ANALYSIS OF OWNERSHIP ALTERNATIVES OF DOMESTIC SATELLITE EARTH STATIONS IN CANADA

PREPARED FOR

DEPARTMENT OF COMMUNICATIONS
DSS CONTRACT OSU77-00383

APRIL 1978

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NOTE: The views expressed in this report are those of the author. The report does not necessarily represent the position of the Department of Communications or the Federal Government, and no commitment for future action should be inferred from it.

ALTERNATIVES FOR OWNERSHIP OF DOMESTIC SATELLITE EARTH STATIONS IN CANADA

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21 April 1978

Mr. W.D. Halayko, P. Eng.
Communications Research Centre
Space Research Centre
P.O. Box 11490, Shirley Bay
Station "H"
Ottawa, Ontario K2H 8S2

Dear Dave:

I am forwarding herewith, three copies of our report, "Analysis of Ownership Alternatives of Domestic Satellite Earth Stations in Canada", for your review.

I am pleased to have been able to participate in this project, and hope that our work will be useful to DOC in developing a policy for ownership of domestic satellite earth stations in Canada. In view of the urgency associated within your department regarding an early decision timeframe, I am pleased that it was possible to deliver this report nominally ahead of schedule.

Please feel free to contact me for any further information you require.

Yours sincerely,

SATEL CONSULTANTS LIMITED

Barry F. Murphy, P. Eng.

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1. INTRODUCTION

1. INTRODUCTION

In late January, saTel Consultants Limited was approached by the Department of Communications to prepare a Proposal covering an Analysis of Earth Station Ownership in Canada. Following discussions with officers in the National Telecommunications Branch and the Department of Supply and Services, Contract OSU77-00383 was awarded to saTel Consultants Limited for the services of B.F. Murphy, Consulting Engineer, to conduct an Analysis of Domestic Earth Station Ownership in Canada, pursuant to a revised Work Statement negotiated by the parties.

Work commenced on the project around February 9, 1978, according to the proposed project schedule.

Interviews were held with interested parties in Canada, such as Telesat Canada, CN-CP Telecommunications, Bell Canada, Canadian Cable Television Association, etc., for the purpose of exploring the stated positions of the major interested industrial organizations, and discussions covering items not included in their respective briefs to DOC, as requested in the Canada Gazette, Part I, dated 10 December 1977, DGTN004-77. In addition, correspondence was directed to Canadian earth station vendors, and subsequent discussions held in respect of their views on the relative merits of earth station ownership and the potential effect it would have on Canadian earth station sales. In

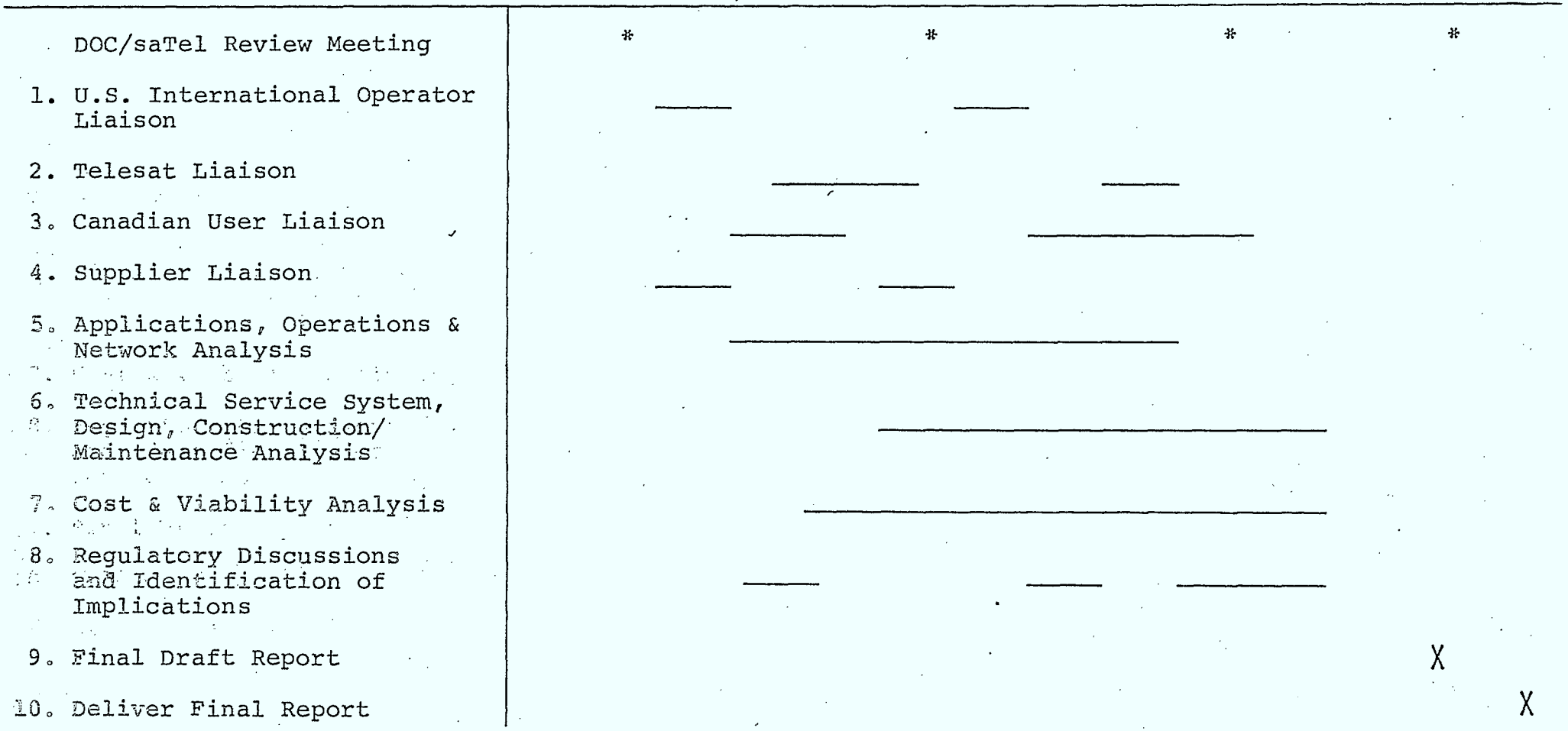
order to take advantage of operational experience in the U.S., where user-owned earth stations are permitted, discussions were held with satellite operators, such as Western Union and RCA; and American Satellite Corporation, the unique specialized common carrier which provides satellite services through leased satellite transponders. In addition, meetings were held with Public Broadcasting System representatives and the principals of TransCommunications Corporation, both of which represent user views of the U.S. situation.

Throughout the analysis, extensive use was made of technical and financial data accumulated by saTel Consultants Limited in respect of earlier work carried out for other clients on whose behalf saTel has acted in respect of satellite services and studies. In particular, saTel Consultants Limited has acted for a number of industrial clients who have established TV and Radio broadcast facilities based upon satellite-derived program material in the remote areas of Canada. These activities have extended from the Northern tip of Baffin Island, at Nanisivik, NWT, through to the Northern parts of the Provinces. During these programs, saTel has been involved in negotiations with Telesat Canada, DOC, CRTC, CBC, etc. in respect of institutional arrangements, as well as the engineering and implementation phases of establishing TV and FM services.

In 1977, saTel carried out a major feasibility study for the provision of Satellite Telecommunication Services in the Andean Nations of South America in conjunction with another local consulting organization. That study, completed in September 1977, provided up-to-date technical, cost, institutional and economic visibility into current developments in satellite technology.

This report represents the synthesis of the foregoing data, along with the analysis of the particular situation in Canada in respect of earth station ownership. The analysis has been delivered according to the agreed-upon schedule with DOC/DSS, and includes both original material developed by saTel Consultants Limited and factual data obtained during discussions with U.S. satellite common carriers in respect of tariff, operational constraints, and restoration procedures.

STUDY PROGRAM SCHEDULE



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Formed in the Fall of 1975, saTel Consultants Limited is a systems, management and marketing oriented telecommunications consulting organization engaged in providing the client/engineering-systems/management interface.

saTel has provided marketing, market research and management services to a number of Canadian and U.S. aerospace and satellite related companies.

saTel has completed a study for Bell Canada entitled, "An Assessment of Non-Canadian Satellite Systems"

- Current Programs
- Future Technology
- Market Perspective

In addition, saTel has worked with Bell Canada on other technical projects relating to telephone plant and accounting matters.

A study has been completed on the feasibility of providing joint TV services via satellite to the communities of Strathcona Sound and Arctic Bay in the Northwest Territories. saTel has undertaken the engineering systems design, procurement, installation, license application and other institutional liaison with Telesat Canada, Department of Communications, Canadian Radio-Television and Telecommunications Commission and the Canadian Broadcasting Corporation on behalf of Strathcona Mineral Services Limited to establish Canadian Broadcasting Corporation TV rebroadcast facilities at Strathcona Sound. Similar activities were carried out for Gulf Minerals Canada Limited in connection with a TV rebroadcast facility in Northern Saskatchewan; Terra Mining and Exploration Limited at Camsell River in the Northwest Territories; and Echo Bay Mines Limited at Port Radium in the Northwest Territories. Discussions are taking place with the Northwest Territorial Government regarding extension of television service to Arctic Bay.

A comprehensive study, analysis, and test program has been carried out for Integrated Satellite Information Services Limited in Saskatchewan in connection with a number of technical and economic alternatives for the distribution of LANDSAT and NOAA high resolution imagery in quasi real time using currently available devices and transmission media to prospective end-users in Canada.

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saTel has concluded a comprehensive operational, technical, and economic study, under contract to the Federal Ministry of Transport, in connection with the overall telecommunication system aspects of a Northern Airspace Plan. This study outlines the configuration, technical and economic alternatives, and economic factors associated with the provision of improved air traffic services, communications and navigational aids in the Canadian Arctic for improved air traffic safety and airspace utilization.

Another study for the Ministry of Transport has been conducted to develop a Long Range Canadian Airspace Systems configuration for the 1991-2000 timeframe covering navigational aids, communications, surveillance and Air Traffic Control subsystem alternatives in Canada.

saTel has completed Engineering, Furnishing and Installing a 16 channel HF News Monitoring/Recording receiving system in support of press operations for Globecom Publications Limited.

A study has been completed of IFR air operations (Air Navigation, Air-Ground Communications and Weather Instrumentation) in connection with the Construction Phase of the Canadian Arctic Gas pipeline.

A system design is being developed on behalf of the Federal Ministry of Transport for an unattended air navigation and communications facility capable of self-contained long-term operation in the Canadian Arctic; a prototype installation is expected to be implemented in 1978 to undertake operational evaluation and engineering measurements.

saTel is currently carrying out system design, economic analysis and licensing action for a two channel 3-hop microwave system for a New Brunswick cable application to extend U.S. and French language TV programming to new CATV service areas.

saTel has been retained by a Community Association in British Columbia to undertake a Project Definition Phase Study to include engineering analysis and system configuration design to provide improved and expanded TV and FM service to a number of communities. Studies of engineering, institutional and financial alternatives and implications to provide improved TV service to communities are being discussed with communities and cable operators in Ontario.

saTel Consultants Limited is also involved in providing services for American companies in terms of product and market identification for telecommunications equipment, and institutional liaison with federal communications authorities on broadcasting and TV matters.

A comprehensive feasibility study was carried out for a satellite communications system for the Andean Nations of South America. This study was completed on schedule in three months in cooperation with another local consulting firm. The feasibility study included identification of seven alternative systems models, and provided a complete technical, economic and viability analysis for each model, together with a recommended implementation and operations management and organization structure for the multi-nation project.

2. EXECUTIVE SUMMARY

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In conducting the Analysis of "Alternatives for Ownership of Domestic Satellite Earth Stations in Canada", a number of factors were reviewed to provide the basis for identifying the alternatives, and commenting on the implications of each.

Discussions were held with U.S. satellite operators, end-use customers, a specialized satellite common carrier, which does not own satellites (AMSAT), and others active in consulting and promotion activities associated with satellite telecommunications in the U.S. During discussions with two U.S. satellite operators, RCA American Communications, Inc. and Western Union Telegraph Company, it was learned that no major technical, operational, or maintenance problems have arisen as a result of private satellite earth station ownership in the U.S. These companies have established contractual obligations, maintenance and operating procedures, and customer liaison committees which have permitted uplink access of TV, Radio, Telephone Message and Data communications from non-company-owned earth stations through their satellites to privately-owned earth stations. Likewise, such services do originate at company-owned earth stations for distribution to user-owned earth stations, and vice-versa. In general, RCA, Western Union, and AMSAT own very few earth stations as compared to the total number of earth stations in the U.S.

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The company-owned earth stations are primarily used for telephone message and data communications among each other for integration with their existing microwave systems, or for the purpose of providing specialized long-haul telecommunications between major centres. The preponderance of satellite usage in the U.S. is for radio and TV distribution, either on a full-time basis or for occasional use. The largest network use of satellite distribution is by the Corporation for Public Broadcasting, which is in the process of establishing over 300 privately-owned earth stations, employing a minimum of four transponders for exclusive satellite distribution of TV and radio programming within the 50 States and Puerto Rico. In addition, several Pay TV/Cable and non-profit Theological networks are operated on an occasional-use basis. As of the end of Calendar 1977, over 700 earth stations were either operational or had filed license applications with the FCC.

Discussions were held in Canada with Telesat, major common carrier organizations, the Canadian Cable Television Association and vendors of earth station equipment, to ascertain positions and attitudes with respect to private ownership of earth stations.

Four basic alternatives for ownership of domestic satellite earth stations in Canada were postulated:-

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- Status Quo
- Regulated Common Carriers
- User Consortia
- Open

In order to assess the implications of the four alternatives, which deliberately exclude a government ownership alternative, existing and future applications were identified, operational implications examined, engineering and implementation factors studied, economic considerations analysed, and regulatory procedural options developed. This information is presented in detail herein for further study and review by DOC.

It is suggested that the majority of new users of satellite services will be for broadcast receive-only and/or specialized small aperture earth stations. No technical or operational difficulties associated with private ownership of such stations could be found. The Economic Analysis for receive-only and specialized small earth stations suggests that there is a distinct cost advantage to the user in being able to own the earth station. This arises primarily from being able to tailor earth station configurations to his particular requirements through co-location with his existing infrastructure and integration within his plant, personnel and maintenance structure. There is also evidence that the capital cost for such earth stations, when translated into equivalent annual costs, could be between 35% and 55% of the

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current tariff charges of Telesat. It is suggested that this overall differential is needed to stimulate implementation of additional earth stations for broadcast services with the anticipated increased demand for satellite channels. Also, the cost differential for receive-only earth stations would make possible introduction of TV and radio services to very small communities, either directly by community funding, or via territorial/provincial assistance programs.

Earth station ownership of such stations, through either consortia or individually, would deprive Telesat of additional earth station revenues. However, such an arrangement would reduce the capital funding requirements of Telesat, which apparently are significant over the next several years. By way of example, 100 additional small aperture receive-only earth stations would yield Telesat some $1.5-$2 Million annually as compared to 1976 annual revenues of some $30 Million in total.

In the interest of expanding satellite broadcast services and TV distribution as broadly as possible within Canada, it would seem that private ownership of earth stations associated with distribution of radio and TV services could be beneficial through either consortia established for the purpose, or by individual users.

It is believed that small aperture specialized earth stations such as would provide telecommunication

services from oil drilling rigs in remote or offshore locations, military and emergency services, data collection or information distribution from/to a large number of locations, etc. can be more cost-effectively implemented by users through use of common infrastructures, logistics, etc., or through integration with other user facilities, such as data sensors, power supplies, and other user electronics.

The same argument can be advanced for larger, more complex, earth stations which are in effect dedicated to a single user, such as might be the case of some earth stations employed by the regulated common carriers. In such cases, the use of the common infrastructure, etc. can probably be complemented by extensive integration of electronics to serve not only the earth station functions but other associated terrestrial functions. Although such arrangements may be more cost-effective, they might complicate cost separation of satellite versus terrestrial plant for the purpose of regulation. Furthermore, overall regulation of common carrier satellite services by CRTC exclusively would seem to be precluded, since earth stations owned by common carriers under provincial regulation would come under the jurisdiction of the appropriate provincial regulatory body.

There seems to be a distinct advantage in single ownership of earth stations providing a broad variety of multi-user services. Effective design, implemenation and maintenance of such earth stations requires coordination and

engineering skills in order to optimize the facility. Under these circumstances, it seems that such earth stations should be owned, maintained and operated by Telesat, in order to take advantage of their expertise in this regard. In order to extend the same thesis to privately-owned earth stations, for possible future applications by other users, private earth station owners should be obligated under the terms of their licenses to permit joint use of their facilities by Telesat or other users on mutually-agreeable commercial terms. Appeal to the regulatory body should be available in the event mutually-agreeable terms cannot be concluded, and all such joint-use arrangements should be filed with the regulatory body for overall review. Furthermore, applicants for private earth station licenses should be required to show the economic justification for same in a manner analogous to that now required to justify private ownership of microwave facilities versus lease of common carrier services.

In the event that a change in policy for ownership of domestic satellite earth stations in Canada is to transpire, the Telesat contention that its Act of Incorporation requires it to own all earth stations will have to be examined, and possible revisions to the Telesat Canada Act contemplated, if in fact there is legal substance to Telesat's claim.

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3. EXISTING SYSTEMS

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In order to provide factual background data for the analysis, a number of existing satellite systems were examined. In most cases, interviews were held with senior personnel of the various operators, and supporting documentation obtained to provide bases for the analysis of the various alternatives for earth station ownership. This process was necessarily limited to Canadian and U.S. operators by virtue of the time and cost constraints of the contract.

Canada

The only domestic satellite operator in Canada is Telesat Canada, which was granted an exclusive franchise by virtue of the 1969 Act of Incorporation passed by Parliament. Telesat is now owned basically in equal proportions by the Government of Canada and the Canadian Telecommunications Industry. The third party public interest set out in the Telesat Canada Act is represented by the single share held by Mr. D.A. Golden, the President of Telesat. Throughout its eight and one-half years of existence, extensive public share ownership has always been held to be inappropriate for reasons of market conditions, financial performance, etc. As of mid-1977, Telesat had retired indebtedness to the Government of Canada for various loans provided during the initial years of operation. During the first four years of operation (1972-76), Telesat showed profits ranging from .28¢ to .59¢ per share on

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the original $60 million equity issued.

During the period 1972-75, three successful launches of the initial Telesat-A spacecraft took place, providing a total of 36 C-Band (4/6 GHz) transponders in geostationary orbit. Recent indications are that F-1 and F-2 of the ANIK-A series have malfunctions which could result in some loss of serviceability or lifetime.

A single Telesat-B spacecraft is scheduled for launch in November 1978. This spacecraft will provide 12 C-Band transponders, comparable to the Telesat-A series, plus 4 K-Band (11/14 GHz) transponders; the K-Band transponders have been contracted to the Federal Department of Communications for follow-on experiments to the government-sponsored CTS (Hermes) spacecraft.

Telesat has recently signed a procurement contract for its ANIK-C program, which will consist of three spacecraft operating in K-Band, each spacecraft having 18 transponders employing spot beam techniques to serve the various regions of Canada. Initial launch of the ANIK-C spacecraft is scheduled for 1980.

During the same period, Telesat Canada has established some 85-90 earth stations across Canada to provide the various customer services throughout the country. It is anticipated that Telesat will have approximately 100 earth stations by mid-1978 provide telephone message, TV,

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and radio service in the populated and isolated regions of Canada. All earth stations are owned by Telesat, and in general are maintained by Telesat either directly or by means of sub-contract maintenance arrangements. Requests for Proposals have been issued for additional K-Band earth stations in support of the proposed ANIK-C program; however, no contracts have been issued to date for operational facilities. Experimental earth stations, in connection with the ANIK-C K-Band transponders, are expected to be funded and operated as part of the Department of Communications follow-on experimental program, although some integration with existing Telesat earth stations is not precluded.

Aside from the federally-funded experimental programs employing K-Band transponders on ANIK-B, commerical utilization of the ANIK-A transponders is divided between telephone message and video/radio distribution in an approximate ratio of 60/40. The nominal fill of the existing 36 transponders is approximately 25%; however, taking into account the provision of a spare satellite for in-orbit protection, system fill is more realistically some 35%-40%. The principal customers of Telesat are, the Canadian Broadcasting Corporation, which uses the satellite for English and French national TV distribution, and TV and radio distribution in the remote/Arctic regions of Canada; and TCTS/CN-CPT, which employ the satellite to complement long haul Toronto-Vancouver telephone message service, and to provide telephone

message service to the remote/Arctic regions of Canada. Modest use of the system is made by the Canadian and U.S. Military for transmission of voice/data communications from the high Arctic.

From the outset, Telesat has adopted a policy that requires ownership of all earth stations by Telesat, as perceived under the Telesat Canada Act, and leasing of whole transponders by customers on a full-period basis. Exceptions to the foregoing policy permit customers leasing full-period service to lease incrementally whole transponders on an occasional-use basis, or partial transponders on a full-period basis, where technical constraints apply (Thule, Greenland - U.S. DoD traffic on ANIK-2 because of earth station elevation angle criteria). The prerequisite in such cases has always been that the principal customer shall be leasing at least one whole transponder on a full-period basis. Exceptions to earth station ownership have been made only in terms of international or non-Canadian use of the Telesat system, viz. interim use by RCA AMERICOM to provide domestic and Alaskan satellite services; and long-term use by RCA of ANIK-A satellite transponders to provide military communications between Greenland/Northern Canada and the Continental U.S. In such cases non-Telesat-owned earth stations located on non-Canadian soil were permitted for use with the ANIK-A series of satellites.

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Throughout its implementation and operations program, Telesat has assumed operational control and responsibility for the space segment following separation from the NASA Thor-Delta boosters provided on a cost-reimbursable basis to Telesat. Telesat carried out all the necessary planning, mission control and long-term satellite control engineering, management and responsibility in terms of satellite operations, diagnostics, operational strategies, etc. Likewise, Telesat has assumed even more responsibility for design, implementation, operations and maintenance of earth stations through its own resources, although routine maintenance of its earth station network is carried out by means of a mix of its own personnel and sub-contract maintenance agencies, which are typically either the common carriers or specialized customer user agencies.

The interface for satellite services has always been the earth station baseband input/output from which the CBC, Common Carriers, and Private Users provide the necessary wire-line, microwave, and broadcast equipments to affect service delivery.

In the last few years Telesat has acceded to the provision of certain elements of the site infrastructure (land, buildings, foundations, power, etc.) by the end-user in an attempt to reduce earth station costs/charges; Telesat has also been amenable to first-line maintenance by the customer, subject to their approval, for similar reasons.

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Such a policy appears to have been successful in enlarging the growth of certain classes of stations, such as receive only television, to such users as the Yukon Territorial Government, and a number of private mining operations in the Northwest Territories and northern parts of certain provinces.

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International

Although detailed discussions were not held with the various international applications listed below, it was felt desirable to include such applications, by way of example, in the background considerations for the analysis.

Intelsat:

The first formal organization to enter into communications on a commercial basis is known to be the International Telecommunications Satellite consortium (Intelsat). Intelsat consists of some 100 countries, bound by an international agreement for the provision of satellite communications services among the member countries. COMSAT of Washington, D.C. were chosen as the system managers in order to provide the necessary planning, engineering and coordination services for the space segment in particular, and system management in general. As such, COMSAT has assumed responsibility through its mandate from Intelsat to plan, specify, procure, launch, and manage a network of geostationary satellites under the sponsorship of the member countries.

Member countries in general own and operate the earth stations by which the various telecommunications services (telephone message, broadcast, data, etc.) are provided among member countries. Criteria for establishment

of earth station facilities and system parameters are developed through Intelsat committees, Intelsat staff, and COMSAT to ensure orderly utilization and development of the network. COMSAT provides control of the network, detailed procedures, etc. in their role as designated system manager.

COMSAT, on behalf of Intelsat, operates a number of geostationary satellites, all of which at the present moment employ C-Band frequency allocations. These satellites are strategically located to provide inter-country/intercontinental services among the member nations. Future plans are to employ a hybrid spacecraft, Intelsat-V, in the C and K frequency bands with a particular interconnection capability between the two frequency bands to cater to the high volume requirements among certain countries at K-Band, and accommodate long-term utilization of earth stations in both the K and C Band by the member nations. In effect, the spacecraft design provides for upgraded capability employing K-Band earth stations by nations with high traffic densities, without early obsolescence of C-Band earth stations by member nations having relatively low traffic densities.

The principal users of Intelsat are the designated international common carriers of the various countries, such as TeleGlobe Canada, the British Post Office, etc., and the largest percentage of traffic carried is telephone message with small fraction of data; international TV/radio broadcast

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transmissions account for the preponderance of occasional use services.

Recently, a number of countries have leased Intelsat transponders for domestic services within the country. Examples of such partial transponder lease range from, Algeria (1/2 transponder), which provides telephone and TV service, to Chile (1 transponder), which provides only telephone message service.

COMSAT provides for system planning, procurement, launch, and satellite operations of the space segment, and overall system management in terms of technical and operational parameters among the member nations. Member nations in general provide and operate their own earth stations in accordance with the overall system plan and technical criteria.

A system of tariffs has been developed for transponder utilization, primarily based upon the number of voice channels, by which member nations are charged for space segment services. Similarly, ground station charges have been developed by Intelsat which are added to the space portion. Video/broadcasting tariffs have been developed to cater to the occasional-use international program transmission market. Partial and/or whole transponder charges for use by individual countries are also available through Intelsat for intra-country services. All countries share in the profits

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of Intelsat derived from the space segment basically in proportion to their utilization of the space segment. This is represented more or less by the capital investment of each country in the space segment assets of Intelsat, under the International Agreement.

Overall management of the Intelsat consortia is generally proportionate to the capital of each country, by means of a number of technical, tariff, operational, etc. committees, and a "Board of Directors" for major policy ratification and development.

Indonesia:

Indonesia established a domestic satellite communications system in 1976, which closely parallels the Telesat Canada system in that it employs two similar spacecraft in geostationary orbit, and provides services to some 30-40 earth stations within the country. The system is operated by the designated telecommunications company, which owns and operates the space and earth segments. In addition, spare space segment transponder capacity is leased to other Far East nations, such as the Phillipines, which in effect own their own stations, and operate independently by means of discrete transponder(s) on the Indonesian space segment.

Detailed information on this regional "mini Intelsat" system was not obtained during the analysis.

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However, it was determined that the system was provided on a turn-key basis by a consortium of American vendors, and uses state-of-the-art techniques such as Demand Assignment Multiple Access (DAMA) and Companded Single Channel Per Carrier FM for "Thin Route" telecommunications services. The system provides for telephone message and broadcast service distribution within the coverage area, employing C-Band frequency assignments.

Algeria:

As noted under the review of Intelsat, Algeria has developed a domestic telephone message and broadcast distribution system employing a satellite transponder leased from Intelsat. In effect, Algeria owns and manages the earth station segment and transponder utilization by which it provides internal telecommunications within its borders.

It is interesting to note that several other countries have embarked on similar arrangements on a smaller scale in order to augment and/or provide additional services via satellite within their respective countries.

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United States

As a result of the Federal Communications Commission policy in the early 1970s, which in effect declared an "open skies" situation in respect of domestic satellite operations in the United States, a number of companies provide satellite services to the Continental and offshore U.S. territories.

AT&T/COMSAT

American Telephone and Telegraph provide extensive satellite communications as a complement to existing terrestrial microwave systems by means of AT&T-owned earth stations and a space segment provided by COMSAT General Corporation. AT&T in effect leases from COMSAT General two 24-channel spacecraft operating at C-Band, which were designed, procured and launched by COMSAT, and for which COMSAT provides the necessary satellite control, etc. The system is used by AT&T largely for telephone message traffic among high density locations in the U.S. As a result of an FCC ruling, General Telephone also provides telephone message services within its franchised area by means of the COMSAT General space segment and earth stations owned by General Telephone.

RCA American Communications, Inc.

RCA Americom is a wholly-owned subsidiary of RCA Corporation, engaged in the provision of satellite telecommunications services throughout U.S. territories.

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RCA Americom has two 24-channel satellites in orbit operating at C-Band. A third spacecraft is in storage in order to honour back-up spacecraft commitments. Current launch plans are indefinite, although RCA has already purchased a Thor-Delta 3914 booster, but has recently reserved a space shuttle launch for the back-up spacecraft.

RCA provides Military and Commercial satellite services through a series of earth stations owned by RCA as shown in Figure 01. It will be noted that the preponderance of earth stations are provided in support of government/ military operations. In addition, RCA Americom provides service primarily for video distribution purposes through either lease of an uplink and transponder for use with customer-furnished earth stations, or lease of a transponder-only for use with customer-furnished uplink stations and receive-only stations. These video distribution services are either on a full-period basis or occasional-use basis. Typical customers of RCA Americom, for TV distribution, are, the Christian Broadcasting Network, Praise the Lord Broadcast Network, Southern Satellite Services, Trinity Broadcasting Network, and Home Box Office. The distribution and ownership of earth stations associated with RCA's satellite services, in total, are shown on Figure 02, and it will be noted that a high percentage of earth stations are customer-owned. In addition, expansion of such customer-owned earth

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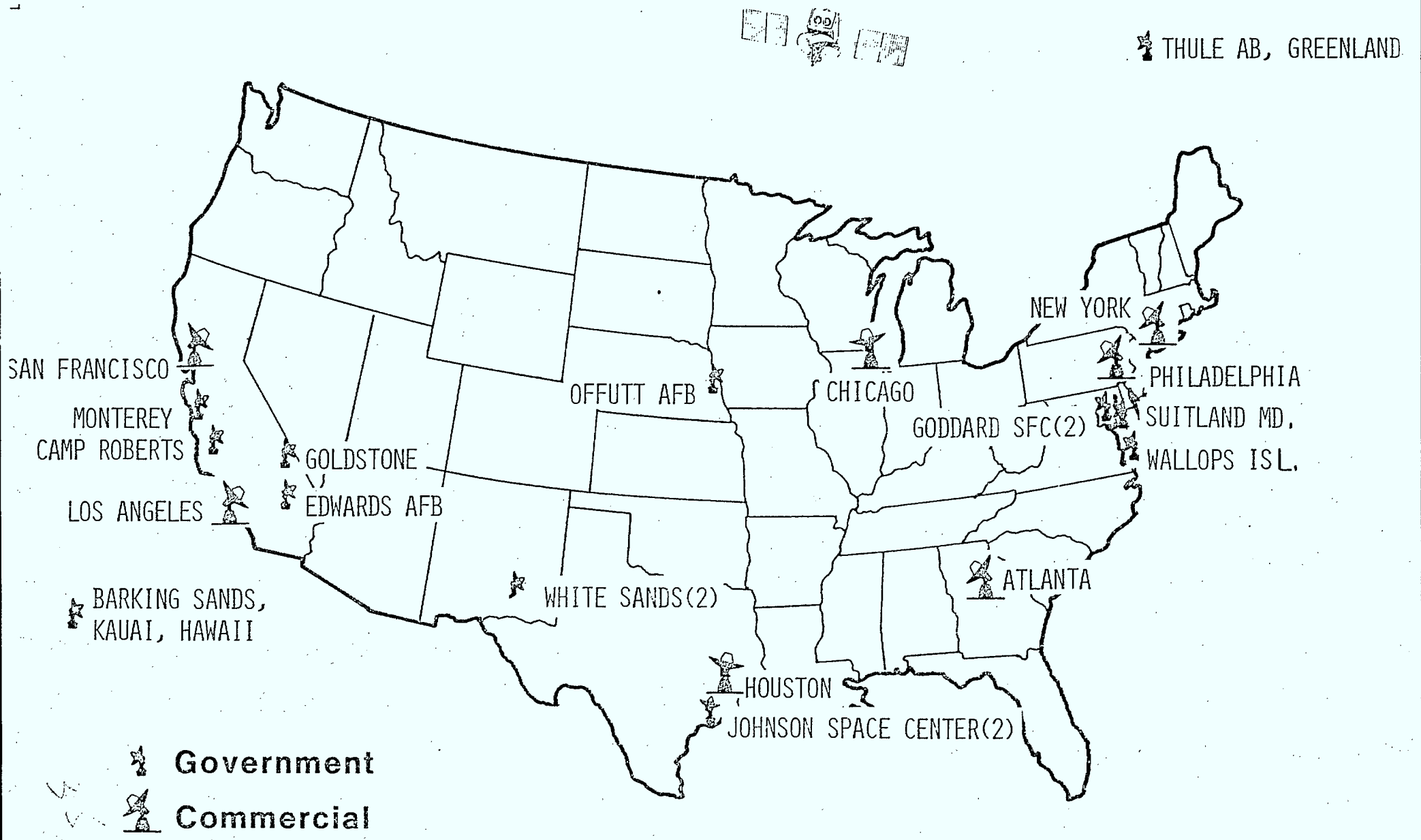
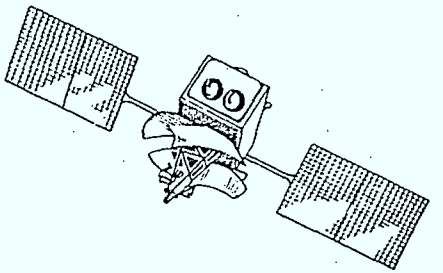
RCA Americom Earth Station Locations



Satellite Networks



Operational earth stations looking at RCA satellites:

- RCA Tracking, Telemetry & Command earth station.
- Major RCA Americom earth station.
- Receive Only station owned by cable TV system. Station serves ( ) systems.
- RCA station dedicated to government.
- Broadcaster-owned earth station.

RCA American Communications

stations is proceeding at a rapid rate, as will be noted from the three Press Clippings from a single month's issue of Communications News, as shown in Figure 03.

RCA Americom also leases transponders to RCA Alaskom for provision of telephone message and broadcast services in the State of Alaska. RCA Americom have tariff offerings for partial transponder, occasional-use service, associated with customer-owned earth stations; to date, this has primarily been utilized by earth station vendors for demonstration and/or engineering tests. However, full-period partial transponder service offerings are available for use with customer-provided earth stations in response to requirements for reliable telecommunications services to oil rigs adjacent to U.S. territory. RCA is also introducing 56 kbps data service on a tariff basis for use either with RCA earth stations and/or customer-furnished earth stations.

In order to formalize technical parameters and operating procedures for customer-owned uplink earth stations, RCA has developed operating restrictions which become part of the customer obligation under the contract. Further, it has developed procedures for restoration of service, which also form part of the service contract. No serious interference contributions have been caused by customer-owned uplink earth stations to date. One notable incident during which interference was caused to Home Box Office television

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Trinity Broadcasting Network Orders Video Satellite Stations

The Trinity Broadcasting Network (TBN), a television broadcaster and producer of Christian programming, has placed an order with Scientific-Atlanta for a transmitting and receiving video satellite earth station to be installed in Tustin, California, and a satellite video receiving earth station for the TBN Phoenix television broadcast station.

TBN will use the earth station to transmit network programming to TBN-owned-and-operated stations and affiliates, and the station will become an integral part of TBN's program distribution facility. TBN currently produces more than 70 percent of the programming used on its stations.

BFM Cable Purchases 18 Hughes Video Terminals

BFM Cable Communications Constructors, a Norwalk, Connecticut-based multiple CATV system operator, has awarded a contract to Hughes Aircraft's Microwave Communications Products subsidiary for 18 satellite video receiving terminals. The agreement calls for completely integrated earth stations and includes both 6 and 4.5-meter antennas. The systems include low-noise amplifiers, 24-channel video receiver with threshold extension, and all necessary power supplies, cables, waveguides, and other integration hardware.

BFM is currently operating or constructing 30 CATV systems around the country. Of the 18 initial ground terminals, five will be installed in Florida, five in Utah, three in South Carolina, two in Michigan, and one each in Colorado, Maryland, and Pennsylvania.

BFM said it plans to use the new receiving terminals initially to provide its subscribers with satellite-transmitted programming from Atlanta's Channel 17, Christian Broadcasting Network, and Madison Square Garden. An optional pay TV service may be offered.

CBN Subsidiary Purchases 30 Earth Stations

Continental Satellite Corporation will purchase 30 satellite earth stations from Scientific-Atlanta over the next two years, including transmitting earth stations capable of providing live programming from several stations in the United States. Continental Satellite is a wholly owned subsidiary of the Christian Broadcasting Network, Virginia Beach, Virginia.

The earth stations will be installed at CBN's owned and operated television stations and at independent TV stations affiliated with CBN. The satellite broadcast network will carry family and religious programming, including CBN's internationally syndicated "700 Club."

Installation has begun for an upgraded transmitting and receiving station at CBN's international communications center in Virginia Beach, and for receiving terminals at CBN stations in Atlanta, Boston, and Dallas.

FIGURE 03.

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service was inadvertent illumination of RCA Americom's satellite by another U.S. satellite operator's earth station during testing.

Sample RCA tariffs, outlining company/customer obligations, technical parameters, charges and contract terms, are included in Appendix A. RCA operating restrictions and procedures, restoration procedures, etc. are included in Appendix B.

It was not possible to obtain detailed financial information in connection with RCA American Communications, Inc. operations to date, since financial data on Americom is "submerged" in the accounts of RCA Corporation. In discussion with Mr. A. Inglis, President, RCA Americom, it was suggested that Americom may show a profit in the next 1-2 years. This seems to be verified by the first quarter summary of RCA Corporation as reported in the Globe and Mail article of Figure 04.

Future plans of RCA Americom could not be obtained in any detail. However, it was noted that contracts with users, such as Home Box Office, require the provision of C-Band services for an extended 10-year contract interval. This suggests continued provision of C-Band service. It seemed RCA Americom has adopted a wait-and-see attitude to expansion into K-Band spacecraft.

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THE GLOBE AND MAIL, FRIDAY, MARCH 31, 1978

RCA expecting record earnings despite profit slide of NBC unit

NEW YORK (DJ) — RCA Corp. of New York will report record first quarter earnings despite an appreciable decline in profit from its National Broadcasting Co. subsidiary, says Edgar Griffiths, president.

And despite his expectation that NBC profits will continue in 1978 to run behind those of a year earlier, Mr. Griffiths forecast record results for RCA for the full year.

NBC is "still quite profitable, but not as profitable as last year," Mr. Griffiths said. He attributed the profit decline entirely to the network's evening television programming.

In January Mr. Griffiths was dissatisfied enough with NBC's ratings that he recruited television's top programming executive from American Broadcasting Co. to become president and chief executive of NBC. The latest television ratings show NBC in third place, after ABC and CBS, in evening prime-time audiences.

The ABC executive, Fred Silverman, is to take charge of NBC in June, too late to take part in the selection of programs for the fall schedule. When asked if that would not hamper Mr. Silverman's ability to turn NBC around, Mr. Griffiths said, "Our people have done the best they can in new programming and with a sizable bank roll. But Fred Silverman will still have freedom of positioning — the selection of day and hour for each show — and that's a key factor."

Hertz Corp., the vehicle-renting subsidiary, is showing impressive gains, and for the first time is expected to surpass NBC as RCA's leading profit source for the next year, Mr. Griffiths said. In 1977, NBC's share of RCA's pre-tax profit dropped to 32.4 per cent from 35.1 per cent in 1976, while Hertz's share rose to 27.9 per cent from 27 per cent.

RCA earned a record $247-million or $3.23 a common share on record sales of $5.92-billion in 1977. In last year's first quarter, it earned a record $48.5-million or 63 cents a share on record sales of $1.37-billion.

Mr. Griffiths said first quarter sales are up about 10 per cent from a year ago, but he would not estimate the earnings increase. He noted that severe winter weather and the coal strike had forced some RCA electronics plants in the Midwest to close for several days. The bad weather also affected retail sales of Coronet Carpets and Banquet Frozen Foods.

RCA's electronic products businesses will have a strong year, Mr. Griffiths said. The company is running about even with Zenith Radio Corp. in the race for leading market share in color television sets and Mr. Griffiths believes RCA can improve its share of the market and its profitability in this business in 1978.

RCA is not any closer to a decision on whether to market its developmental video-disk system. The system plays through television sets programs recorded on phonograph-like disks. It cannot be used for home recording, but it is expected to have a lower price than video-cassette machines, which can record. "We're watching with great interest to see what happens to prerecorded tapes of old movies that are selling for $40 and $50," Mr. Griffiths said.

"If they sell well, then you can rest assured that when $10 and $15 disks come on the scene, we will be there with the best unit at the best possible price."

RCA has gone out of the video game business, and does not expect to re-enter it, except perhaps by making games part of the home entertainment console. RCA continues to make electronic games circuitry for other manufacturers.

The records division had record profit in 1977 when Elvis Presley died and RCA sales of his albums soared "We would have had a record year without the effect of Elvis Presley's death," said Mr. Griffiths. "And the division will have record profit again this year."

The Random House book publishing unit will have higher profit in 1978, after a decline in 1977 because of a write-down resulting from the reorganization of a school book division, he said.

Profit from communications services is strong over all, Mr. Griffiths said. RCA's Alaskan Telephone Co. has had lower earnings, which it attributes to an inability to get a rate increase. It hopes to get the increase later this year through legal action.

Losses at RCA's domestic space satellite communications business will continue through 1978, but at a minimal level, Mr. Griffiths said.

Asked about published reports that RCA may pick a second-in-command this year, he said that would come in one or two years. In that case, Mr. Griffiths would move into the vacant chairmanship and remain chief executive, but a new president would be named.

Mr. Griffiths said the choice will not necessarily be made from among the four principal operating executives who report to him. "There are talented people below that level who are worthy of consideration, and it's possible we would want to go outside the company," he said. "It all depends on the readiness of the people at a given time. A number of our people are new to their responsibilities."

FIGURE 04.

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Western Union Telegraph Company

Western Union has two 12-channel C-Band satellites in geostationary orbit as part of the overall Western Union Telegraph Company operations. The Westar satellites in orbit and on-ground spare are essentially derivatives of the ANIK-A series, providing satellite telecommunications coverage of U.S. territory. Traffic on the Western Union Westar system consists of a mix of company, specialized common carrier, and broadcast services. Traffic assignments on Westar-I and Westar-II are shown in Figure 05.

Western Union company message service is provided by Western Union-owned earth stations, fully integrated with the terrestrial network, as illustrated in Figure 06.

Western Union currently provides three transponders to American Satellite Corporation, an FCC-approved specialized common carrier, providing Military and Commercial services in the Continental United States. It was learned that ASC will be increasing the number of transponders leased from Western Union to four in the very near future.

Western Union also provide broadcast distribution services for cable and network routings. By far, the largest user in this regard is the Public Broadcasting System, which is currently using one transponder for PBS program distribution in the Continental United States, and which will, in

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WESTAR 1	WESTAR 2
OCCASIONAL VIDEO	VIDEO
L.A. MESSAGE	N.Y. MESSAGE
ASC	PHOENIX/SEATTLE
PROGRAM CHANNEL	VIDEO
ASC	N.Y. MESSAGE
VIDEO	S.F. MESSAGE
ASC	VIDEO
PBS	DALLAS MESSAGE
PROGRAM CHANNEL	L.A. MESSAGE
RESERVED	CABLE VIDEO
VIDEO & PBS TEST	CHICAGO MESSAGE
VIDEO & PBS TEST	VIDEO

Traffic Assignments - WESTAR System

FIGURE 05.

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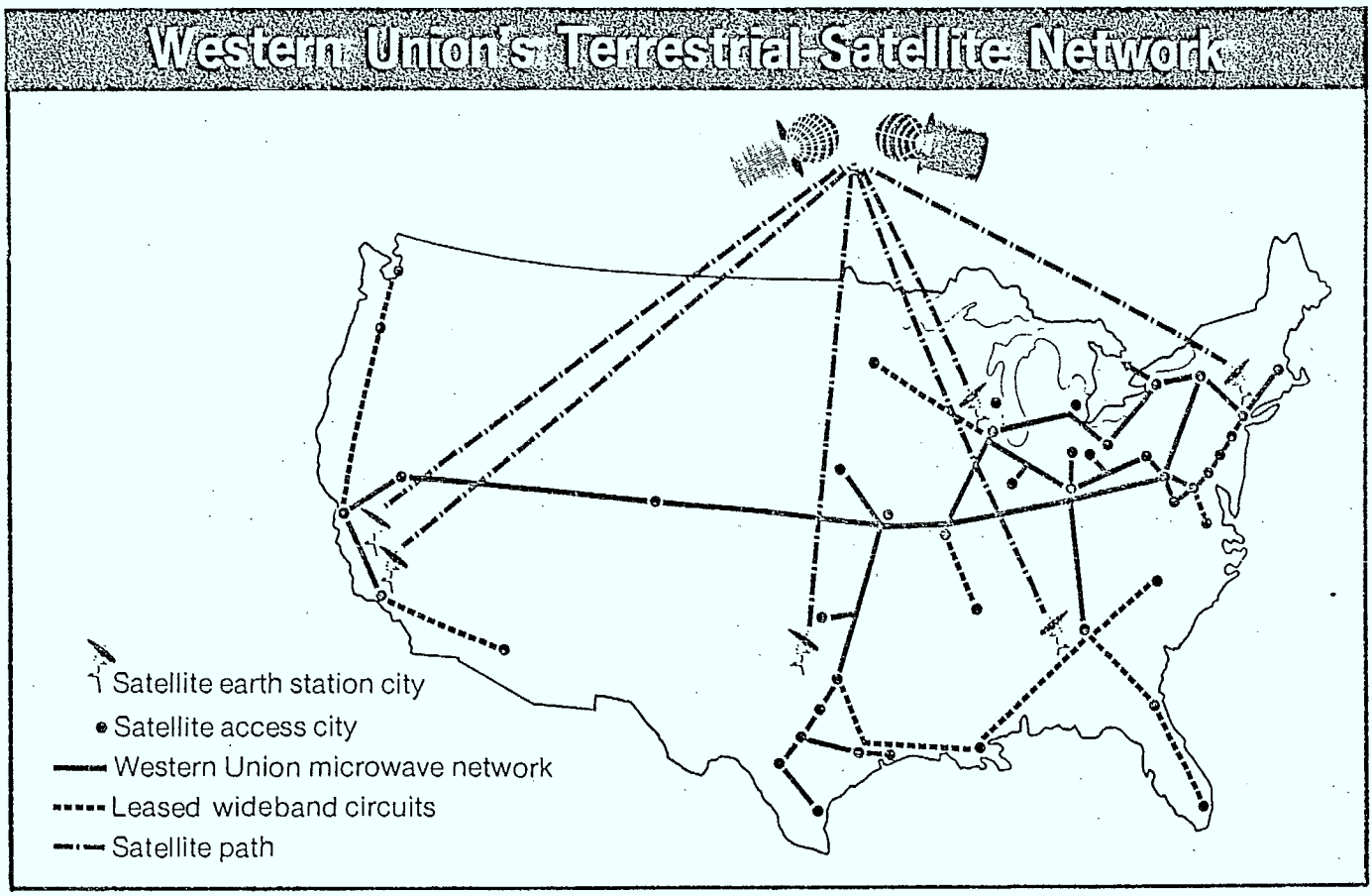

FIGURE 06.

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the relatively near term, employ four transponders as the exclusive method for PBS network distribution to some 150 earth stations in U.S. territory. In addition, between four and twelve high fidelity radio channels will be implemented to serve 170 public radio station locations. All receive-only radio and TV earth stations and 20 uplink earth stations will be owned by the Washington-based Corporation for Public Broadcasting. Another large broadcast network to be carried on Westar will be the distribution of Mutual Broadcasting Systems, Inc. high fidelity radio channels to some 500 privately-owned small aperture earth stations in the U.S.

As in the case of RCA Americom, Western Union offers a variety of services, either through Western Union-owned earth stations, or via customer-owned earth stations. It also has developed, as part of its tariff, criteria for operation of customer-owned earth stations in order to guard against inter-customer interference. These documents are included in Appendices C and D, respectively.

Western Union operates a Technical Liaison Committee with each of its customers, which has been most active during the initial implementation phase of services, in discussing and agreeing to basic technical parameters, performance specifications, operating and maintenance methods, etc. These standing committees deal with changes to system configuration, parameters, etc. and meet as required to discuss and resolve any technical changes and/or difficulties experienced with system operation.

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Peak loadings on Westar-I and Westar-II could exceed transponder capacity following implementation of the PBS system. Accurate determination of Westar profitability is further complicated by the fact that Western Union message transponders are fully integrated with its terrestrial microwave system.

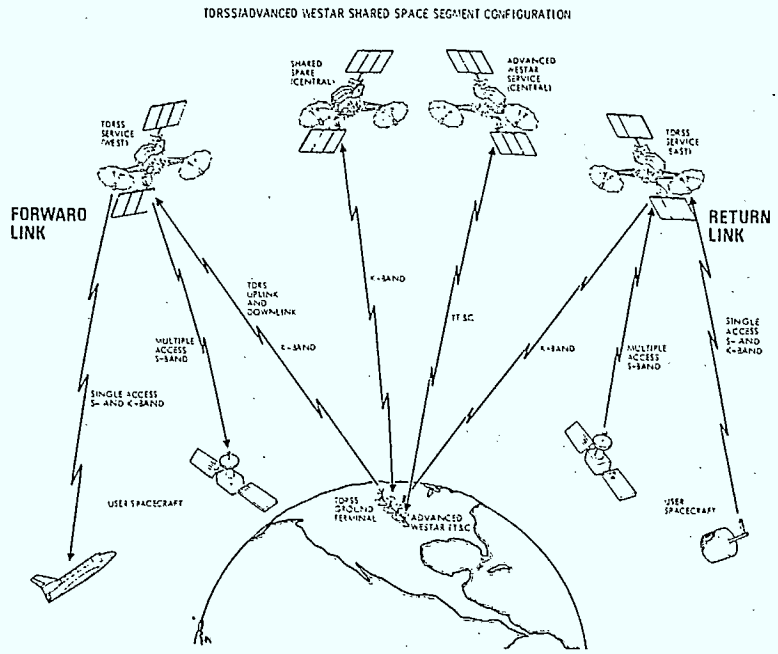
Future planning by Western Union for the next generation of spacecraft has taken the form of a joint program with NASA to provide a Tracking and Data Relay Service Satellite (TDRSS) for NASA, coupled with an advanced Westar satellite to expand Western Union capabilities and eventually replace the current Westar-A series of spacecraft. The basic outline of the shared system is as shown in Figure 07. Initial launch is scheduled for 1980.

It is interesting to note that PBS has leased transponders from Western Union for a period of seven years, subject to renewal for two additional four-year periods at C-Band, presumably to protect the longevity of its substantial earth station investment.

American Satellite Corporation

American Satellite Corporation is a wholly-owned subsidiary of Fairchild Corporation, and an FCC-approved specialized common carrier, engaged in the provision of satellite telecommunications services. Although it originally

TDRSS & ADVANCED WESTAR



A SHARED SYSTEM—Above line drawing shows how the shared TDRSS system, to be built and operated by Western Union, will work. Two of the four satellites depicted will be used by the National Aeronautics and Space Administration to communicate with and monitor the performance of most Earth-orbiting satellites which it intends to launch during the next decade. The third is an in-orbit spare. The fourth will be Western Union's Advanced Westar satellite. The two active TDRSS satellites will communicate to ground through a major, new earth station to be constructed at White Sands, New Mexico. Advanced Westar, on the other hand, will communicate either through the Westar ground network already in place, or through small, K-band terminals to be built at major communication collection points around the nation. These latter will provide the basis for a new digital data communications capability to be offered as part of Advanced Westar service.

FIGURE 07.

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planned to procure and launch its own satellites, because of early difficulties in raising the necessary capital, ASC has leased transponders from Western Union instead.

ASC provides a mixture of Military and Commercial services, largely between earth stations owned and operated by the company, as shown in Figure 08. Two stations, as shown on Figure 08. in the ASC system, are customer-owned, at Orlando and Chicopee, for 56 kbps transmission of the Wall Street Journal by Dow Jones. The balance of the network provides Private Line Message and High Speed Data Transmission to Commercial and Military users.

In pursuing the Medium/High Speed Data market, ASC has developed a Satellite Delay Compensating Unit (SDCU) to reduce the affect of propogation delay for conventional data transmission devices, as outlined on the attached Figure 09.

From discussions with ASC senior personnel, it was learned that, during the early period of transponder lease from Western Union, detailed procedures to avoid interference by ASC into their transponders were largely informal. However, subsequently, detailed technical parameters were developed setting out the obligations of Western Union in terms of transponder characteristics, and the obligations of ASC in terms of earth station requirements and system operation. This portion of the ASC/W.U. Transponder Agreement is included in Appendix E.

AMERICAN SATELLITE NETWORK

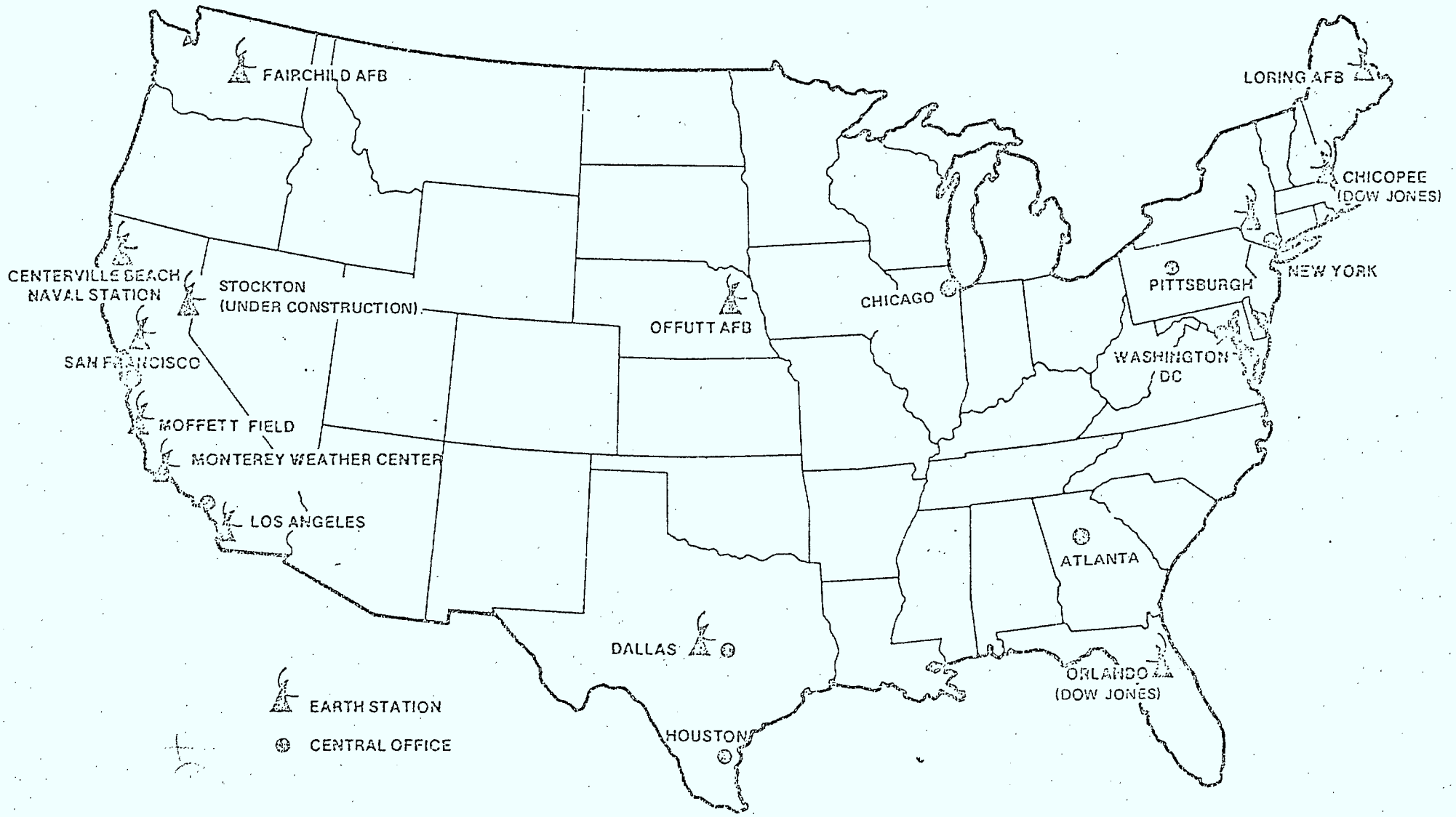
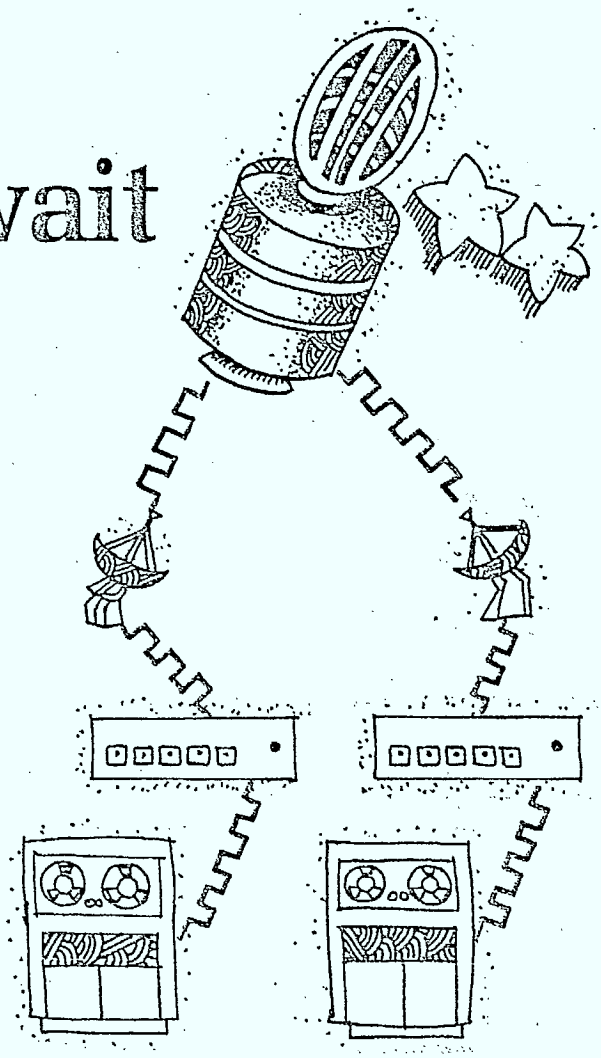


FIGURE 08.

Stop-and-wait no more.

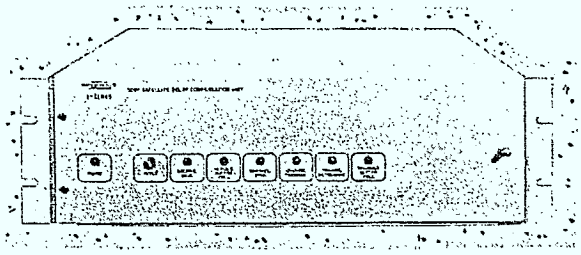


We've eliminated the data delay problem—via satellite.

Though the error-rates on satellite transmitted data have been unbelievably low (1×10^{-9} on a 1.544 Mbps circuit) the speed capabilities to most users have been severely limited by the effect of propagation delay during conventional stop-and-wait ARQ (BISYNC) transmission.

Introducing the SDCU

American Satellite's all-new SDCU (Satellite Delay Compensating Unit) provides a virtually instantaneous acknowledgement to terminal devices. By using an advanced delay-insensitive protocol for channel transmission, the effects of propagation delay are eliminated.



Three times faster than the speed of light . . .

. . . is how fast circuits would have to work to achieve data throughput equivalent to that now attainable on American Satellite circuits equipped with a SDCU! The SDCU is directly compatible with a broad range of terminal equipment. So your throughput is limited only by the basic transmission rate of the line and the capability of your data terminals.

Using the SDCU, your throughput should increase by 2 to 3 times or higher, depending on your data rate and block size.

Improve terrestrial throughput too.

Because all communications channels have an inherent delay, the SDCU can improve both the throughput of terrestrial as well as satellite communications.

Technical and price data are yours for the asking. Stop-and-wait no more.

20301 Century Boulevard · Germantown, Maryland 20767 · 301/428-6040
American Satellite Corporation is a wholly owned subsidiary of Fairchild Industries

AMERICAN SATELLITE CORPORATION

What is interesting to note about ASC's operation is that it provides service entirely through transponders which it leases from Western Union by a combination of ASC-owned earth stations and customer-owned earth stations. According to ASC senior personnel, no major difficulties have arisen with this arrangement, nor have any interference and/or degradation been caused to either the services it provides or to Western Union services.

Satellite Business Systems

SBS is a private carrier consortium of users, headed by IBM and Aetna Insurance Company. A recent agreement with Hughes Aircraft Company provides for construction of three satellites in the 11/14 GHz Band, similar to those being procured for the ANIK-C series. The system is designed to provide specialized network and data services in the Continental U.S. Since the SBS system will not be operational until 1980, no practical operational procedures, etc. are available.

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The most explosive growth of satellite usage and earth station expansion in the U.S. has been in connection with distribution of TV by Cable operators, broadcasters and non-profit Theological organizations.

A summary of these systems, as of the end of 1977, on RCA Satcom and Westar is shown in Figure 10. As of the same period over 750 earth stations were either in service or had filed application for station license with the FCC. Applications are being received for earth station licenses at FCC at the rate of 25-30 per month, and consideration is being given to simplifying the procedures for small aperture earth stations.

It is interesting to note that earth stations are being implemented or planned in virtually every State, including Alaska, by large and small Cable operators alike; for instance, Tonopah, Nevada (Tonopah TV, Inc.) has 480 connected subscribers. Several earth stations also provide message service, such as the Dow Jones, Orlando, Florida, station.

In the two years of operations by Home Box Office, the initial two earth stations have expanded to a network of 184 stations in 42 States. WTCG-TV, Channel 17, Atlanta, has almost 600 Cable Systems, via 100 earth stations, in service or planned, on its network. The Christian Broadcasting

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UNITED STATES
CABLE TV STATISTICAL SUMMARY: DECEMBER 31, 1977

Total cable subscribers	13,000,000
Total cable systems operating	3,917
Total cable subscribers served by satellite	1,174,000

Video Programs Distributed by Satellite

RCA SATCOM: - Available for cable distribution	Charges	Cable TV homes which can be reached
CBN	free	920,000
Channel 17 - WTCG (Southern Satellite)	system charge per sub.	880,000
Fanfare (summer '78) projected	Pay TV	165,000
Home Box Office	Pay TV	1,105,000
Madison Square Garden Events	system charge per sub.	850,000
PTL (started 2/1/78)	free	320,000
Trinity (air date 5/1/78) projected	free	110,000
Viacom Showtime (air date 4/1/78) projected	Pay TV	327,000
Satellite Communications Systems (Holiday Inns + KTVU) 1978 projected	Pay TV	

WESTAR:		
PBS	for Broadcasters (start of network operation 3/7/78)	
Hughes - Paramount satellite time	for Broadcasters	2,000 hrs. ann.
Independent TV News Assn. satellite time	" "	400 " "
Americom Satellite Network proposed	Pay TV plus 3 Broadcast independents	210,000 subs.
Spanish Inter'l Network satellite time	Broadcaster & Cable	3,000 hrs. ann.
Robt. Wold Associates (sports)	for Broadcasters	1,500 " "

FIGURE 10.

Network has almost 50 earth stations, the Spanish International Network, some 12, and Madison Square Garden Sports, about 15 stations, on their respective networks as of the Fall of 1977.

Since several privately-owned earth stations also provide message service, either on a shared basis with the satellite operator, or for private use, a further development in the United States is the emergence of specialized common carriers owning earth stations which use transponder capacity of the satellite operators, Western Union and RCA. An example of this is outlined in the Press Release by TransPonder Corporation, Figure 11.

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FOR IMMEDIATE RELEASE November 23, 1977

TransCommunications Corp.
34 East Putnam Avenue
Greenwich, CT 06830

TransPonder Corp. of Greenwich, CT, announced today the receipt of FCC approval of its application for license of a transmit and receive satellite earth station for Kansas City, MO. This is the first such license issued to an independent common carrier for communications through both RCA and Western Union domestic satellites. The approval extended to the entire 4 and 6 GHz band and to the full domestic satellite orbital arc.

TransPonder Corp. is the common carrier associate of TransCommunications Corp. the consulting firm headed by Hubert J. Schlafly and Robert E. Button, which played a major role in the establishment of the first satellite - interconnected earth station network in the USA. The Kansas City earth station is the first phase in the Trans-Ponder Corp. plan to expand the present receive-only earth station network from its present TV program function to multiple two-way all-purpose operations. This will make satellite communications available to many more users in all parts of the country not now served, and will develop the earth station, now under-utilized, to its fullest potential in terms of service to its whole community.

FIGURE 11.

4. APPLICATIONS, OPERATIONAL IMPLICATIONS, NETWORK CONTROL

4. APPLICATIONS, OPERATIONAL IMPLICATIONS, NETWORK CONTROL

Users and Services

Satellite telecommunications uses can be broadly classed into a few main applications:-

Broadcast Services
(Radio and TV)

Two-Way Telecommunication Services
(Telephone, Data, etc.)

One-Way Telecommunication Services
(Data Collection, Facsimile, etc.)

Broadcast Services:

Principal users of satellite systems in this application are Radio and TV Networks, Cable/Pay TV operators, non-profit Theological institutions, and specialized Sports/News users. Although only the CBC employs satellite radio and TV distribution in Canada, an explosive growth in such applications has taken place in the U.S. The full mix of earth station ownership exists in the U.S., viz. satellite carrier, network and private. This mix extends to both originating and receive-only earth stations.

Institutional users of satellite Broadcast services have requirements for fixed network distribution from a central location to a large number of receive locations, from a number of fixed regional locations, and from random

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locations. This latter application, involving C-Band transportable earth stations providing specialized current events, sports and news programming, requires special coordination in terms of radio frequency interference, satellite transponder assignments, etc. To date, the CBC has employed such a Telesat transportable station without any major difficulties. In the event a transportable station was owned by the broadcaster, similar procedures would be required.

One innovation, which could make satellite distribution of TV more attractive to broadcasters, cable operators, etc., would be the refinement of dual video transmission in a single transponder. Cost-effective 2-carrier Fm video transmission would effectively cut space segment charges in half, without causing a large increase in earth station costs, such as would be incurred using TDMA dual video techniques.

There is another important Canadian user of Broadcast Services to be considered -- small communities. There still is a large number of small communities which do not enjoy CBC radio and TV services at all, or which have sporadic/poor service. There are many more which do not have second or third services. Although at the present time only CBC radio and TV programming are available on the Canadian satellite system, it is possible to contemplate additional broadcast services in the future.

Notwithstanding, it has only been possible for the CBC to extend its TV services to communities having a population of 500 or more, due to financial limitations. As is shown in Chapter , private ownership of receive-only earth stations reduces the cost of such facilities, and would permit a greater number of locations to be served for the same budget amount. In practice, it could also make earth station ownership affordable by the community itself.

Two-Way Telecommunication Services:

The main Canadian users of satellite telephone, data, etc. are the Common Carriers (TCTS, CN-CPT, TeleGlobe). In addition to U.S. Common Carriers (AT&T, W.U., etc.), specialized Common Carriers, such as AMSAT, Trans-Ponder Corporation, etc., also use satellite transponders in providing private telecommunication services to end-users. In a few cases, individual U.S. users can own earth stations to provide either end-to-end service or one-end service to a carrier-owned earth station (Cities Service for oil rig service in the Gulf). As in the case of Broadcast Services, the full mix of earth station ownership exists in the U.S.

The potential for comparable specialized applications exists in Canada. Whether such applications develop may depend on the policy covering earth station ownership.

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One-Way Telecommunication Services:

Two principal applications for this class of service are, collection of remote data (environmental, industrial, etc.) from a number of locations on a regular or special basis, and "broadcast" of special information (facsimile, news, stock exchange, etc.) from a central point to a large number of locations. The former application involves a large number of transmitting stations, while the latter would involve only one transmit station to a large number of receive-only stations. Obviously, development of demand for these classes of service would be sensitive to earth station costs. Furthermore, close integration of earth station packaging, locations, etc. is required with customer-furnished facilities in order to keep overall costs competitive and/or attractive.

In summary, applications exist for satellite services which involve a broad range of earth station configurations, ranging from one-way special transmit and receive designs through single/multichannel RTV stations, and up to large multichannel telephone message/data stations. Most applications are sensitive to system cost, and hence earth station costs or charges. Broadcast Services are especially dependent on earth station user costs, as are the large one-way collection and distribution networks outlined earlier.

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Operational Considerations, Coordination and Restoration

The basic question to be examined is, what effects would private earth station ownership have that are different from Telesat ownership of earth stations?

Under Telesat ownership, in theory, a unified structure exists for Operations. In fact, because of the large geographic dispersion of stations, this is accomplished through a number of sub-contractors, who, in many cases, are the users of the earth stations. At main locations, such as Allan Park, Lake Cowichan, Halifax and Frobisher, Telesat has permanent staff who provide full-time or part-time operations functions. All other locations are operated unattended.

Central monitoring of system service parameters being transmitted through the satellite is provided via Allan Park. This covers satellite characteristics, transmission parameters, satellite and uplink serviceability, etc. A Network Control Centre (NCC) exists in Ottawa to provide overall system management and coordination with users. The Network Television (NTV) earth stations in Southern Canada are operated unattended, but have remote monitoring and control electronics to permit manual control as a back-up to the CBC Network Control System, which permits remote program origination switching from Toronto and

Montreal via the satellite. The status of the remaining 80-odd locations is effectively determined, subjectively, by end-users, through either TV viewing and/or telephone usage. Maintenance sub-contractors or Telesat personnel are dispatched to repair earth stations with technical or service anomalies. An annual maintenance program is provided to restore, periodically, performance to original criteria. Major tasks, such as re-pointing earth station antennas, emergency transponder changes, major retrofits, etc., are programmed and carried out by Telesat and sub-contractor staff.

Telesat maintains central spares, test equipment, etc., and provides central technical support and management.

Under separate earth station ownership, very little would change, except that maintenance and operation of earth stations would be provided by the user, not by Telesat or its sub-contractors. Telesat would still monitor satellite characteristics, etc., and NCC would coordinate overall system operations with users. Any concern over harmful interference has no basis in fact, on the strength of U.S. experience. As included in the Appendices to this analysis, procedures have been developed which work, and which provide for operational integrity, restoration, etc.

The fact that central spares, test equipment, and technical support might not be available would be offset by lower maintenance costs (travel, living and administration),

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Clearly, the overall system integrity and user serviceability would be unaffected by private earth station ownership. Actual experience in the U.S has demonstrated this to be so. In fact, it is suggested there is even more subtle pressure on user agencies to correct service problems than might exist on Telesat, in spite of outage rebates.

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5. TECHNICAL DESIGN, CONSTRUCTION & MAINTENANCE

5. TECHNICAL DESIGN, CONSTRUCTION AND MAINTENANCE

The role of system design engineering was reviewed in respect of non-Telesat-owned earth stations under the following factors:-

- Performance Criteria
- System Design/Implementation
- Maintenance Standards and Methods

Performance Criteria

A number of considerations impact on the establishment of performance criteria. Except where absolute standards and performance criteria have been established, generally there is a need for a trade-off between system cost, availability and technical performance in order to meet a range of customer requirements. In many cases, it is difficult to establish technical performance criteria which will accomplish customer requirements, customer budgets, etc. Often it is necessary to carry out a number of iterations to determine the optimal performance criteria versus cost and other requirements; this is particularly true in the case of specialized applications or low cost applications, where certain compromises can be made in order to provide service within budgetary constraints.

Although common carriers have a fairly wide range of customer service offerings, these do not always coincide with the above-noted process. There is a tendency to rely on

the catalogue of service offering in proposing solutions to customer requirements for lower cost applications. In addition, traditional practice has established more or less standard interfaces between common carrier services and customer-furnished equipment. To some extent, Telesat is the exception to this general practice, in that Telesat accepts the provision of basic site infrastructure and other related facilities by the customer in order to make such services more cost-effective.

The actual determination of an optimal earth station configuration is made awkward because of the relationship between customer personnel, the providing franchised common carrier, and Telesat. Either a more direct relationship is required, or a process by which the customer is able to carry out the various iterations necessary to optimize his requirements. The obvious solution in the latter case would be that the customer be responsible for the entire facility, from an engineering system design point-of-view, in collaboration with Telesat, for satellite and system performance trade-off data.

Generally, the Canadian Telecommunications Industry has adopted performance standards which have been developed to ensure the worst case performance and integrity of the terrestrial network. To some extent these standards have been used in connection with satellite telecommunications

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services, even though such standards may not apply. The performance standards required for the Toronto-Vancouver satellite voice channels require a noise contribution approximately one-half that established in the CCIR practical planning objectives. Although such performance standards clearly indicate the ability of satellite communications to provide high quality services, the application of such standards to specialized and/or remote services can increase the cost of services via satellite considerably.

It is suggested that a more pragmatic approach to determination of individual performance criteria must be established, so that the cost of services is more nearly tailored to customer need and/or budgetary constraints. Such an objective could be accomplished by either more direct Customer/Telesat coordination and visibility, or through customer determination of standards as a result of customer-furnished analysis and earth station facilities.

The foregoing discussion has tended to concentrate on small/medium earth station applications which would be used by a single user, or oriented towards a single class of service (for example, Radio and TV). It is suggested, where a number of different user requirements and mix of users exists, or where the complexity of the earth station is substantial, that a single owner such as Telesat is the most effective mechanism for developing requirements for common facilities. In order to extend the same principle to single

user/service type stations owned privately, the joint use process outlined in Chapter 7. would be a condition imposed upon the original owner, whereby Telesat and the owner would negotiate a viable commercial joint-use arrangement; and in the event mutual agreement was not possible, the appropriate regulatory body would be available for a ruling.

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System Design/Implementation

There is no doubt that the initiatives taken by Telesat in permitting the customer to furnish the basic site infrastructure (land, buildings, foundations, power, etc.) and transportation logistics has decreased the cost of earth station services, particularly in the case of specialized services and/or remote locations. This Telesat policy has fostered the introduction of a number of receive-only television stations and a few telephone message stations by a number of remote industrial organizations and small communities. Since a number of other activities are normally associated with implementation of satellite services, a further extension of this policy, which would permit total customer responsibility for installation and maintenance, could only result in a further lowering of service costs. In fact, such arrangements have been carried out for the provision of receive-only television service in the Yukon Territories and other remote parts of Canada. It is suggested that the ultimate extension of these economies would be the complete provision of earth stations by the customer, including procurement, licensing, implementation, etc.

Under such an arrangement, close coordination with Telesat Engineering personnel would be required in order to ascertain satellite and system characteristics whereby customer-furnished earth stations would meet the previously

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established performance criteria. In some cases it is quite possible that the necessary trade-off studies would be performed by Telesat for the customer on a consulting basis.

Many of the same comments as above apply to the process of system design and earth station design in terms of arriving at optimum trade-offs which accrue to the customer's advantage financially. In many cases, considerable savings can be accomplished by integrating earth station components with customer-connected equipment, such as Radio and TV rebroadcaster, data sensors, facsimile machines, etc. In the case of sophisticated earth stations, common use of computer processors, power supplies, frequency sources, etc. can be employed to reduce overall station costs. However, this requires that the traditional interface, or earth station output, be erased and that all hardware be examined from a total systems point-of-view. Whether such an arrangement could be accomplished through intimate coordination between Telesat and the user is unclear. Because of commercial arrangements, integration, such as proposed, has not formerly been attractive. The alternatives are that Telesat provide the total facilities package, or that the customer provide the total facilities package. Given the Economic Analysis in respect of the earth station hardware portion only, which is included herein, there is increasing pressure from users to choose the latter alternative.

In considering the system design phase of the latter alternative, there would appear to be more pressure to develop total cost-effective solutions for the provision of service by user groups, irrespective of space versus earth segment costs. To some extent Telesat, and now TCTS, might prefer solutions which require significant space segment costs with less significant earth station costs, in order to improve the satellite fill factor. On the other hand, a given user is concerned only with the total service costs and not necessarily to individual component costs. It is felt that such user pressures might well produce innovations which would make satellite telecommunications more attractive to a broader variety of users. There is some evidence to support this contention, since user support was primarily responsible for the introduction of small aperture (4.5 Meter) receive-only television earth stations in both Canada and the United States. There appear to be a number of application areas where similar initiatives could produce cost-effective system designs to make satellite telecommunications more viable. Whether such initiatives will be forthcoming from within TCTS/Telesat, in the absence of a change of earth station ownership policy, is difficult to assess. However, there is always the pressure within TCTS/Telesat to maximize satellite fill, and this in itself could slow down the necessary innovation.

The following examples are two illustrations of areas where further innovative improvements could attract additional satellite system users.

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Dual Channel Video

As an example of further possible enhancements to system and earth station design, it is felt that the concept of two video channels per transponder, which Telesat demonstrated using 5.5-5.6 MHz audio sub-carrier techniques, could be improved by inserting the program sound digitally in the synchronizing pulses. This has the effect of reducing the top baseband modulating frequency, hence improving the FM improvement factor for a given peak deviation.

The technique of over-deviation already demonstrated by Telesat and Intelsat has been assumed, along with the standard 13 dB weighting and pre-emphasis factor, to examine the feasibility of 2-carrier FM dual channel video transmission using "sound-in-sync" techniques and 6M earth stations with a G/T = 25 dB/°K.

The analysis suggests that picture qualities having S/N = 45-47 dB can be achieved with relatively low cost earth stations. It is acknowledged that further investigation into the emperical values of intermodulation and adjacent channel spurious products would be required. Transponder assignments which would minimize any such effects would also have to be examined.

Dual Channel Video Model

Assume G/T = 25 dB/°K (6M and 75° LNA)

Assume B_{IF} = 17 MHz

Δfpp = 20 MHz (from Comsat ref)

fm = 4.2 MHz

b_o = 2.5 dB

b_i = 5.0 dB

For 2 Equal FM Carriers in 33 dBw Transponder

$$P_D = 33.0 - 5.0 - 3.0$$

$$= 25.0 \text{ dBw Per Carrier}$$

then

$$(C/N_o)_D = P_D + G/T + 228.6 - L_D$$

Where $L_D = 92.45 + 20 \text{ Log}f + 20 \text{ Log}d$

f = GHz

d = KM

$$(C/N_o)_D = 25.0 + 25 + 228.6 - 196.1$$

$$= 82.5 \text{ dB-Hz}$$

$$C/N = C/N_o - 10 \text{ Log } B_{IF}$$

$$= 82.5 - 72.3$$

$$= 10.2 \text{ dB}$$

$$S/N_W = C/N_{o_T} \left[\frac{3\Delta f_{pp}^2}{fm^3}\right] + 13$$

$$= 82.5 + 10 \text{ Log } \left[\frac{3 \times (20 \times 10^6)^2}{(4.2 \times 10^6)^3}\right] + 13$$

$$= 82.5 - 47.9 + 13$$

$$= 47.5 \text{ dB}$$

In order to improve intermodulation and adjacent carrier spurious Δf_{pp} could be reduced to 15 MHz, which would produce a nominal picture S/N_W of 45 dB.

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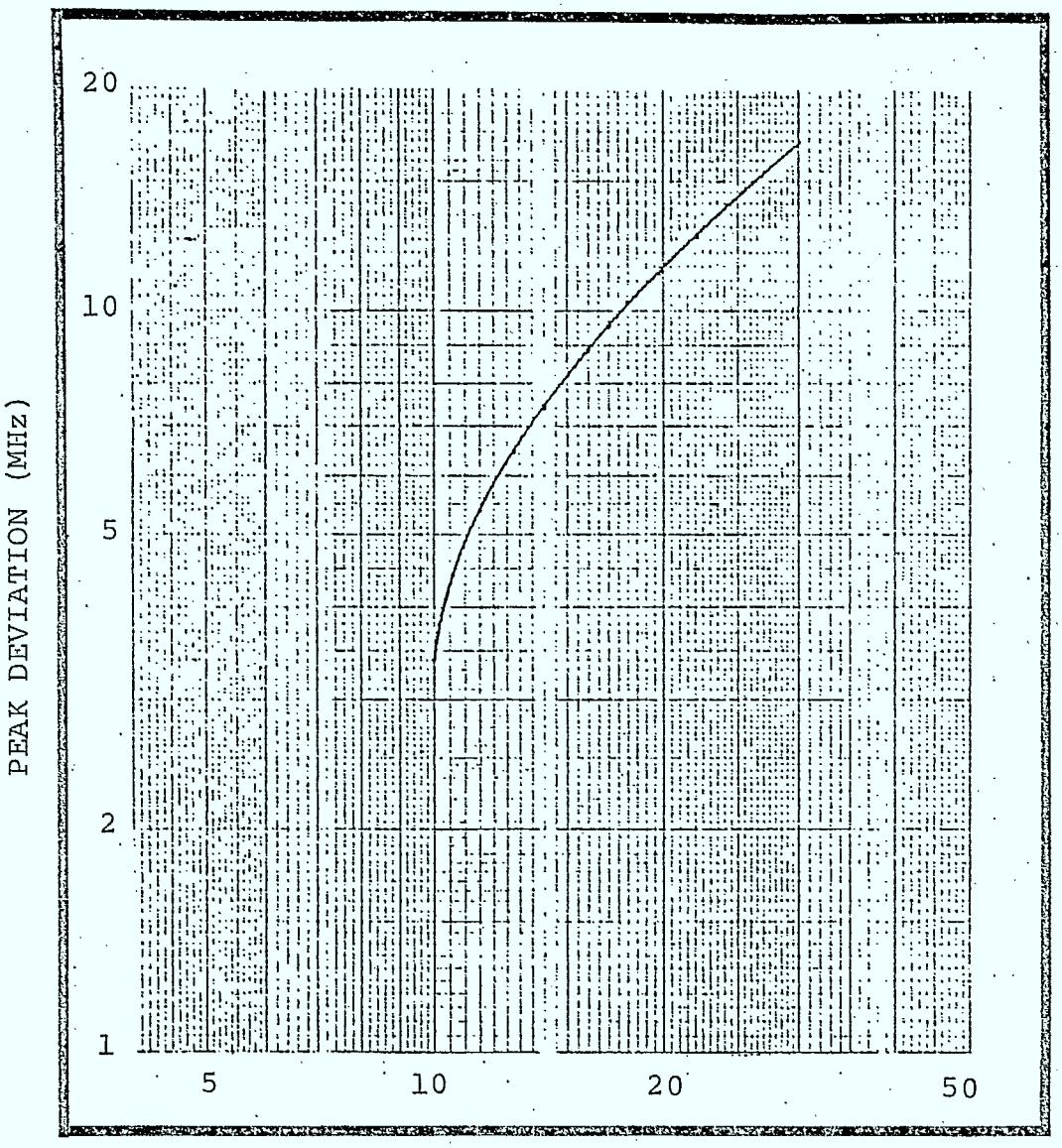

Permissible Peak Deviation as a
Function of RF Noise Bandwidth
for TV Transmission

(CL-29-71 Comsat Labs 1971)

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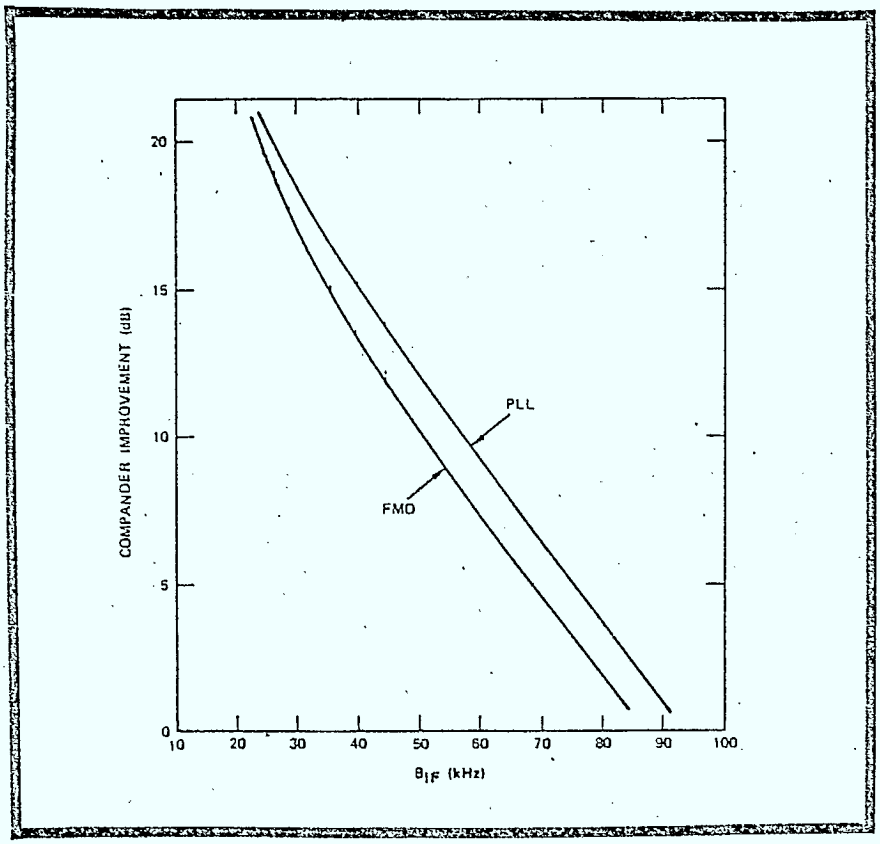
Companded FM (CFM) SCPC Telephone Message

The results of earlier work on determining the capacity of an ANIK-type transponder, employing voice-activated CFM SCPC transmission for telephone service from small earth stations (4.5M) to medium size stations (10-11M), are included to illustrate improvements in transponder capacity which might be possible using this technique. Also included is data showing possible cost trade-offs of station G/T in terms of antenna size and preamplifer noise figure, and anticipated trends due to currently planned state-of-the-art improvements in GAsFET preamplifier technology. Station costs for CFM equipment, which includes companders, echo suppressors, disabler and synthesizer, along with the necessary high stability converters and rf hardware, were found to be at least comparable to digital stations.

The use of companded FM in the SCPC mode can produce advantages in terms of transponder capacity due to the companding improvement as referenced. Coupled with cost-effective small aperture (4.5M) earth stations, it appears that overall satellite transmission costs for specialized telephone and medium speed (2.4 to 4.8 kbps) alternate data can be made attractive.



SCPC/CFM COMPANDING IMPROVEMENT

Campanella, Snyderhoud and Wachs
Proc IEEE, March 1977

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INPUT PARAMETERS

SATELLITE SATURATED EIRP	=	33.0	DBW
USABLE TRANSPONDER BANDWIDTH	=	36.0	MHZ
SATELLITE G/T	=	-7.0	DB/OK
SATURATION FLUX DENSITY	=	-80.0	DBW/M2
INPUT BACKOFF	=	5.0	DB
OUTPUT BACKOFF	=	2.5	DB
GROUND STATION G/T - STATION A	=	31.7	DB/OK
GROUND STATION G/T - STATION B	=	22.0	DB/OK
UPLINK FREQUENCY	=	6.3	GHZ
DOWNLINK FREQUENCY	=	4.0	GHZ
NOISE PER VOICE CHANNEL - STATION A	=	7500.0	PWP0
NOISE PER VOICE CHANNEL - STATION B	=	10000.0	PWP0
VOICE ACTIVATION IMPROVEMENT	=	4.0	DB
IF BANDWIDTH	=	19.0	KHZ

LINKS TO - GROUND STATION A

TOTAL (C/NO)T W/O COMPANDING	=	75.6	DB-HZ
TOTAL (C/NO)T WITH COMPANDING	=	55.6	DB-HZ
TOTAL C/N	=	12.9	DB
UPLINK (C/NO)U	=	62.6	DB-HZ
DOWNLINK (C/NO)D	=	56.6	DB-HZ
UPLINK EIRP PER CARRIER	=	41.4	DBW
DOWNLINK EIRP PER CARRIER	=	-6.7	DBW
TOTAL EARTH STATION TRANSMIT EIRP	=	78.6	DBW
NO. OF CARRIERS-ONE WAY	=	13047.4	
TEST TONE TO NOISE RATIO(UNWTG)	=	23.6	DB

LINKS TO - GROUND STATION B

TOTAL (C/NO)T W/O COMPANDING	=	74.4	DB-HZ
TOTAL (C/NO)T WITH COMPANDING	=	54.4	DB-HZ
TOTAL C/N	=	11.6	DB
UPLINK (C/NO)U	=	69.6	DB-HZ
DOWNLINK (C/NO)D	=	54.5	DB-HZ
UPLINK EIRP PER CARRIER	=	48.4	DBW
DOWNLINK EIRP PER CARRIER	=	.3	DBW
TOTAL EARTH STATION TRANSMIT EIRP	=	78.6	DBW
NO. OF CARRIERS-ONE WAY	=	2606.4	
TEST TONE TO NOISE RATIO(UNWTG)	=	22.4	DB

SYSTEM

TOTAL EARTH STATION TRANSMIT EIRP	=	78.6	DBW
NO. OF GROUND STATION B	=	1.0	
TOTAL UPLINK EIRP PER CIRCUIT	=	49.2	DBW
TOTAL ONE-WAY CARRIERS	=	4344.9	
CARRIERS PER STATION A	=	2172.5	
CARRIERS PER STATION B	=	2172.5	

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INPUT PARAMETERS

SATELLITE SATURATED EIRP	=	33.0	DBW
USABLE TRANSPONDER BANDWIDTH	=	36.0	MHZ
SATELLITE G/T	=	-7.0	DB/OK
SATURATION FLUX DENSITY	=	-80.0	DBW/M2
INPUT BACKOFF	=	5.0	DB
OUTPUT BACKOFF	=	2.5	DB
GROUND STATION G/T - STATION A	=	31.7	DB/OK
GROUND STATION G/T - STATION B	=	23.0	DB/OK
UPLINK FREQUENCY	=	6.3	GHZ
DOWNLINK FREQUENCY	=	4.0	GHZ
NOISE PER VOICE CHANNEL - STATION A	=	7500.0	PWP0
NOISE PER VOICE CHANNEL - STATION B	=	10000.0	PWP0
VOICE ACTIVATION IMPROVEMENT	=	4.0	DB
IF BANDWIDTH	=	19.0	KHZ

LINKS TO - GROUND STATION A

TOTAL (C/NO)T W/O COMPANDING	=	75.6	DB-HZ
TOTAL (C/NO)T WITH COMPANDING	=	55.6	DB-HZ
TOTAL C/N	=	12.9	DB
UPLINK (C/NO)U	=	62.6	DB-HZ
DOWNLINK (C/NO)D	=	56.6	DB-HZ
UPLINK EIRP PER CARRIER	=	41.4	DBW
DOWNLINK EIRP PER CARRIER	=	-6.7	DBW
TOTAL EARTH STATION TRANSMIT EIRP	=	78.6	DBW
NO. OF CARRIERS-ONE WAY	=	13047.4	
TEST TONE TO NOISE RATIO(UNWTG)	=	23.6	DB

LINKS TO - GROUND STATION B

TOTAL (C/NO)T W/O COMPANDING	=	74.4	DB-HZ
TOTAL (C/NO)T WITH COMPANDING	=	54.4	DB-HZ
TOTAL C/N	=	11.6	DB
UPLINK (C/NO)U	=	68.6	DB-HZ
DOWNLINK (C/NO)D	=	54.6	DB-HZ
UPLINK EIRP PER CARRIER	=	47.4	DBW
DOWNLINK EIRP PER CARRIER	=	-.7	DBW
TOTAL EARTH STATION TRANSMIT EIRP	=	78.6	DBW
NO. OF CARRIERS-ONE WAY	=	3281.3	
TEST TONE TO NOISE RATIO(UNWTG)	=	22.4	DB

SYSTEM

TOTAL EARTH STATION TRANSMIT EIRP	=	78.6	DBW
NO. OF GROUND STATION B	=	1.0	
TOTAL UPLINK EIRP PER CIRCUIT	=	48.4	DBW
TOTAL ONE-WAY CARRIERS	=	5243.8	
CARRIERS PER STATION A	=	2621.9	
CARRIERS PER STATION B	=	2621.9	

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INPUT PARAMETERS

SATELLITE SATURATED EIRP	=	33.0	DBW
USABLE TRANSPONDER BANDWIDTH	=	36.0	MHZ
SATELLITE G/T	=	-7.0	DB/OK
SATURATION FLUX DENSITY	=	-80.0	DBW/M2
INPUT BACKOFF	=	5.0	DB
OUTPUT BACKOFF	=	2.5	DB
GROUND STATION G/T - STATION A	=	31.7	DB/OK
GROUND STATION G/T - STATION B	=	24.0	DB/OK
UPLINK FREQUENCY	=	6.3	GHZ
DOWNLINK FREQUENCY	=	4.0	GHZ
NOISE PER VOICE CHANNEL - STATION A	=	7500.0	PWP0
NOISE PER VOICE CHANNEL - STATION B	=	10000.0	PWP0
VOICE ACTIVATION IMPROVEMENT	=	4.0	DB
IF BANDWIDTH	=	19.0	KHZ

LINKS TO - GROUND STATION A

TOTAL (C/NO)T W/O COMPANDING	=	75.6	DB-HZ
TOTAL (C/NO)T WITH COMPANDING	=	55.6	DB-HZ
TOTAL C/N	=	12.9	DB
UPLINK (C/NO)U	=	62.6	DB-HZ
DOWNLINK (C/NO)D	=	56.6	DB-HZ
UPLINK EIRP PER CARRIER	=	41.4	DBW
DOWNLINK EIRP PER CARRIER	=	-6.7	DBW
TOTAL EARTH STATION TRANSMIT EIRP	=	78.6	DBW
NO. OF CARRIERS-ONE WAY	=	13047.4	
TEST TONE TO NOISE RATIO(UNWTG)	=	23.6	DB

LINKS TO - GROUND STATION B

TOTAL (C/NO)T W/O COMPANDING	=	74.4	DB-HZ
TOTAL (C/NO)T WITH COMPANDING	=	54.4	DB-HZ
TOTAL C/N	=	11.6	DB
UPLINK (C/NO)U	=	67.6	DB-HZ
DOWNLINK (C/NO)D	=	54.6	DB-HZ
UPLINK EIRP PER CARRIER	=	46.4	DBW
DOWNLINK EIRP PER CARRIER	=	-1.7	DBW
TOTAL EARTH STATION TRANSMIT EIRP	=	78.6	DBW
NO. OF CARRIERS-ONE WAY	=	4130.9	
TEST TONE TO NOISE RATIO(UNWTG)	=	22.4	DB

SYSTEM

TOTAL EARTH STATION TRANSMIT EIRP	=	78.6	DBW
NO. OF GROUND STATION B	=	1.0	
TOTAL UPLINK EIRP PER CIRCUIT	=	47.6	DBW
TOTAL ONE-WAY CARRIERS	=	6275.1	
CARRIERS PER STATION A	=	3137.5	
CARRIERS PER STATION B	=	3137.5	

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INPUT PARAMETERS

SATELLITE SATURATED EIRP	=	33.0	DBW
USABLE TRANSPONDER BANDWIDTH	=	36.0	MHZ
SATELLITE G/T	=	-7.0	DB/OK
SATURATION FLUX DENSITY	=	-80.0	DBW/M2
INPUT BACKOFF	=	5.0	DB
OUTPUT BACKOFF	=	2.5	DB
GROUND STATION G/T - STATION A	=	31.7	DB/OK
GROUND STATION G/T - STATION B	=	25.0	DB/OK
UPLINK FREQUENCY	=	6.3	GHZ
DOWNLINK FREQUENCY	=	4.0	GHZ
NOISE PER VOICE CHANNEL - STATION A	=	7500.0	PWP0
NOISE PER VOICE CHANNEL - STATION B	=	10000.0	PWP0
VOICE ACTIVATION IMPROVEMENT	=	4.0	DB
IF BANDWIDTH	=	19.0	KHZ

LINKS TO - GROUND STATION A

TOTAL (C/NO)T W/O COMPANDING	=	75.6	DB-HZ
TOTAL (C/NO)T WITH COMPANDING	=	55.6	DB-HZ
TOTAL C/N	=	12.9	DB
UPLINK (C/NO)U	=	62.6	DB-HZ
DOWNLINK (C/NO)D	=	56.6	DB-HZ
UPLINK EIRP PER CARRIER	=	41.4	DBW
DOWNLINK EIRP PER CARRIER	=	-6.7	DBW
TOTAL EARTH STATION TRANSMIT EIRP	=	78.6	DBW
NO. OF CARRIERS-ONE WAY	=	13047.4	
TEST TONE TO NOISE RATIO(UNWTG)	=	23.6	DB

LINKS TO - GROUND STATION B

TOTAL (C/NO)T W/O COMPANDING	=	74.4	DB-HZ
TOTAL (C/NO)T WITH COMPANDING	=	54.4	DB-HZ
TOTAL C/N	=	11.6	DB
UPLINK (C/NO)U	=	66.6	DB-HZ
DOWNLINK (C/NO)D	=	54.7	DB-HZ
UPLINK EIRP PER CARRIER	=	45.4	DBW
DOWNLINK EIRP PER CARRIER	=	-2.7	DBW
TOTAL EARTH STATION TRANSMIT EIRP	=	78.6	DBW
NO. OF CARRIERS-ONE WAY	=	5200.5	
TEST TONE TO NOISE RATIO(UNWTG)	=	22.4	DB

SYSTEM

TOTAL EARTH STATION TRANSMIT EIRP	=	78.6	DBW
NO. OF GROUND STATION B	=	1.0	
TOTAL UPLINK EIRP PER CIRCUIT	=	46.9	DBW
TOTAL ONE-WAY CARRIERS	=	7436.8	
CARRIERS PER STATION A	=	3718.4	
CARRIERS PER STATION B	=	3718.4	

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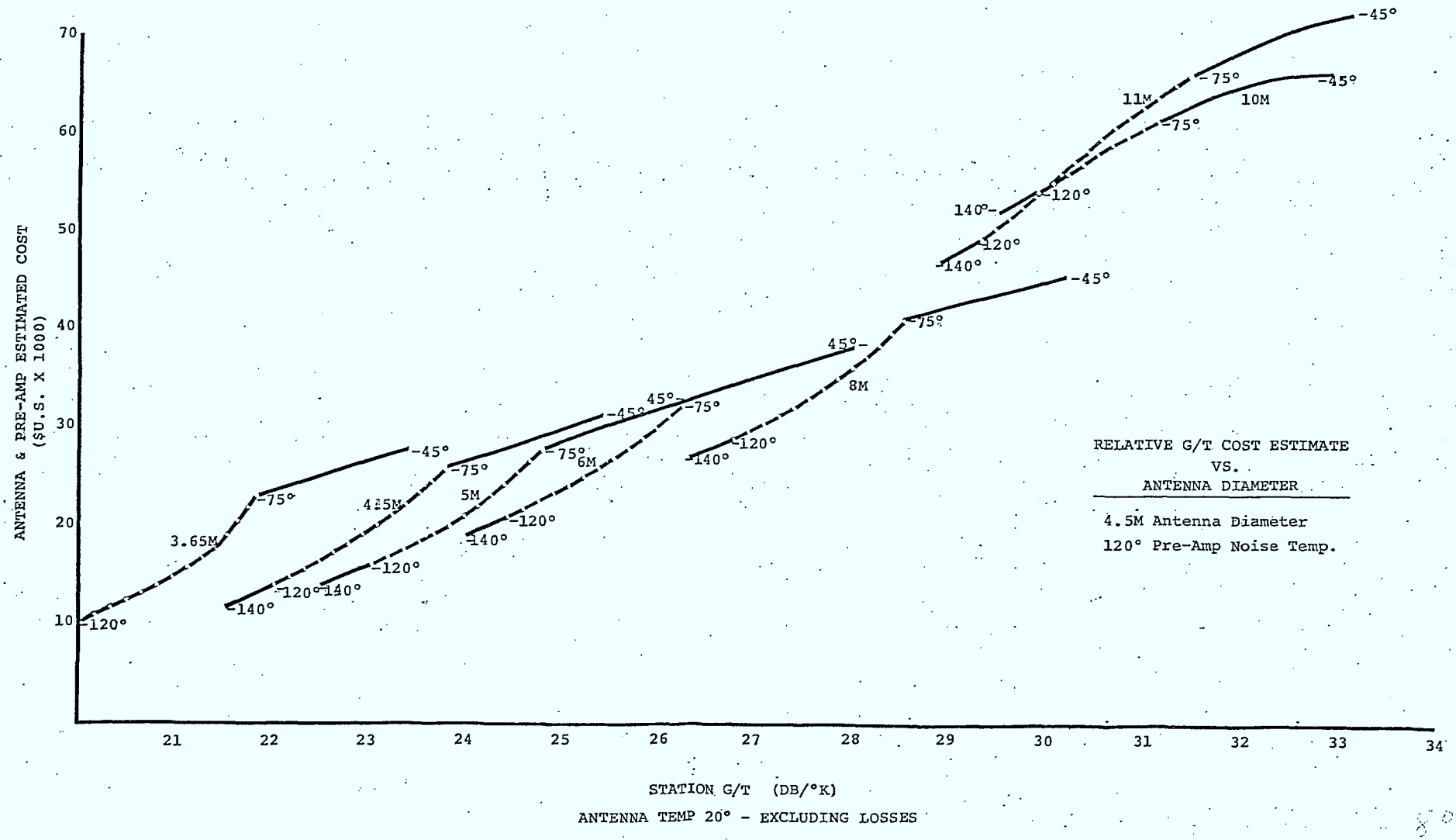
ANTENNA & PRE-AMP ESTIMATED COST
($U.S. X 1000)
70
60
50
40
30
20
10
21
22
23
24
25
26
27
28
29
30
31
32
33
34
STATION G/T (DB/°K)
ANTENNA TEMP 20° - EXCLUDING LOSSES
3.65M
4.5M
5M
6M
8M
10M
11M
-45°
-75°
-120°
-140°
RELATIVE G/T COST ESTIMATE
VS.
ANTENNA DIAMETER
4.5M Antenna Diameter
120° Pre-Amp Noise Temp.

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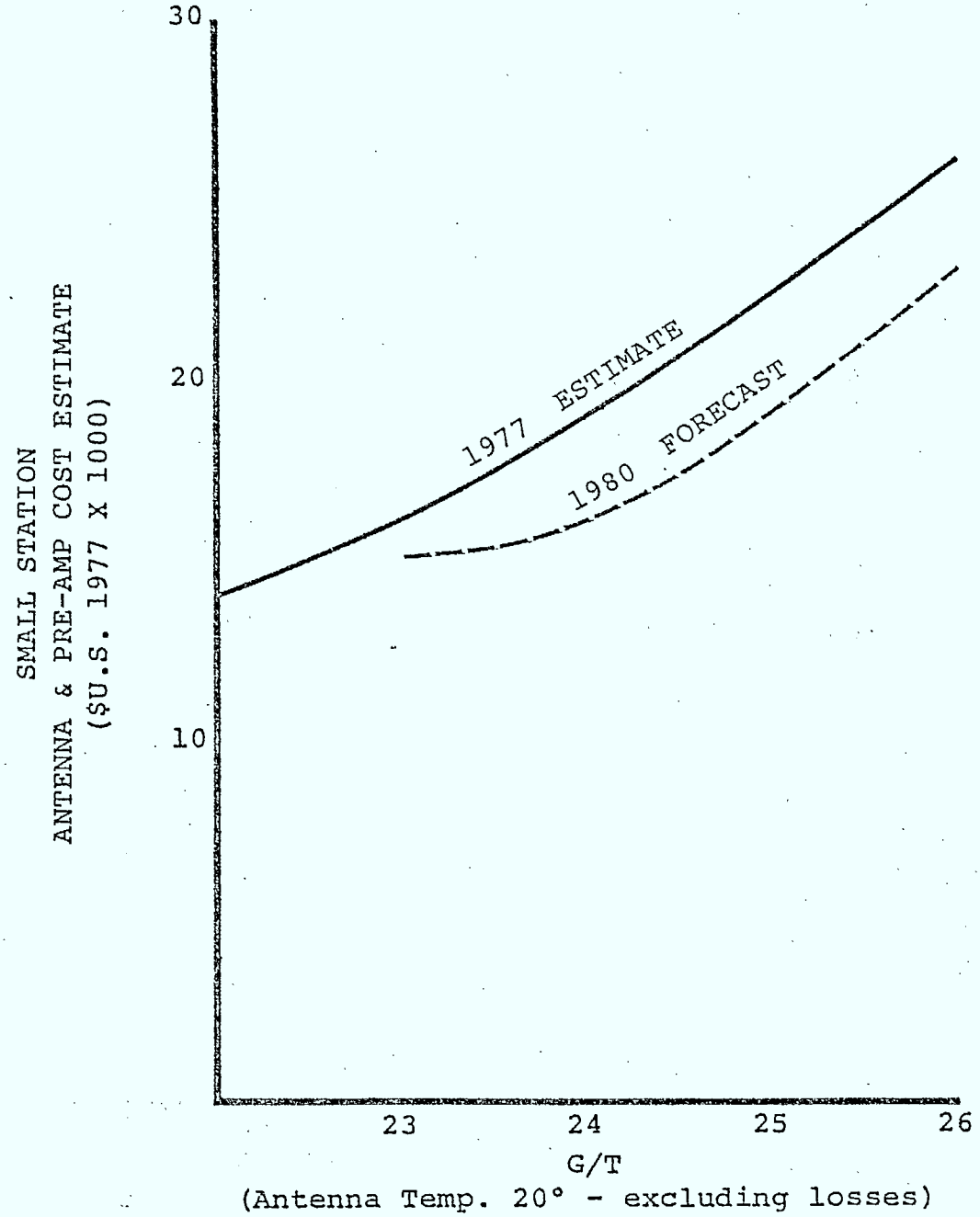
OUTSTATION
ANTENNA & PRE-AMP COST
ESTIMATES VS. G/T



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In the event a non-Telesat earth station ownership policy was adopted, it would be incumbent on Telesat to establish an effective forum by which it would recognize future interests of users in its future planning. It would also make even more pressing the requirement to continue existing services for periods which would permit amortization of privately-owned earth stations.

Although the foregoing argument favours private system design, implementation and ownership of small/specialized/common service earth stations, the process for medium to large, or complex, earth stations can only be handled effectively by a single agency, such as Telesat. As such, Telesat would have the technical and managerial expertise to integrate requirements in a cost-effective manner. Joint-use provisions, as previously outlined, would be available to permit expansion of future Telesat participation at privately-owned earth stations. Alternately, a private owner could elect to sell his earth station at a later date to Telesat, in order to facilitate common user implementation.

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Maintenance Standards

Under Telesat earth station ownership, maintenance standards, spares, technical personnel and test equipment are available to all stations in the system. Some 80%-85% of these stations are unattended, and require customer/user feedback for day-to-day service quality monitoring. Telesat has an annual maintenance program to measure and restore facilities to required performance.

Common spares and test equipment are used for corrective and annual maintenance, and vendor instruction manuals are complemented by in-house procedures and methods.

Under non-Telesat earth station ownership, users would provide all maintenance, as is now being done for first-line maintenance by several customers. This has the advantage of employing on-site personnel, when applicable, thus reducing travel, living, etc. expenses. It would have the disadvantage that a common pool of personnel, spares and test equipment might not necessarily exist. In the alternatives where either Common Carrier or Consortia earth station ownership are considered, a common pool would conceivably be created; in many cases, existing on-site or regionally located personnel and test equipment would be available.

For individual privately-owned stations, there would not be a comparable situation, although participation with others, including Telesat, for common spares, etc. would be

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possible. Vendor-supplied spares arrangements are also possible to work out, as opposed to on-site spares.

Overall, however, the serviceability of Canadian-supplied, small earth stations is quite high, as evidenced by Telesat's availability records. This suggests that minimum maintenance is required for a properly designed and implemented facility. Annual maintenance could be provided under contract by Telesat, vendors, etc., if found to be imperative.

Telesat would be responsible for developing maintenance standards associated with satellite access, which would probably take the form of those in the Appendices. Regular and/or annual supervision by Telesat of private earth stations accessing the satellite could be required at least initially, although most, if not all, monitoring of uplink standards, performance, etc. could be accomplished by Allan Park.

As proposed herein, those complex stations, where maintenance and operations standards are held to be critical, would continue to be owned, maintained and operated by Telesat.

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6. ECONOMIC ANALYSIS

6. ECONOMIC ANALYSIS

The following analysis is primarily based on TV Receive-Only (TVRO) Earth Stations of the so-called "Frontier Coverage Package" (FCP) series so designated by Telesat. Cost/price analyses of other configurations is more difficult, since there are many derivatives to consider. Some data is presented for Thin Route Message service for comparative purposes.

In any event, the RTV analysis is considered typical of cost/price relationships given an increased demand for earth stations, introduction of design and manufacturing innovation, and customer trade-offs on cost/performance.

- TV Receive Only Earth Stations

Since Telesat Canada is required by its Act of Incorporation to achieve a maximum level of Canadian Content, only cost data from Canadian vendors is presented. Aside from the current large exchange rate between the U.S. and Canadian dollar, Canadian/U.S. selling prices for small aperture (4.5M) RTVs are narrowing, although Canadian prices are still approximately 10%-15% higher; when coupled with the current 13% exchange rate, Canadian RTV earth station prices appear to be nominally the same as U.S. prices.

In developing the economic analysis of RTVs, several cases were examined:-

- 4 GHz (4.5M) Single Channel Fixed Frequency, 45-50dB Video S/N.
- As above with additional Fixed Frequency Channel(s).
- 4 GHz (4.5M) Single Channel Frequency Agile, 46-50dB Video S/N.
- 11 GHz Single Channel Fixed Frequency (for use with ANIK B/C).
- Conversion from 4 GHz to 11 GHz RF Frequency.

The basic electronics/antenna costs, FOB vendor, are shown in Figure 12.

Telesat Canada's policy on implementation of FCP service is to permit the customer to furnish the site, building, power, footings, and transportation. As such, these costs are capitalized by the user, and do not bear on actual Telesat 5-year annual lease charges, which are shown comparatively with direct Telesat facility costs in Figure 13.

It is recognized that such a comparison does not include Telesat capital costs for Engineering, Procurement, etc., nor does it include provision for G&A, taxes, profit, etc. However, it is the direct kind of comparison made by Telesat's customers and potential users. It is also a first approximation use in assessing profitability of an investment, the so-called Payback Period on capital. Based on Figure 13, it appears this interval ranges from 0.95 to 1.8 years, with first-line maintenance charges excluded.

4 GHz (4.5M) RTV Earth Stations

- Single Channel Fixed Frequency

1-10	$25,000 ea.
100-	$20,000 ea.

- Four Channel Fixed Frequency

(add $1,000 + $7,500 per channel)	$48,500 ea.

- Single Channel Frequency Agile

1-10	$30,500 ea.

11 GHz RTV Earth Stations

- Single Channel Fixed Frequency

  As above, plus non-recurring engineering charges

- Conversion of Existing 4 GHz Station

Single Channel	$ 9,500
Each Additional Channel	$ 3,000

RTV ELECTRONIC/ANTENNA COSTS

(FOB Vendor, excludes building, implementation costs, etc.)

FIGURE 12.

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SINGLE CHANNEL FIXED FREQUENCY RTV			SINGLE CHANNEL FREQUENCY AGILE RTV			ADDITIONAL CHANNEL FIXED FREQUENCY		
- Equipment Cost	$25,000		- Equipment Cost	$30,500		- Equipment Cost	$ 8,500	
Installation			Installation			Installation		
4 Man-Days @ $250.00	1,000			2,000			1,000	
Misc. Materials	500							
Less Installation Charge	-1,500		Less Installation Charge	-2,000		Less Installation Charge	-1,000	
. Total Direct Capital Cost		$25,000	. Total Direct Capital Cost		$30,500	. Total Direct Capital Cost		$ 8,500
- Annual Lease (5 Years)	$13,896		- Annual Lease (5 Years)	$24,216		- Annual Lease (5 Years)	$ 9,000	
First-Line Maintenance	3,996		First-Line Maintenance	480		First-Line Maintenance	540	
. Annual Charge (5 Years)		$17,892/yr.	. Annual Charge (5 Years)		$24,696/yr.	. Annual Charge (5 Years)		$ 9,540/yr

TELESAT DIRECT CAPITAL COST VERSUS ANNUAL CHARGES
RTV EARTH STATIONS

Notes:-

1. Site, building, power, foundation, transportation, etc. provided by Customer.

2. Excludes Telesat Engineering and Procurement Capital Costs.

3. Annual charges exclude cost of Customer furnished transportation, board and lodging, for Telesat maintenance personnel.

FIGURE 13.

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CUSTOMER-OWNED SINGLE CHANNEL FIXED FREQUENCY RTV

(Site Development Costs, Excluded)

CAPITAL COSTS

- Equipment, Antenna, Installation	$27,000
- Engineering and Procurement	5,400
	$32,400

ANNUAL COSTS

- Capital @ 10% (428.17/Month X 12)	$ 5,140
- Maintenance (12%)	3,996
- Administration (3%)	974
	$10,110

CAPITAL AND ANNUAL COST
CUSTOMER-OWNED RTV

Notes:-

1. Capital mortgage rate 10%, 10 years monthly payments.
2. Maintenance per Telesat charge.

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TABLE I

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FACILITY	TELESAT CHARGE	CUSTOMER COST
1. Single Channel Fixed Frequency RTV	$ 17,892	$ 10,110
2. Additional Fixed Frequency Channel	$ 9,540	$ 3,430
3. Single Channel Frequency Agile RTV	$ 24,696	$ 11,880

ANNUAL CHARGE/COST RTV SERVICES
TELESAT VERSUS CUSTOMER-OWNED

Notes:-

1. Maintenance for all cases, 12%/Year.
2. Other customer costs per Table I.

TABLE II

In the case of commercial users (broadcasters, cable, etc.), the annual charges would be modified by the existence of qualified maintenance personnel, existing organizations, and an investment/tax structure, which could result in even lower "annual costs". A detailed analysis of such cases is dependent on accounting practices employed, and clearly is beyond the scope and timeframe of this analysis.

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- Other Earth Stations

Although a detailed analysis of other earth station configurations was not undertaken for reasons outlined herein, a few examples are worth noting.

- Thin Route Message Earth Stations

Canadian earth station vendors indicate prices for 4.5M stations, providing two 2-way non-redundant telephone channels, employing Telesat standard delta modulation, in the $125,000-$175,000 range, FOB factory. As in the case of FCP TV stations, Telesat has offered to have customers provide all installation improvements and support. The annual charge for such a station, which includes connection to the Allan Park main earth station, is in the $75,000-$85,000 range, plus the complementary space segment charge of some $50,000-$60,000 per 2-way telephone circuit/year. All charges provide for Full-Period Private Line (FPPL) service. In addition, FPPL users must pay recognized terrestrial charges to franchised carriers for connection from Allan Park to the distant end. In the case of Pan Arctic Oils Limited, which has an earth station at Rea Point, NWT, connected to its Calgary Head Office switchboard, the terrestrial circuit charges are approximately equal to the Telesat earth station charge, plus the Bell Canada space segment charge.

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Two observations can be made regarding the situation, which exists also at a number of locations served by Bell Canada. The first factor is the Payback Period on the earth station investment is comparable to that for the RTV stations. This suggests a similar economic relationship. The second factor is the use of tandem satellite-terrestrial circuitry of roughly equal cost and distance, to span a connection equal to the satellite portion or the terrestrial portion.

One asks why the satellite should not be used to connect the locations more directly, given its so-called distance insensitive properties versus the distance sensitive costs of terrestrial circuits? It has been held that the customer charges for developing a satellite connection to the existing Edmonton earth station, and thence the 150 miles of terrestrial circuitry to Calgary, would be more expensive. This position is based on two considerations, the charges for the Edmonton break-out, and the higher transponder power utilization needed to communicate between the Edmonton and Rea Point earth stations. Since the relationship between Telesat cost and charges can only be assumed to bear the relationship previously demonstrated, it seems that the analysis is biased from the standpoint of relatively high earth station charges. On the second consideration, it has been pointed out in this analysis that transponder utilization

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which employes state-of-the-art modulation techniques and traffic improvement can reduce transponder power percentages considerably.

It is suggested that both earth station charges and system design innovation would reverse the situation in respect of the Rea Point-Calgary service cost comparison. Further, it is suggested that under the lower user cost situations implicit in these approaches, many more industrial and small community locations would employ satellite communications in order to provide basic and safety services, which, under the present arrangement, are too prohibitive from a cost point-of-view.

Dual TV/Transponder

In order to reduce space segment annual charges per TV channel, two basic methods have been demonstrated.

The simplest method consists of transmitting two independent TV FM carriers through a transponder, with each carrier power level backed-off, and with limited deviation, to avoid intermodulation products and interference. The second method requires digitizing two TV channels, and subsequent high speed digital transmission through a single transponder, preferably from a single uplink, although more complex TDMA techniques may be used for independent origination points. Terminal equipment for this technique is very expensive.

The 2-carrier FM method has been used commercially by Intelsat; and is viable, since receiving stations with high G/T are generally employed (Intelsat-A stations), and the program sound is carried on an independent transponder in order to permit maximum deviation of the pure video component.

Telesat has demonstrated dual TV 2-carrier FM using picture-sound audio multiplex techniques at approximately 6.5 MHz. Since the additional basebandwidth limits overall deviation within 1/2 of the transponder, full benefit of the FM improvement factor in terms of the picutre component cannot be obtained. Thus, even though a considerably higher downlink EIRP is available from ANIK-A, relatively high G/T earth stations are required for acceptable signal quality.

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It is suggested that the high Telesat leasing charge for an 8-10M dual TV/transponder earth station makes the viability of two TV channels/transponder uneconomical over a relatively large network. It has already been shown that independently-owned RTV stations can be operated at between 35%-55% of Telesat charges, and the same effect would occur for a dual video configuration. Further, it is known that lower G/T stations could produce the same picture quality if the presence of the multiplex sound sub-carrier was eliminated. A practical alternative would be the insertion of the program sound in the sync pulse interval, as is currently done by the CTV Network on terrestrial microwave. Finally, state-of-the-art low noise preamplifier transistorized GAsFET technology is producing devices with improved noise temperatures at relatively low cost, and indications are that costs will be reduced for the same NF, and that lower temperature devices in the future will be comparably priced to higher NF devices today. The earth station incremental cost of providing dual video/transponder versus single channel video is approximately $15,000-$20,000.

The adjacent channel intermodulation effects noted earlier remain to contend with, however, optimal choice of transponders within the frequency plan can minimize the effect. Alternatively, use of a standby or "spare" satellite could eliminate any interference products to other satellite services.

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In summary, it is felt that 2-carrier FM dual video/transponder service could be made viable to broadcasters/cable industry, assuming customer-owned earth stations were a reality, and certain innovations were employed to optimize picture transmission. It seems obvious that the presence of additional programming on the satellite system, through the introduction of such a situation, could only be beneficial to more Canadians, in extending a wider choice of educational, parliamentary and entertainment programming. By the same token the presence of additional programming would increase the number of earth stations.

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The Effect on Telesat

As Telesat Canada has indicated in its Position Paper to DOC on earth station ownership, a major fraction of its revenues accrues from earth station leases. Telesat contends that without the 45% of revenue it claims from earth stations, the charge for transponders would have to be increased.

An assumption that all existing earth stations would remain as is, and that no increase in space segment utilization transpires, leads to the conclusion that any additional customer-owned earth stations would neither affect Telesat capital investment, engineering demands, nor alter its present revenue. In the case of customer-owned RTV stations, for example, all that would occur is that additional viewers would be able to enjoy French and English CBC programming more cheaply.

If, as postulated earlier, private earth station ownership creates a demand for additional space segment utilization, and hence revenue, be it TV, Radio, Message, Data, etc., then the profitability of Telesat is increased for no increase in Capital investment by Telesat itself.

Telesat points out that the longer-term earth station investment provides a stabilizing effect which offsets the shorter-term higher risk space segment investment.

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The combination of earth segment and space segment capital investment effectively smooths out what would be very cyclic if it only included space segment capital requirements. To some extent this is true. On the other hand, the relatively high depreciation rate for the space segment (14%-17%/year) has the effect of providing a high proportion of cash flow to finance new capital investment or retire debt.

Telesat indicates that 45% of its revenue accrues from earth stations, which in the 1976 Annual Report represented 38% of the Property Assets of the company. It further maintains that its viability would suffer were it not permitted to own earth stations. This contention is valid as shown on a comparative analysis of 1976 Actual data from the Telesat Annual Report, and a hypothetical situation where no earth stations were owned by Telesat. Only two factors of the financial statement were examined, the Statement of Earnings/Earnings per Common Share, and the Asset portion of the Balance Sheet; development of an entire set of comparative financial position, earnings and changes would require a recapitulation of Telesat's seven year history, more visibility into transactions, and many assumptions which may or may not be valid.

The only changes made were to eliminate earth segment (except for an assumed $5M TT&C, etc.) from the Assets and Earnings statements, and to reduce Operating and

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TELESAT CANADA 1976 COMPARATIVE STATEMENT

	With Earth Station Ownership	Without Earth Station Ownership
ASSETS		
Property		
Satellites	$ 74,524.	$ 74,524.
Earth Station Facilities	54,127.	5,000. (est.)
Other	1,257.	1,257.
PreOperational Development	9,970.	9,970.
	$139,878.	$ 90,751.
Accumulated Depreciation & Amortization	59,956.	48,200. (est.)
	$ 79,922.	$ 42,551.
Construction in Progress	15,249.	12,448.
	$ 95,171.	$ 54,999.
Current Assets	4,569.	4,569.
	$ 99,740.	$ 59,568.
STATEMENT OF EARNINGS		
Operating Revenue	$ 29,580.	$ 17,992.
Operating Expenses		
Operations & Administration	$ 8,427.	$ 3,000. (est.)
Depreciation & Amortization	18,006.	14,290.
	$ 26,433.	$ 17,290.
Earnings from Operations	$ 3,147.	$ 702.
Other Income	$ 1,419.	$ 1,259.
Earnings Before Taxes	$ 4,563.	$ 1,961.
Taxes Deferred	$ 2,196.	$ 943.
Net Earnings	$ 2,370.	$ 1,018.
Earnings per Common Share		
(6,000,001 Common Shares)	$ .40¢	$ .17¢
(4,000,001 Common Shares)	$ -	$ .25¢

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Administrative expenses to reflect no technical staff, maintenance and operating expenses for the earth segment.

As a first approximation, it can be seen that the deletion of earth station investment would reduce the depreciated Property Assets of Telesat some $40 Million, or the Assets at cost by $50 Million. Given the same access to government start-up financing, this, in all likelihood, would have permitted initial equity capitalization at a lower value than the original $60M. Based on the ratio of assets with and without earth station ownership, $40M would seem to be a viable amount.

However, it is clear that the Net Earnings would be reduced drastically by some $1.3M. Assuming the initial 6,000,001 share issue, the earnings per share would be less than half the 1976 actual. On the other hand, if the initial share issue were only 4,000,001, as suggested above, the Earnings per Share would have been $0.25 in 1976.

In summary, it can be seen that with no earth stations, a corresponding reduction in capital investment, the same space segment revenue, and reduced operations and administrative costs, Telesat Canada would be less profitable than it currently was in 1976. It can be postulated that customer-owned earth stations in the future would not change the existing profitability, and could result in increased space segment demand, which would improve Telesat's profitability.

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The effect on the ANIK-C program is not clear. Capital requirements for earth station deployment would be eliminated, easing the pressure for financing. Depending on system fill, the profitability of K-Band services could be greater than at present, since additional transponders clearly represent the most profitable revenue source. On the other hand, a marginal system fill would produce the same downward trend in profitability, as the foregoing analysis illustrates.

Finally, all of this may be somewhat academic, since, under the terms of the TCTS/Telesat Agreement, a guaranteed return is provided, along with a high use of K-Band transponders by TCTS member companies. If a change in earth station ownership policies in Canada would not alter the basic provisions of the TCTS/Telesat Agreement, the question becomes -- What earth station ownership policy best satisfies the Public Interest?

The Effect on the Canadian Electronics Industry

Assuming the Canadian content provisions of the Telesat Canada Act would apply to customer-owned earth stations, it is suggested that private ownership of RTVs by small communities, industrial operations, etc. would result in increased sales of small aperture earth stations. There remain, still, many communities not covered by the CBC ACP, where no TV or inadequate picture quality exists. In many cases the solution to the problem is satellite-derived programming, but current Telesat charges either preclude or "slow down" expansion to small communities.

By way of example, the recently accounted Northwest Territories Government "Communications Program" for service to communities with populations of 250 or more includes almost $2M over a five year timeframe, 75% of which is annual operating costs. Of the $1.5M total five year operating budget, $1.14M is allocated to earth station charges at 18 locations, the remainder being for local maintenance. Assuming the funds were employed to purchase earth stations, it is estimated an additional 10-12 locations could be provided with service. Furthermore, this represents a potential increase in earth station sales for Canadian vendors of some 50%-60% on the NWTG program alone.

It is suggested that similar provincial programs and small community interest in satellite-derived CBC program

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delivery would be accelerated and/or enhanced by private earth station ownership, and thus create a much larger market for Canadian earth station vendors.

Any increased Canadian production of small aperture earth stations should enhance the competitiveness of Canadian vendors on the International market as well.

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7. REGULATION

7. REGULATION

In the event that a private earth station ownership policy was adopted, it would be necessary to preserve the basic statutory and regulatory precedence which now exists in respect of earth stations.

It would be necessary to impose upon earth station owners, the same technical criteria which are now imposed upon Telesat for license application. This would ensure that Canadian international obligations would be satisfied in terms of coordination with adjacent countries, such as the U.S., etc. Furthermore, it would ensure proper frequency coordination within Canada according to procedures already established by DOC.

User agencies could either carry out the necessary engineering analysis required to conform to established procedures themselves, or have such engineering work carried out for them under contract.

In addition, the current requirements for an economic analysis to justify private systems would seem to be a necessary prerequisite to license an earth station under these circumstances. In any event, existing procedures are already in place by which such justification must be developed. Such procedures are designed to act in the public interest where a common infrastructure is deemed to be

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advisable by DOC. These arrangements would be no different than the procedures currently required in respect of private microwave systems.

It is noted that consideration is currently being given in the U.S. to simplifying license application procedures for RTV earth stations in view of the high volume of applications being processed. It would appear that a similar relaxation of requirements for RTV facilities might be contemplated in Canada in order to minimize engineering costs associated with such applications. This would be consistent with the procedures employed for low power FM and TV broadcast stations as opposed to procedures required for high powered urban license applications.

In order to continue the precedent established under the Telesat Canada Act in respect of Canadian content for earth stations, it would be necessary for earth station applicants to certify a minimum Canadian content consistent with that now achieved by Telesat Canada. Although such a provision is not explicit in the Radio Act, nor is it exercised in respect of other station licenses, the extension of the Canadian content provisions to private earth station ownership could be accomplished through the license procedure. It is debatable that any legislative changes

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would be required to accomplish such a caveat, although it could be desirable to include, in licensing procedures, phraseology comparable to that which now exists in the Telesat Canada Act of Incorporation.

No difficulties are foreseen in administering the foregoing license procedures, since it would be incumbent upon applicants to conform to DOC regulations in any event.

A further condition precedent to earth station license applications would have to be formal agreement between the user and Telesat, and the broadcaster (CBC, etc.) in terms of use of satellite facilities and program material. This requirement would be essentially the same as that now employed under Telesat earth station ownership.

In order to ensure public interest considerations in the event of privately-owned earth stations, a condition precedent of earth station license should be that each earth station owner would be required to make available his earth station resources for use by others under a commercially-negotiated arrangement which equitably satisfies each user(s). In the event that such a commercial arrangement cannot be negotiated successfully between the parties, the existing provisions of the Railway Act provide for arbitration by CRTC, and are likewise provided for in the current draft legislation before the House of Commons. Such a provision of license would accommodate situations where

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common earth station usage is economical and in the public interest. Similar arrangements in the U.S. have occurred even though the motive for such arrangements has been commercial rather than regulatory.

In the event that it is decided to adopt a policy of private earth station ownership by other than Telesat Canada, it is strongly urged that the obligation be imposed upon the original owner to share the basic earth station infrastructure with all future users on a commercial and equitable basis, subject to arbitration by the CRTC in order to provide best for public interest considerations.

Although the foregoing comments represent a modest departure from existing policy and procedures, it is felt that no major difficulties would be experienced in administering such a policy, since mechanisms are already in place by which such a policy could be managed. In effect, international obligations and domestic objectives could be achieved under the umbrella of existing legislation and administrative practices.

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8. ALTERNATIVES

8. OWNERSHIP ALTERNATIVES

In contemplating the strategies available for domestic satellite earth station ownership, there appear to be four basic alternatives, excluding the possible alternative of government ownership:-

- Status Quo (Telesat Ownership)
- Regulated Common Carriers
- User Consortia
- Open Ownership

As a result of the work carried out in this analysis, an attempt has been made to identify the major factors associated with each of the ownership alternatives.

Status Quo

A continuing policy of exclusive ownership of domestic earth stations by Telesat Canada would preserve the undivided nature of satellite telecommunications in Canada. Telesat would continue to have total responsibility for the entire system, within the framework of the TCTS/Telesat Agreement.

Such an arrangement should provide adequate visibility into capital investment, operating and maintenance costs, other expenses, and profit, if Telesat records of account are isolated from those of TCTS, and are not clouded by the revenue settlement plan provided for in the aforementioned agreement.

It is likely that the overall viability of Telesat in its own right could be maintained at the present level of earnings through continued investment by Telesat in earth station assets. However, as pointed out in the Economic Analysis, it is also possible that the viability of Telesat may not suffer from a lack of investment in earth station assets, given the different capital requirements and reduced operating costs. Although such a comparative analysis is beyond the scope and terms of reference of this work, such an analysis would be useful in assessing the impact of any change in earth station ownership policy.

In theory, procurement economies of scale implicit under Telesat ownership should provide lower capital costs, and hence lower user tariffs for the provision of service. In point of fact, very few Telesat procurements have resulted in such a situation due to the natural business reluctance to invest in inventory in an uncertain market climate. As a consequence, very little procurement cost advantage has been obtained through Telesat, as the exclusive purchaser, that could not have been obtained otherwise by individual buyers and/or consortia.

On the contrary, it has been shown in the previous Economic Analysis that Telesat tariff charges exceed the equivalent cost for private earth station ownership, especially in the case of small and/or specialized stations. This view

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was echoed at the CRTC Hearings in connection with the TCTS/Telesat agreement, and generally prevails throughout Position Papers submitted in response to Notice DGTN004-77, Canada Gazette, Part I, December 10, 1977.

One has to wonder whether, in the presence of the TCTS/Telesat agreement, with its guaranteed rate of return, sufficient incentive and independence will prevail at Telesat in terms of profit and innovation motives. This doubt is not intended to reflect on individuals at Telesat Canada, but does recognize the tendency inherent in the arrangement to affect the basic policies and work environment created by inclusion of Telesat within TCTS.

The very essence of a common carrier suggests an overall system design philosophy which accommodates a large number of foreseen requirements. Whereas this philosophy has economies of scale applicable to large numbers of similar services, a system design which attempts to accommodate, comprehensively, a large number of dissimilar services, in many cases has the effect of penalizing some users in order to arrive at a suitable overall compromise. This is the dilemma which a common carrier must solve, unlike a specialized user who need only solve his own requirements.

There is no doubt that the present engineering, procurement, and project management expertise which reside at Telesat would be under-utilized in the event that part or

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all of future earth stations were permitted to be owned by other than Telesat Canada. However, it is possible to contemplate the continued employment of this expertise on a consulting basis to users implementing their own earth stations. This would establish clearly the client-user relationship needed to ensure earth station system configurations tailored to user requirements and/or capital budgets, while at the same time making optimal use of the skilled resources available at Telesat.

On the other hand, there is a strong case for single ownership of medium to large, complex earth stations, which actually provide a broad range of services to a number of customers. Telesat Canada could rightfully continue as earth station owners and operators in these cases. Individual customers would conceivably still have the opportunity of demonstrating that a private earth station would meet their requirements more economically through the DOC licensing procedures suggested herein, and this process would have the beneficial effect of introducing competition into earth station cost/charges.

Finally, there remains the contention by Telesat, as ably presented by Telesat witnesses at the CRTC Hearings on the TCTS/Telesat Agreement, that the Telesat Canada Act of Incorporation sets out the company as the exclusive owners of earth stations. Any change in earth station policy may require a change in the Act, if the contention is legally valid.

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Regulated Common Carrier Ownership

It can be argued that, were regulated common carriers permitted to own earth stations, it would be merely an extension of the present earth station monopoly situation. Although such may be the case in-principle, such an ownership policy could result in some integration of system hardware into more cost-effective configurations. In effect, the present Telesat service interface would cease to exist within earth stations, and could permit streamlining or elimination of duplications in electronics. Whether such factors would have any significant effect on subscriber tariffs would seem to depend on the actual service involved (telephone message, data, video, radio, etc.), rather than on the general principle of integration. It may well be that satellite digital services, providing telephony and data, could be made more cost-effective through joint use of a common processor for both satellite transmission and terrestrial transmission, however, it does not appear likely that any similar advantage would accrue in the case of video service. In fact the requirements of high-speed digital transmission could dictate earth station design parameters and siting to the detriment of video users in terms of overall costing arrangements.

As in the case of all alternatives of non-Telesat ownership of earth stations, this alternative would reduce Telesat requirements for capital, by transferring capital

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funding to the regulated common carriers. It is unclear whether this process would reduce customer tariffs intrinsically, because of the resulting overall rate structure.

The present federal regulation of satellite services through CRTC would effectively be fragmented to the extent that CRTC would still regulate Telesat Canada in terms of the space segment tariff and CN-CPT, Bell Canada, and B.C. Tel for end-to-end rates involving their respective earth stations. Overall end-to-end rate regulation for other common carriers would be divided between CRTC and the appropriate provincial authority. Unless a clear distinction was established in terms of capital and operating accounts for satellite versus other facilities for earth stations owned by federally-regulated common carriers, the task of CRTC regulation of satellite services could be made cumbersome.

In the event that common carrier ownership of earth stations was permitted, and Telesat chose to divest itself of existing earth stations, the provisions of the TCTS/Telesat agreement provide that TCTS members shall have an option and first claim to purchase and own such earth stations. That provision seems to remove the ability of any non-TCTS members to acquire any existing earth stations, and could create competitive and/or legal complications in connection with any sale of existing earth stations.

In view of the CRTC concern expressed in its judgment on the TCTS/Telesat agreement concerning competition on long-haul non-telephone traffic, such as data and video communications, and current considerations before the CRTC in terms of interconnection, it would appear that a policy of carrier-owned stations would effectively preclude options available to users of such services. This, in turn, is likely to impede the growth of satellite utilization for such applications.

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User Consortia Ownership

In attempting to identify practical alternatives for earth station ownership, it was concluded that a group of users would be more viable in the first instance in terms of initial purchase price reductions implicit in quantity procurements, and follow-on pooling of maintenance, spares, test equipment, etc. Further, a consortium of users, such as the broadcasters, cable TV operators, etc., also has potential in terms of additional space segment utilization.

System management through a consortium would minimize detailed operational involvement by Telesat Canada personnel, since the consortium would provide internal coordination. The same principle would apply in terms of system design, procurement, implementation, etc., and thus produce a more cost-effective solution for the individual members of the group.

As in the case of non-Telesat earth station alternatives, the capital funding requirements by Telesat would be eliminated along with maintenance and operation costs. Furthermore, a long-term commitment to satellite services would be obtained because of the individual investment by members of the consortium. It is suggested that business incentives, such as would be inherent in broadcaster or cable company operators, would provide additional

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inertia to system growth and foster the development of innovative solutions to earth station implementation and space segment utilization.

Ownership of earth stations for such specialized applications as TV and Radio distribution by the agencies involved permits the user to select performance criteria and implement an earth station design which is matched to either the market requirements or budgetary constraints. Such factors as co-locating earth stations with cable head-ends, integration with common infrastructures and maintenance and operating personnel, and joint investment with geographically-associated users, make earth station ownership by means of a consortium much more attractive financially and operationally than does the present Telesat ownership structure or the common carrier ownership alternative.

It is argued by the common carriers that the introduction of earth station ownership to user consortia would fragment the existing Canadian market. On the other hand, a user consortium, consisting of TV and Radio broadcasters and cable operators, where joint use and ownership was shared among a broad base, could be the only mechanism for establishing a unified cable/broadcast satellite distribution network. Under such an arrangement, cable operators and/or individual broadcasters could establish a pool of

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earth station resources and satellite utilization, which any one member would find uneconomical, but which, through a consortium, would be affordable. It is suggested that such an initial arrangement would create additional demand for satellite utilization; the basic problem is to establish in the first instance such a cost-effective solution.

Under existing license practices and policies of DOC, suitable provision exists for economic analysis of private ownership of earth stations versus common carrier service, in the same way that private microwave applications are examined vis-a-vis common carrier services.

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Open Ownership

It is possible to contemplate an ownership policy analogous to the U.S., where individual users are licensed to operate satellite earth stations. In the U.S. the principal applications served by such policy are, television and radio distribution, and certain specialized applications, such as earth stations located on oil drilling rigs in the Gulf and exploration and drilling ships engaged in operations in offshore U.S. waters. Additional applications of a specialized nature have been identified, such as remote data collection platforms and news, stock, etc. distribution networks.

It can be argued that a truly opened earth station ownership policy could be awkward and difficult to manage from Telesat's point-of-view. However, as pointed out herein, and as documented in the Appendices to this Analysis, suitable procedures have been developed in the U.S. which have satisfactorily made such system management routine.

In connection with individual ownership of small aperture receive-only stations, there can be no dispute that such earth stations can cause any deleterious effect on system operation. As noted in the Economic Analysis, private station ownership of such facilities by small communities, either independently or through territorial/provincial assistance programs, is substantially cheaper than present

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Telesat service tariff charges. It seems difficult to argue that such an ownership policy should not be adopted in view of the public interest considerations involved in providing at least basic CBC services throughout the country. It is possible to contemplate even lower cost, smaller earth stations with nominally reduced performance for use at small communities where off-air broadcast reception distances do not require the same high quality signal as would be required by medium to large urban areas. In order to satisfy statutory requirements, it is contemplated that any such individual community earth station would require an affiliation agreement with the broadcaster, such as is now required by Telesat Canada, except that such a requirement could be a condition of earth station license award

In the case of individually-owned specialized earth stations, as noted above, it is suggested that design and implementation can be accomplished more cost-effectively by the user through total integration of earth station configuration with customer-furnished equipment and logistics. Another example which is considered relevant to this class of application would be ownership by the Military and Emergency Measures Organization of small aperture,highly transportable, self-contained earth stations for deployment under strategic or national disaster conditions.

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As noted under earlier alternatives associated with non-carrier-owned earth stations, adequate procedures now exist within DOC which require the license applicant to demonstrate that private ownership is more viable than use of common carrier leased facilities.

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General

Telesat has pointed out repeatedly that it is required to achieve a minimum level of Canadian content in respect of earth station implementation by virtue of the provisions of its Act of Incorporation. In order to carry forward this precedent, it would be necessary to require alternative earth station owners to comply with this provision equally. It is visualized that the necessary certification, comparable to that now required by Telesat, would be a requirement in the earth station license application.

In the event that a non-exclusive earth station ownership policy is adopted, that is, neither Telesat, nor the common carriers only, it is suggested that all earth station licensees would be required to enter into commercial arrangements for joint use of earth stations with other users in order to optimize, wherever possible, the use of the earth station infrastructure. In the event that mutually-agreeable commercial arrangements for such joint use could not be negotiated, application would be made to the regulatory agency for consideration in much the same way as inter-carrier arrangements are currently handled. Even satisfactorily concluded commercial joint use arrangements would require filing with the appropriate regulatory agency, in order to ensure public interest considerations are met.

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