carried out on polarization re-use system in the 12/17 GHz bands.

5.1.5 Uplink Fade Compensation

In order to fully utilize the downlink available power. the uplink fades must be compensated for by either utilizing an Automatic Gain Control feed-back loop on board the satellite or by adaptive power control at the uplink earth stations. The use of AGC is recommended since it provides a greater degree of compensation, particularly in view of earth station HPA limitations at 17 GHz that may restrict the available uplink fade compensation range which could be provided by adaptive uplink power control. Because of uplink fades (uplink C/N degradations), the effect of the uplink noise on the downlink C/N may exceed 0.5 dB for a small percentage of time. A further degradation may yet be caused by uplink and downlink induced cross polarization interference in a frequency reuse system. A point worth noting is that, due to the particular nature of a DBS system, it is quite likely that an uplink station may serve an area in proximity with the uplink site. This leads to a higher probability of simultaneous uplink and downlink attenuation and cross polarization interference which may amount to a significant degradation in the total C/N for a small percentage of time. The compounded effect of cross polarization interference may then require a larger system margin in order to limit the threshold operation of TVRO terminals to an acceptable level. However, as was mentioned earlier, depending on the channelization plan and uplink and downlink spotbeam configurations, it may be possible to reduce the cross polarization interference by means of frequency off-setting and spatial isolation methods.

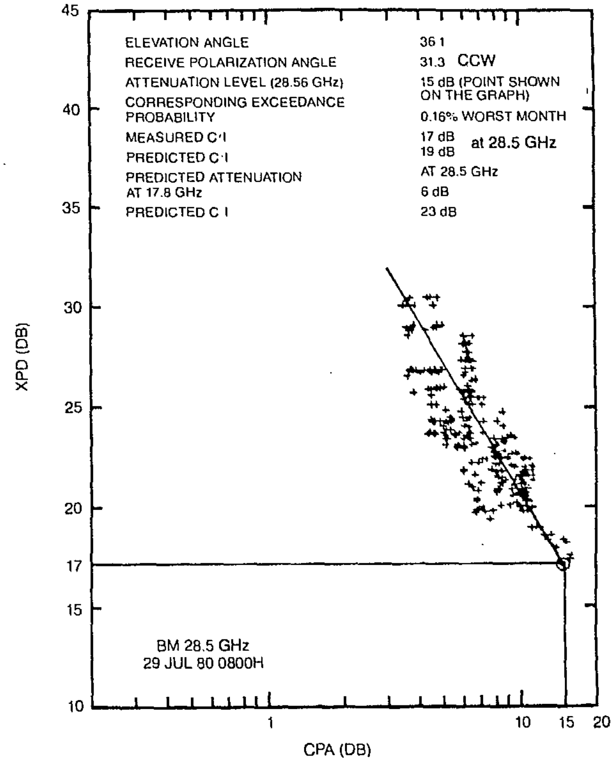

Figure 5.1.1 Measured and predicted hydrometeor induced cross polarization interference

5.2 Preliminary Calculations of System Parameters of a Canadian DBS System based on RARC 83 Preparatory Activities

In this section, the key parameters are derived for a future DBS system for Canada. The assumed parameters in terms of the uplink and downlink frequency bands, performance objective, the number of channels per spot beam and the total number of spot beams are based on information made available through RARC preparatory activities in Canada. The channelization plan, type of polarization and beam isolation through the use of polarization diversity are the issues likely to be subjected to considerable debate in RARC 83 planning. In the present study, a 20 MHz noise bandwidth per RF channel is assumed.

In the following section, a rudimentary analysis within the context of the present study is conducted to estimate the required satellite EIRP level and the associated system parameters.

A two satellite system is considered in the following sections (two largely separated orbital slots). However, other scenarios such as one satellite system or two side-by-side satellites may prove more efficient depending on the power, weight, frequency plan and propagation constraints.

5.2.1 Assumed DBS System Characteristics

Although not critical to the system calculations, a satellite model using two orbital positions was selected for illustrative purposes. The satellite serving Eastern Canada could be located at 105° West, while the satellite serving Western Canada would be located at 140° West. Eclipse occurs after local midnight of the western most point of the service regions. The following are the assumed key system characteristics used as the basis for system calculation:

- The number of the Spot beams per satellite for this configuration is 3, see Figures 5.2.1 and 5.2.3.
- One video and 2 audio channels per RF channel
- Video S/N requirement 42 dB for 99% of worst month
- Single Linear Polarization
- 1 meter antenna diameter receiving earth stations
- LNA noise figures of 2 – 3 dB
- Uplink Frequency Band 17.3 – 17.8 GHz
- Downlink Frequency Band 12.2 – 12.7 GHz
- Uplink fade is compensated for by utilizing an Automatic Gain Control feedback loop on board the satellite

5.2.2 Performance Objective

The availability objective generally considered in RARC 83 planning is 99.9% of the worst month for operation above the FM threshold and 99% of the worst month for operation above the adopted signal performance objective. In Canada, worst month measured rain rate statistics for different rain regions show a marked departure from the yearly statistics. Depending on the fraction of the time considered, the ratio of the worst month probability of a certain rainfall rate to the yearly probability may range from 1.7:1 to 4:1 for 1% of the worst month and 2.8:1 to 4:1 for 0.1% of the worst month from coast to coast. The available worst month data indicate that if a system is designed for a worst month availability of 99.0% or equivalently 7.3 hours operation below the objective during the worst month, the average monthly exceedance over a year will be approximately 1.8 hours for B.C. and 4.3 for Newfoundland.

Propagation studies show that for Eastern Canada, the constraint of 99.9% worst month operation above FM threshold (44 minutes, C/N about 9 dB) may significantly increase the space segment cost of a future DBS System for Canada. In view of the fact that the above 44 minutes in the worst month is formed by isolated heavy rainfall spells which may not all coincide with the prime viewing time, one may conclude that the above mentioned threshold exceedance objective may be too excessive. This is further accentuated by the fact that a TV picture below FM threshold will still have a viewable quality down to a carrier-to-noise ratio of about 6 dB. For the purpose of the present study, 99% of the worst month is taken as the desired system availability for a performance objective of a total C/N better than 12 dB (including interference) or equivalently S/N better than 42 dB. The 99.9% objective, if one is required, is recommended to be C/N better than 6 dB, which corresponds to a viewable signal still available under heavy fading.

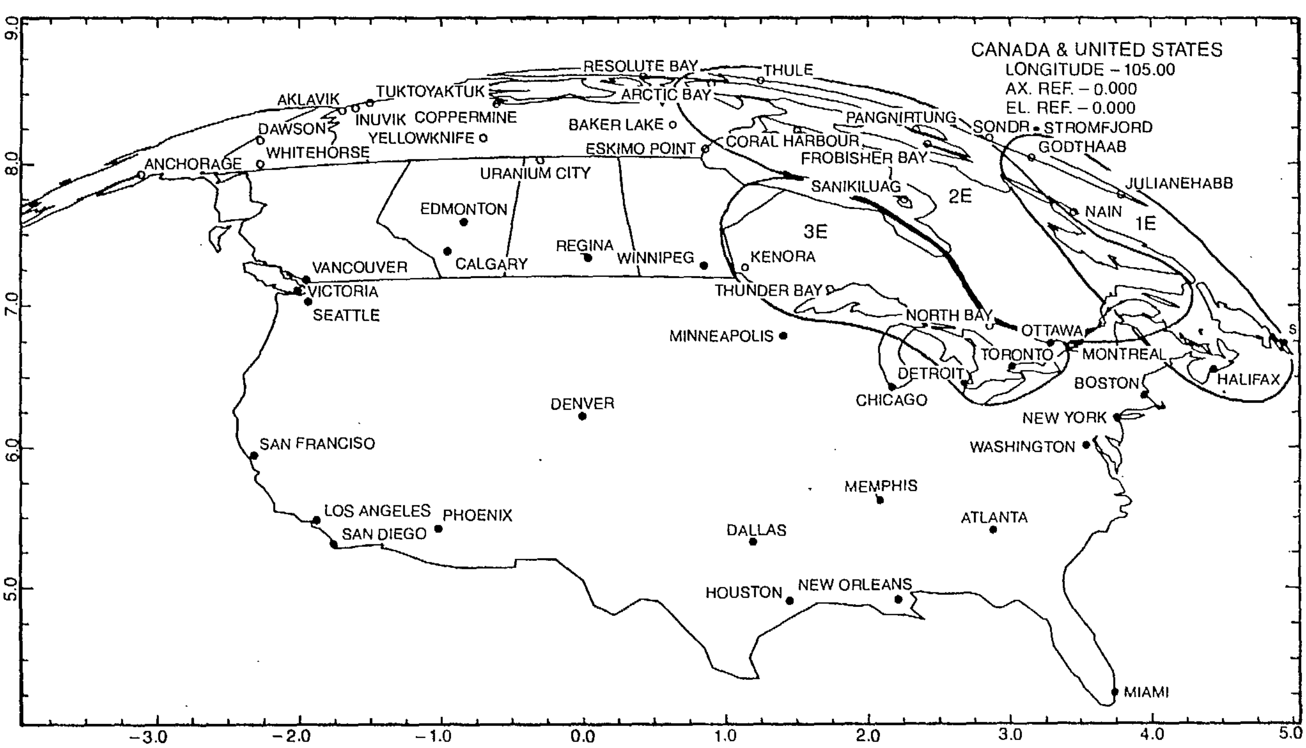

Figure 5.2.1 Coverage of the Eastern Spot Beams

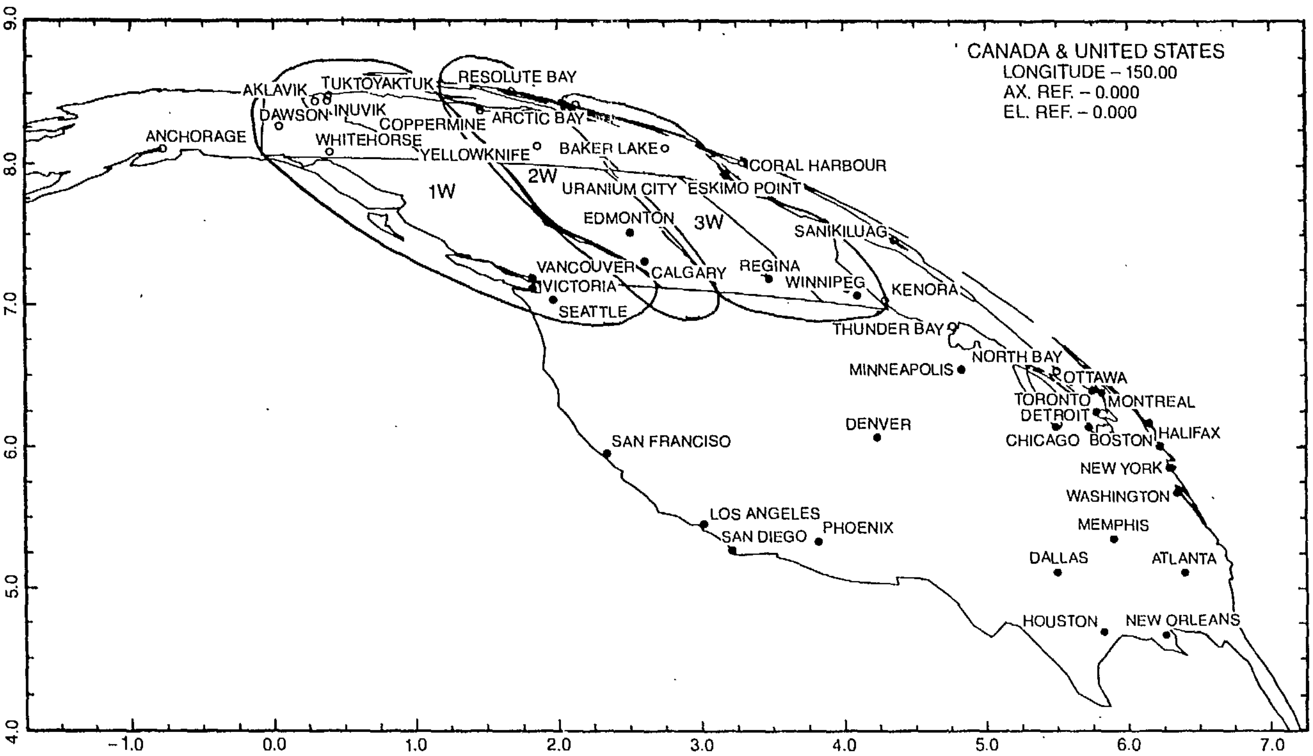

Figure 5.2.2 Coverage of the Western Spot Beams

5.2.3 Required System margin Per Spot Beam

The required propagation margins for rain attenuation, atmospheric absorption and noise enhancement due to cloud bursts for different spot beams are listed in Table 5.2.1. Other losses associated with the downlink are as follows:

DOWNLINK
0.5 dB TVRO (Im) pointing loss
0.3 dB Satellite pointing loss (edge of beam)
0.5 dB TVRO aging

5.2.4 System Parameters

The system Parameters assumed are listed below:

C/N equal or greater than 12dB Total — 99% WM (Worst Month)

Video S/N equal to or greater than 42 dB

Noise Bandwidth = 20 MHz

Peak Video Deviation 6.3 MHz (results from above parameters)

Audio Subcarrier = 5.14 MHz (BW 15 KHz, Dev. 60 KHz)

Main Carrier deviation by Subcarrier = 1.0 MHz

Second Subcarrier (Second Language or radio Program) = 5.41 MHz (BW 15 KHz, Dev. 60KHz),

Main Carrier deviation by Subcarrier = 1.05 MHz

Audio S/N better than 48.4 dB 99% WM

Audio Sub-Carrier C/N better than 14.7 dB 99% WM

5.2.5 Receive Terminal Parameters

A 1 m antenna was selected as a baseline antenna, with an assumed efficiency of 70%. This is in accord with the recently reported antennas with very high efficiencies through the use of plannar corrugated feed horns (Andrew 1.8 m, 12 GHz antenna). As far as the receiver is concerned, low-cost FET LNAs with 3.5 dB noise figure are currently available and it is expected that, within a few years, noise performance would reach 2-3 dB level. The receive G/T for two different LNA noise figures is as follows:

Antenna Diameter = 1 m

Antenna Efficiency = 70%

Antenna Gain (dB) = 40.8 (12.5 GHz)

Unfaded System Noise	= 359	LNA NF = 3 dB
Temperature (6° Elev. Ang.) K	= 240	LNA NF = 2 dB

System G/T (dB/K)	= 15.2	LNA = 3 dB
	17.0	LNA = 2 dB

Table 5.2.1 Required Propagation Margin (Rain Attenuation, Atm. Abs., Noise Enhancement)

Spot Beam	Uplink (17.6 GHz)		Downlink (12.5 GHz)	
	99.9% Worst Month	99.0% Worst Month	99.9% Worst Month	99.0% Worst Month
(St. John's, Halifax) 1E (105°W)	17	4.2	9.0	2.7
(Montreal) 2E (105°W)	13.5	2.3	7.1	1.1
(Toronto, Ottawa) 3E (105°W)	13.5	2.3	7.1	1.1
(Winnipeg) 3W (140°W)	14.0	2.7	7.4	1.5
(Calgary, Edmonton) 2W (140°W)	8.5	2.0	4.5	0.9
(Vancouver) 1W (140°W)	6.7		3.5	1.3

5.2.6 Transmit Earth Station Parameters

Due to a large frequency separation between the uplink and downlink, a separate satellite antenna feed system (and possibly separate reflectors) may be required for the uplink. In this way, the uplink and downlink beam patterns can each be optimized over a single band, resulting in higher efficiencies and better beam shaping capability. Assuming that the feeder links are covered by small spot beams, large satellite G/T figures are feasible. However, if regional uplink capability is required, a satellite G/T of about 2 dB/K may be desirable. It is to be noted that, for a two satellite system, like the one under consideration, simultaneous visibility of both satellites (140°W and 105°W) may not be possible on a nationwide basis.

The baseline feeder link antenna size is assumed to be 5 meters and with this antenna diameter, an HPA power of 1000 watts seems to be adequate.

Satellite G/T**	=	2 dB/K
Saturating Flux Density	=	–79.0 dBW/m²
Input Backoff	=	0.0 dB
Required Earth Station EIRP	=	83.9 dBW
Combining Network Loss	=	1.4 dB
Feeder Loss	=	0.5 dB
Miscellaneous Losses	=	0.5 dB
5m Antenna Gain at 17.6 GHz	=	57.4 dB
Required Net HPA Power	=	766 watts
Recommended HPA Power	=	1000 watts
HPA Output Backoff	=	1.2 dB

**Assumes a minimum satellite antenna gain of 35 dB (Eastern or Western Regions) an input loss of 1.0 dB, a system noise figure = 8.4dB, providing a minimum G/T = 2 dB/K.

5.2.7 Satellite Transmit and Receive Antenna Gains

Assuming an over-size transmit antenna is used for beam shaping and a beam taper of not larger than 2 dB (peak-to-edge gain ratio), the spot beam configurations in Figures 5.2.1 and 5.2.2 lead to the following Edge of Coverage gains for the six spot beams. An output mux loss of 1.0 dB is included in the listed figures.

Spot Beam	Edge of Coverage Gain (dB) Including Output Loss (2 dB Taper)
1E	37.5
2E	35.0
3E	37.0
3W	37.0
2W	38.0
1W	36.0

5.2.8 Required Total Unfaded C/N Per Spot Beam

In order to meet a total C/N equal or greater than 6 dB for 99.9% of the worst month or a C/N equal or greater than 12 dB for 99.0% of the worst month, the following *unfaded* levels are required for the six spot beams.

	To Meet 6 dB C/N For 99.9% WM	To Meet 12 dB C/N For 99.0% WM
Spot Beam	Unfaded C/N dB	Unfaded C/N dB
1E	15.5	14.6
2E	13.4	13.0
3E	13.4	13.0
3W	13.8	13.4
2W	10.6	12.8
1W	9.6	13.2

Note that, in the above figures, allowance is made for uplink and downlink adjacent satellite and adjacent channel interference.

5.2.9 Required EIRP Level and Estimated TWT Power Per Spot Beam

To obtain the required satellite TWT power of the individual beams, the edge EIRP level of the six spot beams has to be determined. Noting the required unfaded C/N values listed in the previous section, link calculations (Table 5.2.4) result in the edge EIRP levels listed in Table 5.2.2. Using the edge of coverage antenna gain listed in Section 5.2.7, the estimated mimimum TWT power for the individual spot beams are calculated and shown in Table 5.2.3.

It is interesting to note that the majority of the cases require an edge-of-coverage EIRP level of 48-49 dBW. For Eastern Canada, the availability objective of 99.9% of the worst month (44 minutes) for C/N equal or greater than 6 dB would result in a required EIRP level of 51-52 dBW, depending on the type of receiver used.

5.3 Conclusions

A first cut system analysis has been carried out for a future DBS satellite, and the results indicate that a future low-powered DBS system with 53 dBW peak EIRP would satisfy the system requirements in Canda. Spot Beam-edge EIRP levels of 48 to 52 dBW can deliver a good quality TV signal to low cost small size receivers (1 meter). A DBS satellite system with these characteristics would provide a high level of performance for the viewer. The video S/N performance would equal or be greater than 42 dB for 99% of the worst month.

Table 5.2.2 Required Edge EIRP per Spot Beam (2 dB Taper), dBW

Spot Beam	99.9% WM		99.0% WM	
	LNA NF = 2 dB	LNA NF = 3 dB	LNA NF = 2 dB	LNA NF = 3 dB
1E	50.7	52.1	49.8	51.2
2E	48.6	50.0	48.1	49.6
3E	48.6	50.0	48.1	49.6
3W	49.0	50.5	48.5	50.0
2W	45.7	47.2	47.9	49.4
1W	44.7	46.2	48.3	49.8

Table 5.2.3 Required TWT Power per Spot Beam, (2 dB Taper), Watt

Spot Beam	99.9% WM		99.0% WM	
	LNA NF = 2 dB	LNA NF = 3 dB	LNA NF = 2 dB	LNA NF = 3 dB
1E	21	29	17	24
2E	23	32	21	29
3E	23	32	13	19
3W	16	23	15	20
2W	6	9	10	14
1W	8	11	17	24

Table 5.2.4 Sample Link Calculation

Parameter	Unit	
Uplink		
Satellite G/T	dB/K	2.0
Saturating Flux Density	dBW/m^2	–79.1
Input Backoff per Carrier	dB	0.0
Required Flux Density	dBW/m^2	–79.1
C/N_o Thermal	dB-Hz	105.1
Noise Bandwidth	MHz	20.0
C/N Thermal	dB	32.1
Downlink		
Satellite EIRP (at saturation)	dBW	51.0
Output Backoff	dB	0.0
Satellite EIRP per Carrier	dBW	51.0
Path Loss (6° Elevation Angle)	dB	206.6
Earth Station G/T	dB/K	15.2
C/N_o Thermal	dB-Hz	88.2
Noise Bandwidth	MHz	20.0
C/N Thermal	dB	15.2
Interference (C/I)		
(minimum satellite spacing 18 degrees)		
Adjacent Satellite		
– uplink	dB	52.7
		22.8
– downlink		
Adjacent Channel		
– uplink	dB	35.0
– downlink		40.0
	dB	
Total Interference	dB	22.3
Total Unfaded C/N	dB	14.4