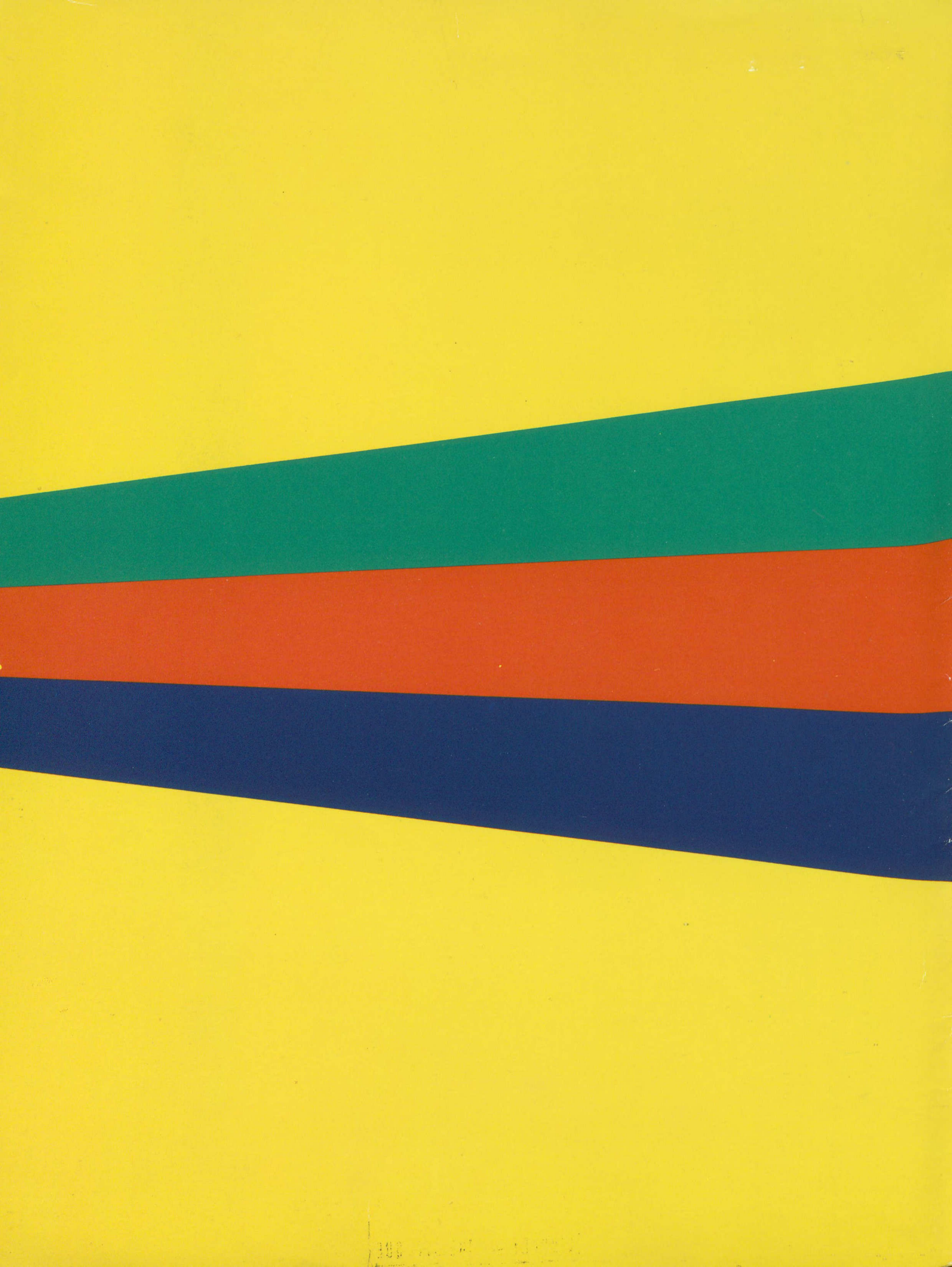
1978-79

Research and development

Government of Canada
Department of Communications

Gouvernement du Canada
Ministère des Communications



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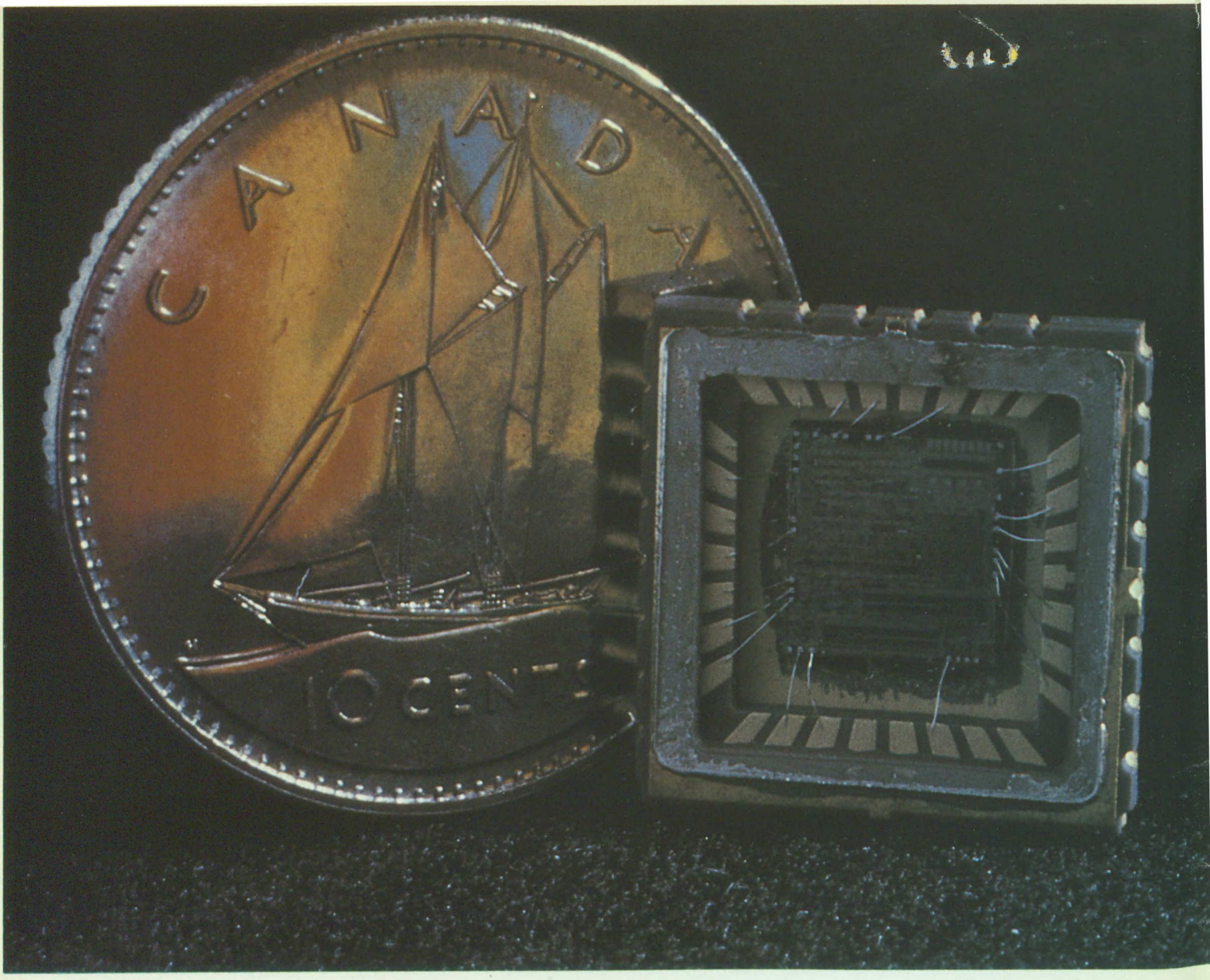
Research and Development

1978-79



Microprocessors, essentially miniature pre-programmed computers, are putting machine intelligence into an increasing range of home, business and industrial equipment.

Contents

Preface

The 1978/79 fiscal year was a period of significant scientific progress, coupled with the clear recognition that solutions are still needed for a host of problems, economic and social as well as technical.

Canadian-designed fibre-optic transmission systems began going into operational networks, reflecting the maturity that our domestic industry has attained in a relatively few years. SaskTel laid plans for creation of one of the world's largest fibre-optics applications to date and invited bids from suppliers. In other parts of the country, field trials in urban and rural locations were underway or in advanced planning stages.

Telidon, the world's most sophisticated videotex system, was introduced in August 1978, giving Canada a lead in what promises to be a major growth area in home and business communications during the 1980s and beyond. Telidon is the product of developments that began in the laboratories of the department's Communications Research Centre and is an example of the opportunities being created by advances in microelectronics and other current technologies.

Dramatic growth in the use of radio for communications is pushing the limits of available frequencies. Means have to be found to use the spectrum more efficiently, broaden it to include ever higher frequencies or, as is actually being done in DOC laboratories and elsewhere, undertake development in both directions.

A variety of spectrum research programs were initiated or continued. In addition, planning began for a nationwide "cellular" radio telephone system aimed at increasing usability of the spectrum many times over what is possible today.

Satellite communications is another promising growth area, now that the era of small "economy" earth stations is fast approaching. Canada has a number of successful suppliers of space and terrestrial hardware, and a significant portion of their output is exported. To strengthen the industrial base, provide a strong nucleus for further expansion and make the most efficient use of available expertise and financial resources, a "chosen instrument" policy has been adopted under which one company is designated as prime contractor for design, manufacture and marketing of communications satellite systems. Other companies are being encouraged to specialize in earth station manufacture through a variety of industry support programs.

Canadian providers of information for Telidon, the Canadian-developed videotex and teletext system, have found the system superior for generating, preparing, processing and storing of graphics and text. The information provider terminal shown on the photo is manufactured by Norpak Ltd., of Pakenham, Ontario, Canada.

Despite Canada's outstanding record of innovation in some areas of telecommunications, our limited research and development (R&D) capability in the cable TV and broadcast spheres has been a serious weakness, reflected in Canada's substantial trade deficit in broadcast and cable TV equipment. In 1978/79, DOC approached associations representing these two important industries with a view to setting up special facilities for R&D of Canadian-designed hardware and systems.*

Canada's vast distances and long hops between heavily populated areas have made effective communications a necessity for the country's survival. Fueled by this imperative, Canadians have developed a coast-to-coast telecommunications system that is universally recognized as one of the most advanced in the world.

Canada was the first country to establish a domestic satellite communications system and a national packet-switched data network. It is a leader in the design of digital systems for telephone and other telecommunications applications. Canada is also a pacesetter in achieving cost economies in telecommunications. For example, average charges for basic telephone service in Canada remain among the lowest anywhere, despite the country's relatively small, scattered population and formidable topographic and climatic barriers.

A key to such achievements has been continuing innovation by government and university laboratories and by private enterprise, building on experience from the earliest years of the telecommunications industry.

*As a result the Cable Telecommunications Research Institute was set up in October 1979.

This report, covering the fiscal year from April 1, 1978 to March 31, 1979, reviews some of the more important research and development projects underway or completed at the department's Communications Research Centre (CRC), at the David Florida Laboratories, a major facility dedicated to advancing space communications technology, and at university and industrial laboratories under Department of Communications (DOC) grants and co-operative programs. Also included is information on economic and social studies carried out by the department in conjunction with its technological activities.

The report is aimed at making DOC R&D undertakings more widely known and at encouraging interested organizations or individuals to pool their knowledge and resources with the department where common goals make such co-operation appropriate.

One focus of this report is the fast-expanding information economy which is bringing about fundamental changes in the industrial world and in our personal lifestyles, and is transforming Canada's communications expertise into an increasingly valuable resource.

There is growing awareness of fundamental changes in our society in the wake of energy shortages, resource scarcities and rising costs. As societies restructure themselves to conserve and live within their resources, they may turn even more intensely to communications to draw people together. No one can predict the shape of the changes to come but 1979 will go down as the year in which we became aware that major changes were imminent.

A 1.2 m, low-cost earth terminal, used for demonstrations of direct-to-home satellite broadcasting, installed on the roof of the Parliament buildings by Communications Research Centre technicians.

The information economy: what options for Canada?

Picture the surreal world of a not-too-distant tomorrow. Your television set is a home computer and communications centre as well as a multi-channel entertainment outlet. A visual display on your telephone tells you the telephone number of the party calling, before you answer. Your automobile dashboard flashes facts and figures about routes for avoiding heavy traffic and estimates your arrival time. At the office – which could be in the home as readily as in a downtown building – you sit before a video terminal exchanging data, conversation and smiles with distant colleagues or customers, and instantly obtaining information on demand, from computer memory banks across the country.

Hardly a scrap of paper is in sight. Your correspondence and filing are handled electronically, not by a secretary. There is just a trickle of conventional mail.

Such scenarios, being played out in the minds of planners, visionaries and Cassandras, are not pipedreams. The technology to create such a world has been developed. Most of the equipment required is already on the market and in use.

Newspaper reporters and editors produce texts on video terminals linked directly to computerized typesetting machines.

Word-processing systems allow a few operators to do as much work as dozens of secretaries using conventional typing and filing equipment.

Automatic banking machines let customers handle their own transactions at hours they choose.

Warehouses are operated with computer-controlled hoisting equipment that can remember where each crate or pallet is stored and retrieve it on coded command.

The main agents of change are micro-electronic devices that pack complex and, by the standards of a decade ago, incredibly versatile circuitry onto silicon or ceramic chips measuring just a few millimetres across. Microprocessors, essentially miniature pre-programmed computers, are putting machine intelligence into an increasing range of home, business and industrial equipment. The cost of microcircuitry is declining as its use and complexity increases. Scientists are now talking about superchips that will increase many times over the switching, computing and memory power available in today's most intricate components.

The changes that have occurred so far are sweeping enough to be described as a revolution. This revolution, brought on in part by the meshing of communications and computers, is giving rise to the information economy, that is to say, an economic system where the production of information is the dominant factor.

The revolution is well advanced. Terrestrial and satellite telecommunications networks provide links across the continent and around the globe for all kinds of voice, video and data traffic.

Most advanced nations are convinced that there is nothing to be gained from trying to stand fast against the tide of change. Indeed, if seized now, the opportunities for growth and innovative leadership are considerable.

In 1978, the United Kingdom committed £400 million (Cdn. $1 billion) to aid its micro-chip industry. It tripled funds available to the National Enterprise Board to £3 billion (Cdn. $7.7 billion), a large portion of which is directed to the electronics industry.

France allocated FF 2.25 billion ($625 million Cdn.) to development of information technologies. The Government of Japan stated its intention to promote the computer and data processing industries and help Japanese industry and society adjust to anticipated changes.

Early in 1979, Canada announced a $50 million program for assisting large-scale projects in the Canadian electronics industry, including establishment or expansion of domestic semi-conductor design and production facilities. The federal Department of Communications assigned another $9 million to the development, testing and promotion of Telidon, a videotex system designed in DOC's Communications Research Centre.

In the past, technology has set our social priorities. The impact of new technology on lives and livelihoods has been viewed as secondary, if considered at all. Such a narrow perspective is no longer acceptable in Canada and many other countries. Accordingly, the department is treating the economic and social implications of the information economy as prime issues and as major targets for research.

The department's Telecommunications Economics Branch provides advice to senior management on the economic aspects of major policy activities. It conducts economic analyses, maintains statistics and provides a focal point for the integration of information economy policy development.

During fiscal 1978/79, the branch conducted economic and policy research studies aimed at identifying and assessing issues arising from the technological and economic changes taking place. The results represent Canada's contribution to an Organization for Economic Co-operation and Development (OECD) report on the information economy to be published in 1980. The report itself will represent a major input to an OECD High Level Conference on Information, Computer and Communications Policies for the 1980's.

The branch's first step was to measure the extent of information activities in the Canadian economy. With the assistance of Statistics Canada, the branch measured the growth of information workers in the Canadian labour force. By 1971, almost 40 per cent of Canada's labour force was engaged in information related activity.

The branch also investigated the role of information labour and capital in Canadian manufacturing. An important aspect of the study was to gain an understanding of the ease of substitution of information and non-information inputs. Such knowledge is important for assessing the effect of further reductions in the price of information technology and the potential effectiveness of policies designed to foster the information revolution or to alleviate some of its undesirable side effects.

A second study focused on the impact of technical change in Bell Canada on the rate of productivity growth, the level of employment and the occupational mix of the company.

In addition to this OECD-related work, the branch let contracts for preliminary studies to identify major socio-economic impacts of the information revolution. These studies emphasized impacts on employment, industry structure and location, international competitiveness, vulnerability and socio-political concerns as areas requiring further empirical investigation and assessment.

The branch also began an investigation of the demand and supply of new information and communications services with a view to establishing the economic viability of such services, developing industrial and marketing strategies and studying policy implications and options for such developments. In 1978/79, a consultant developed methodologies for forecasting the demand for new services. Further studies in this area are being pursued.

The potential effects of technological change on individual Canadians and our society are being investigated by the department's Broadcasting and Social Policy Branch.

During fiscal 1978/79, the department identified a number of issues that merit particular attention, including:

- the labour market implications of Telidon, on employment, occupational distribution of the labour force, and training requirements;
- the rights of information providers and consumers for access to interactive communications systems;
- the implications of Telidon for privacy, caused by the ability of interactive communications systems to store, analyze and retrieve financial, political and other information about thousands of individuals;
- consumer rights in the face of stored personal data, including the right to examine files to correct erroneous information;
- the extent to which government bodies should be permitted to access public networks, for example, to control the flow of funds between financial institutions as part of a monetary restraint program, to obtain information for police or national security purposes or to support government policies; and
- the impact on political processes, particularly of instant polls and referendums that can be conducted readily on interactive communications systems.

Little analysis of potential labour market repercussions has been done in Canada and other countries. To begin filling this critical void, the department engaged a consultant to evaluate the introduction of Telidon videotex systems and their probable effects on employment levels, occupational distribution, productivity, worker attitudes and morale. The study was published in May 1979 under the title, "Videotex and the Canadian Labour Market: Some Potential Effects".

At year-end, the branch developed plans for detailed research into several issues, notably the development of community data bases for videotex systems, constraints on information provider access to videotex systems, and public awareness of the social uses and impacts of computer communications. Also considered is a field trial of communications technology that includes social as well as technological considerations.

Along with the work of the economics researchers, these studies will form part of the data that will help guide departmental strategists in decisions they have to make now for the critical years ahead.

Canada has a substantial foundation on which to build as it moves further into the information age. The country has one of the world's most advanced telecommunications systems. Its fixed assets alone are currently estimated to be $20 billion at book value and possibly twice that at replacement value.

Along with operating expertise, Canadian industries are active in every aspect of communications: satellites, earth stations, telephone and data switching, transmission systems, apparatus and business communications. Growth has been considerable in the comparatively newer fields of word processing and advanced office systems.

Ever since transistors and other solid state components supplanted vacuum tubes, at one time a strong domestic industry, we have had resoundingly negative trade balances in electronics products. Recently, we have recorded trade deficits of well over a billion dollars annually, led by heavy imports of computers and home entertainment equipment.

Rapidly advancing information and communications technology, estimated to be making itself obsolete every three years, is continually presenting fresh opportunities to reduce or even eliminate these deficits through innovation and industrial strategies.

Many problems remain to be resolved but unlike previous economic revolutions, we have an idea of what lies ahead.

The basic Telidon system consists of a keypad, a TV display unit, a decoder including display generator, a telecommunications link and a central computer containing a Telidon data base.

Once in touch with the data base, the user can access information in the data base – or, in theory, any number of other Telidon data bases to which he or she is connected – simply by pushing a button.

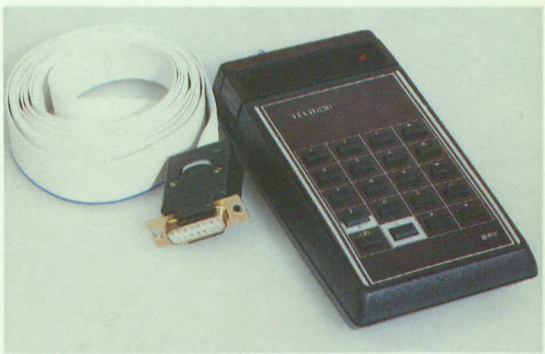
The decoder converts the TV display unit – an ordinary or slightly modified TV set – into a videotex display unit. Essentially, it receives the communication codes from the central data bank and computer, and then converts them into a form suitable for display on the screen.

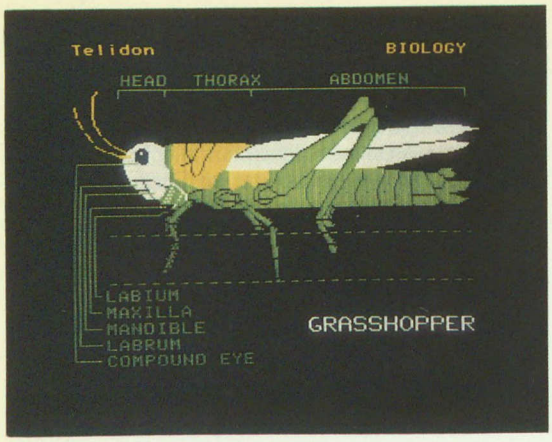
New home and business services: introducing Telidon

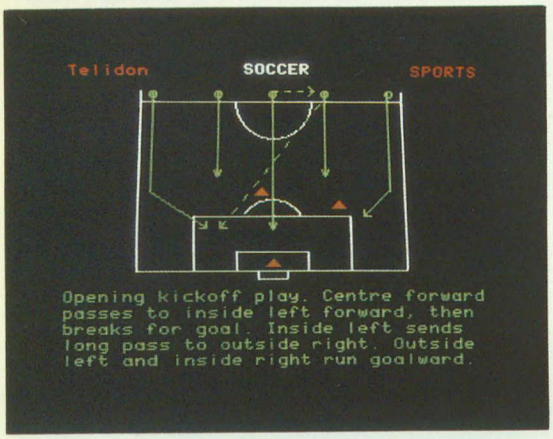
A significant step in the evolution of the information economy will occur when communications and information systems using large centralized data processors and memory banks become widely available to the general public. Publicly accessible computer networks similar to our telephone or cable TV networks may be set up. Economies of scale and high-volume use will keep costs to individual subscribers low.

Britain, France, Canada and several other countries have already begun field trials of a form of interactive visual communications called videotex, which uses computer data bases and modified TV sets to supply a wide variety of information to consumers.

In August 1978, the Department of Communications announced the introduction of an advanced interactive system, called Telidon. Telidon was derived from on going research, conducted at the Communications Research Centre, into the transmission of complex images over switched telephone lines.







A host of educational applications for Telidon

Telidon's advanced graphic capabilities render possible the electronic transmission of mathematical, scientific and technical illustrations; comparative charts in economics, demographic data and statistics; musical scores, maps and profiles in economics and geography.

By adding a special interface device and keypad to an ordinary TV set, Telidon enables users to dial up text or graphic information stored in any number of computers. DOC anticipates that before long, the cost of the necessary television set modifications could be as little as a few hundred dollars. Affordable Telidon terminals would provide a broad market for the hardware and for computer-stored information services including anything from weather reports and airline schedules to complete university courses available on demand. Telidon has the potential for many business applications. It could also be used in the home to calculate budgets, store important family data, do school work, or for recreation such as computer games. More advanced Telidon terminals will provide direct terminal-to-terminal communication.

Although the Canadian and other videotex systems have been developed to meet the same basic requirements, Telidon takes a different approach and is more sophisticated technically. For example, Telidon can present intricate three-dimensional diagrams and illustrations in a variety of colours with a tonal range, clarity and resolution unmatched by any other system.

Another key technical and, ultimately, cost advantage is that the Canadian system of storing information is independent of the communications media or the receiving hardware. Despite future changes in terminal, transmission or data base management technologies, the system will be able to adapt. Users won't see their terminals become obsolete within a few years. Similarly, information providers can avoid the massive expense of having to reformat their data in order to accommodate future technical advances.

More flexibility has been built into the Telidon system by offering a choice of components reflecting varying degrees of sophistication.

Telidon is attracting a lot of attention in Canada and in other countries. The system has been widely demonstrated and DOC officials have talked to many potential manufacturers, information suppliers (such as publishing companies, broadcasters and educational bodies), cable and telephone companies and others, as the system moves out of the labs and into the marketplace.

A number of field trials and market studies are underway. For instance, the Ontario Educational Communications Authority (OECA) is experimenting with educational applications of Telidon, transmissions over normal television broadcast channels, as well as over the telephone network. Bell Canada will test 1,000 Telidon terminals over the next few years. Several other telephone companies are planning to conduct market trials and field tests of Telidon terminals, including tests over coaxial cable and fibre-optic transmission systems. Cable TV operators will also be experimenting with Telidon as a home information technology.

The question of standards is central to the development of videotex. Standards are required to cover a wide range of system characteristics for Telidon at the national and international level. These are essential if, for instance, a citizen is to remain free to move from one region of Canada to another without being forced to replace equipment. Standardization also gives the user access to a wide range of information sources within Canada and abroad without unnecessary technical barriers. The department has been active in initiating and co-ordinating Canada's participation in the international standardization process through such organizations as the International Telecommunication Union and the International Standards Organization. Compatible standards will be developed on the basis of international agreements, so DOC has been active in several key international standardization meetings and will remain active as long as necessary to achieve Canada's standardization objectives.

New satellite communications services

During the last 10 years, communications satellites have become cost-effective substitutes for existing terrestrial systems. There are now about 70 operational or pre-operational communications satellites in orbit from many countries with an estimated total capacity equivalent to about one million telephone circuits.

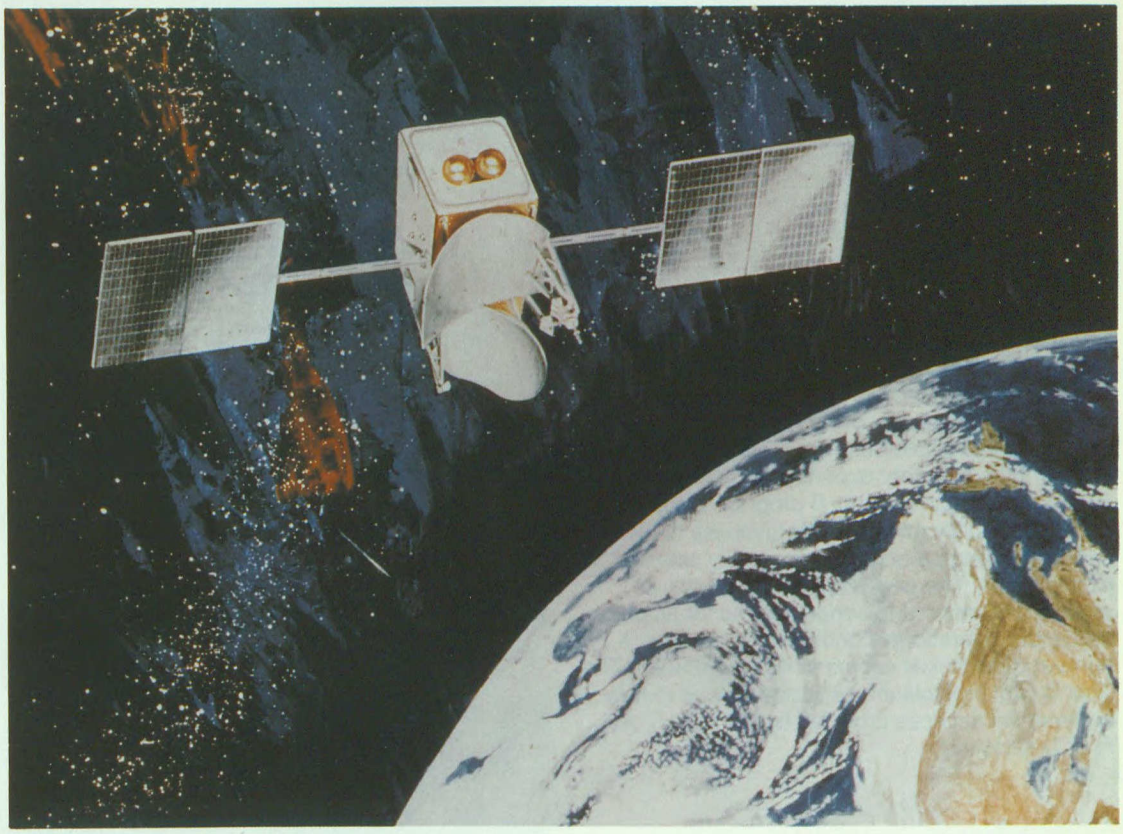
Because of its harsh climate and scattered population centres, Canada is reaping particularly useful benefits from satellite communications. Telesat Canada, through its three Anik A satellites operating in the 6/4 GHz bands, has provided TV and radio program distribution to regional centres, thin-route message services and TV reception to some remote areas of Canada.

This commercial satellite system has gone a long way in solving many of Canada's communications problems. But the Anik A series of satellites could not satisfy easily or economically all the requirements for extending TV and radio services to smaller communities or specialized users or provide direct television broadcast services to community or individual receivers. In addition, the segment of the geostationary orbit reserved for satellites operating at 6/4 GHz frequencies is in danger of becoming saturated.

Fortunately, frequency allocations in the higher 14/12 GHz frequency bands will be available on the Anik C satellite. These are reserved for satellite use, and, because of the use of these higher frequency bands, interference with terrestrial networks is eliminated. Earth terminals therefore, can be located in and close to centres of population. This has created the opportunity for services which were not possible with the 6/4 GHz satellite systems.

To investigate the possibilities of the 14/12 GHz frequency band, Canada, in a joint program with the United States and with participation by the European Space Agency, developed the Hermes satellite. The spacecraft, launched in January 1976, has been operated by DOC. Communications experiments began in April 1976, with Canada and the U.S. sharing the use of satellite time equally. Hermes exceeded its design lifetime of two years and because of the success of the experiments, and the continued satisfactory operation of the satellite, the original two-year mission was extended.

This hybrid computer at the Communications Research Centre combines digital and analog computing methods and is used in the design and simulation of attitude control systems for spacecraft.



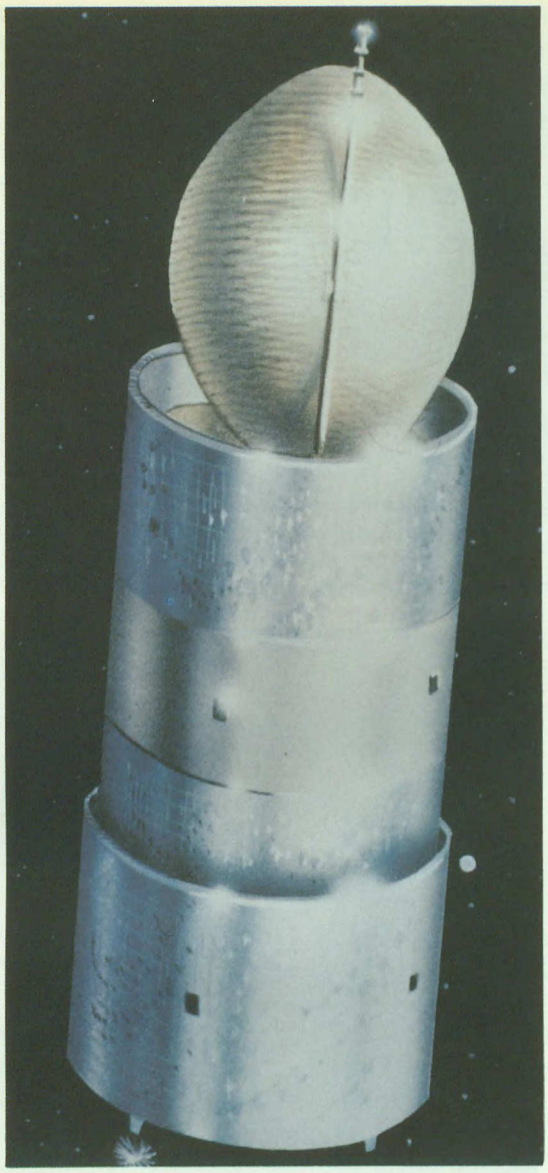
Anik B

The equipment pictured here is all the Canadian homeowner of the future (as early as the mid-80's) would need to receive high-quality color TV direct from satellites. At left is a 60 cm parabolic dish antenna with a tiny outdoor electronics package mounted opposite its centre. This antenna unit feeds satellite signals to the small receiver/converter unit atop the standard TV set.

In Canada, major experiments have been conducted with Hermes in telehealth, tele-education, advanced technology, community interaction, TV broadcasting, and government services by universities, hospitals, federal and provincial departments, native organizations and industry. These experiments involve the use of a large number of earth stations with antennas ranging from 3 m in diameter for two-way television, voice and data to as small as 60 cm in diameter for television receive-only under selected conditions. Hermes also tested three advanced technology subsystems – a lightweight, flexible power array which tracks the sun and provides operating power, a three-axis stabilization system, and a 200-watt travelling wave tube amplifier.

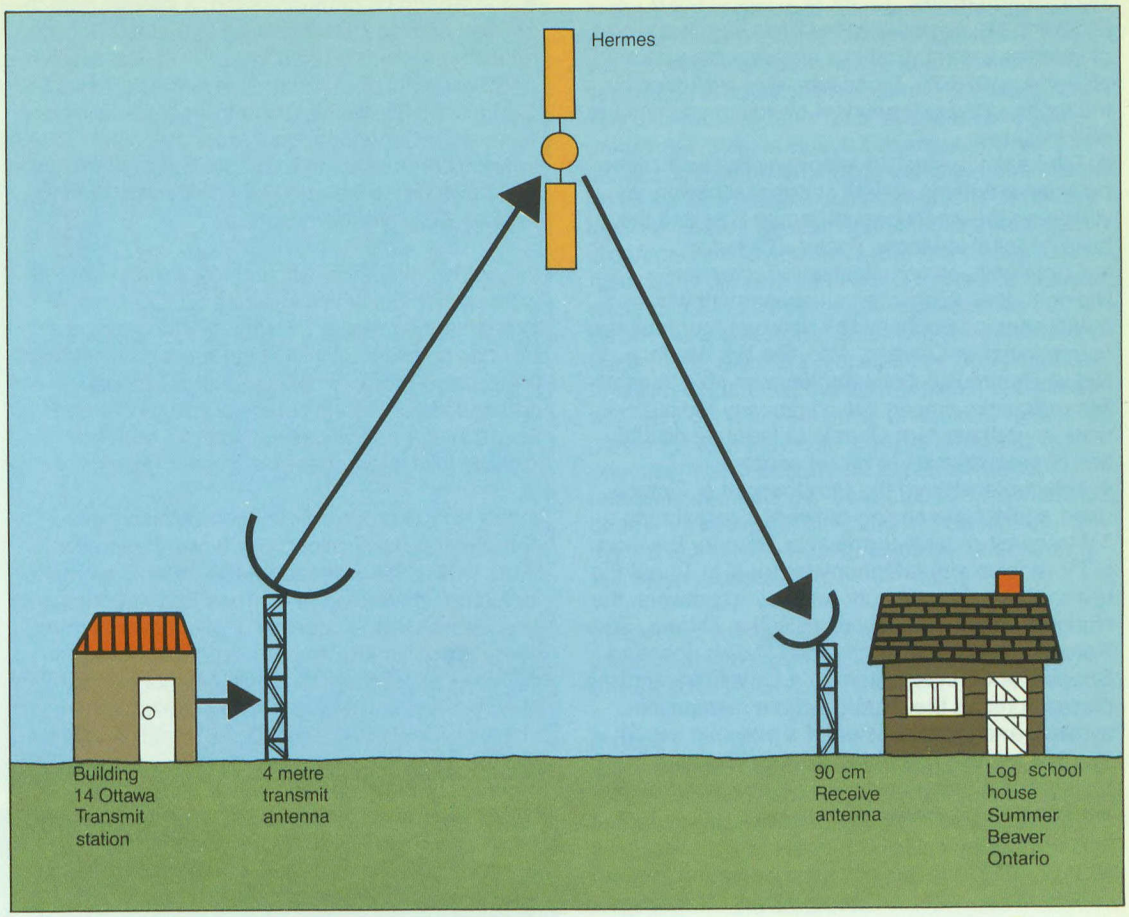
The experimental nature of Hermes, time-sharing with the U.S., and the large number of experiments competing for satellite time, limited the extent to which economic viability, and institutional issues could be studied. As a result, and to ensure Canada's lead in this developing technology, DOC entered an agreement with Telesat Canada to install and lease to the department up to four 14/12 GHz communications transponders on the Anik B satellite, launched in December 1978 to replace one of the Anik A satellites. The 14/12 GHz portion of Anik B includes four regional beams and four transponders, and was built largely by Canadian industry, using technology developed in the Hermes program. The satellite became available in March 1979 for operational and experimental use for two years.

The Anik B program is continuing the exploration and development of new communications services by satellite. The Hermes program demonstrated the technical feasibility of such services using satellites, and created user awareness through a number of exploratory experiments and demonstrations. The current Anik B program is testing the utility, desirability and cost effectiveness of these services through a number of carefully selected pilot projects. The pilot projects are usually of extended duration and conducted, as far as possible, under operational conditions. In addition, a number of technical experiments are planned. The Anik B pilot projects are expected to lead to new commercial services provided by the Anik C or Anik D satellites.



Anik C

OECA DBS Experiment
One way video and audio transmitted via Hermes to an Ojibwa village in Northern Ontario



Log school house
Summer Beaver

TVRO
Hopedale, Labrador

1978/79 activities

Following the original two-year mission, a new set of Hermes communications experiments was approved for 1978/79. Proposals were evaluated by the reconvened independent evaluation committee, and included:

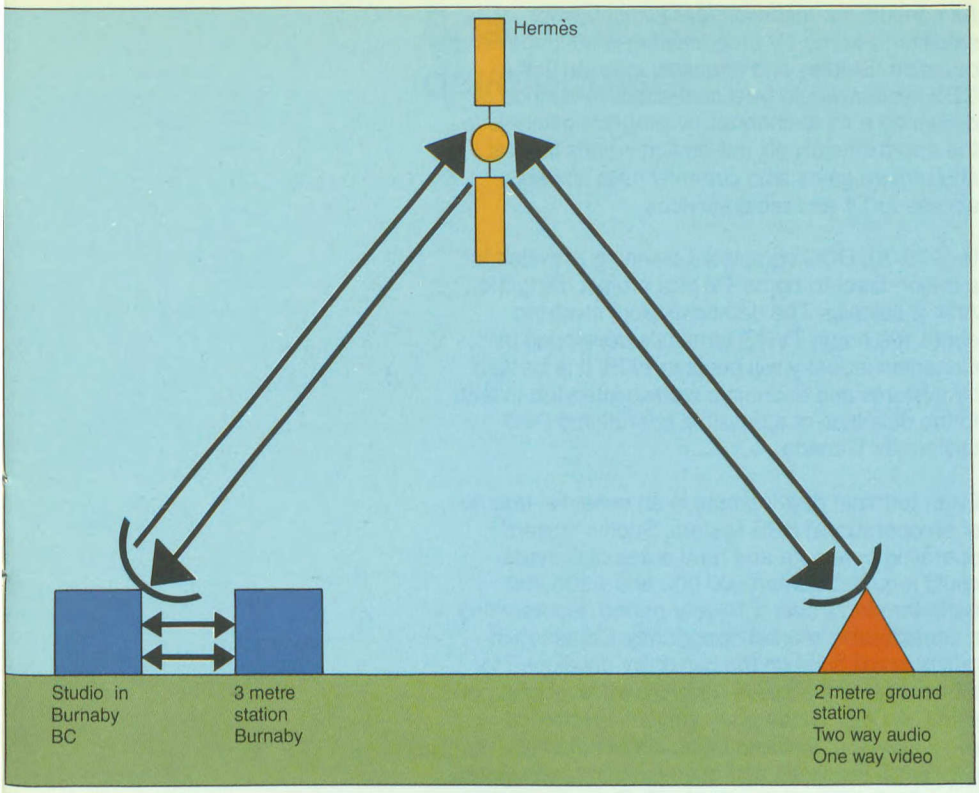
- Telehealth: a satellite-telephony link was set up between a nursing station at Kaschechewan, a village on the west coast of James Bay, and the base hospital at Moose Factory, Ontario;
- Community communications: Taqramiut Nipingat, Inc., sponsored an experiment which established a telephony link between four Inuit communities in Quebec. Also, the Wa Wa Ta Native Communications Society was able to establish radio links among five community radio stations in northwestern Ontario to facilitate distribution of programming to native people.
- Teleconferencing: the Government of Ontario used a teleconferencing network incorporating a TV transmit-receive terminal in Thunder Bay and a TV receive and telephony terminal in Toronto; a teleconferencing network was set up between the National Research Council (NRC) in Ottawa, Spar Aerospace Ltd. in Toronto and NASA's Johnson Space Center in Houston for a series of technical discussions on the shuttle remote manipulator system; and the extension of a previous experiment re-established video-teleconferencing links between the communities of St. Raymond de Portneuf and Buckingham in Quebec;
- TV broadcast demonstration: a special demonstration of direct broadcasting of television to small receiving terminals used four 1.2 – 1.6 m receive-only terminals at Summer Beaver, Slate Falls, Mine Center and South Bay Mine in western Ontario to receive OECA educational programs in the schools in each community. In Labrador, 1.6 m terminals in Makkovik, Postville and Hopedale were used to receive CBC Northern Service.

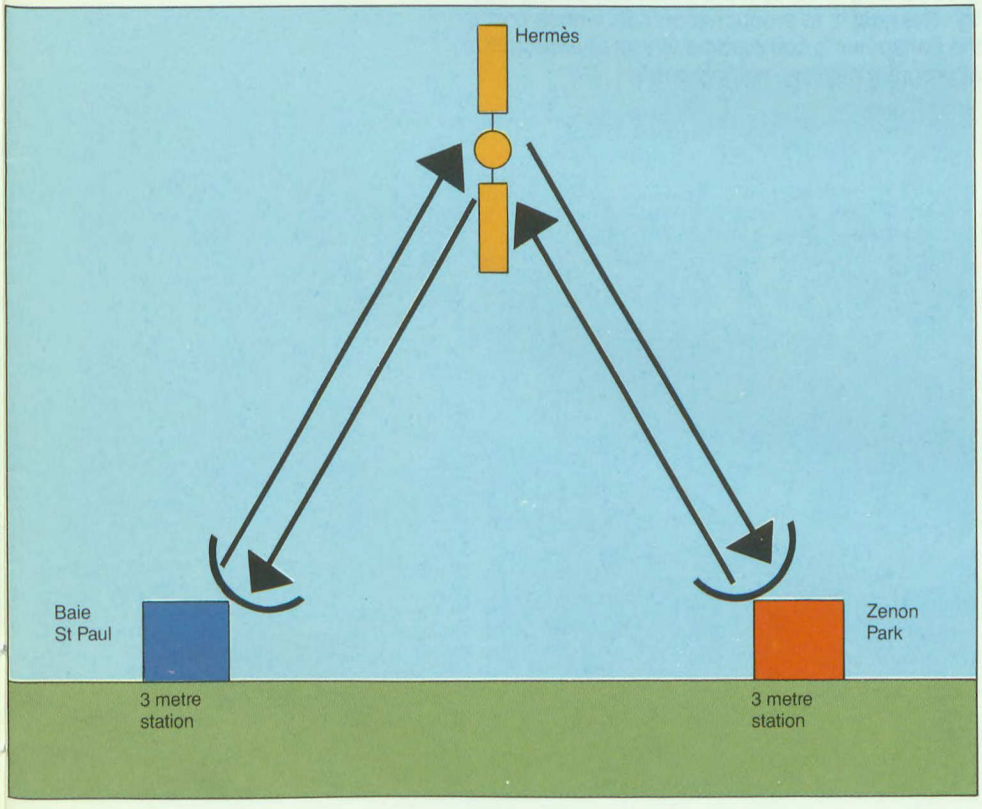
In addition, a number of technical experiments were carried out which included a DOC/Comsat experiment on digital TV transmission using the Hermes satellite; an NRC time-transfer experiment linking laboratories in the U.S. and Canada for comparison of high-accuracy clocks; and a continuation of the University of Toronto work on satellite-linked long baseline interferometry.

In the Anik B program, detailed planning was completed and 17 pilot projects were approved. Work was well advanced on the ground segment, including conversion of Hermes earth terminals for use with Anik B. A number of pilot projects in the same areas as the Hermes experiments were selected by DOC. In the East, Memorial University of Newfoundland plans to make available, via an interactive network, educational health programs and physician consultation to seven remote communities in Labrador and Newfoundland. In Quebec, several provincial departments and universities will work with the Quebec Ministry of Communications and DOC to deliver health care, education, and other government services to residents of the province. In Ontario, the Ministry of Government Services plans to evaluate a satellite-based network providing for the information transfer requirements of several provincial ministries for voice, facsimile, teletype, and video transmission. The OECA will use Anik B to study the viability of extending its video network to improve delivery of interactive educational programming to remote communities in the province.

Transportable earth station used to transmit and receive two-way audio and one way video for educational experiment, British Columbia

3 metre transportable earth stations used to transmit two way video and audio for a cultural exchange between Zenon Park in Saskatchewan and Baie-St-Paul in Quebec experiment 09





In the West, a group of Alberta participants led by the Alberta Educational Communications Authority, will connect a program centre in Edmonton with several isolated northern communities using one-way and two-way links for educational and community services. In British Columbia, the Ministry of Education is co-ordinating the implementation of an interactive satellite communications system to improve access to adult and community education programs and to academic and technical courses. Also, DOC plans to use Anik B to feed community cable distribution systems in remote areas of British Columbia, complementing similar terrestrial feeds in the more populous parts of the province. In northern Canada, the Inuit Tapirisat of Canada will carry out a project using an interactive satellite communications system to improve access to educational instruction and to permit teleconferencing of meetings. It will also test the viability of an Inuit television broadcasting service designed to reduce the cultural impact of southern television productions.

In addition, a major direct satellite-to-home TV broadcasting demonstration is planned, and is described elsewhere in the report.

Future

The Hermes mission and communications experiments will be completed in 1979/80. A demonstration of 12 GHz satellite communications is planned for Australia and Hermes will be moved from its present geostationary orbit slot at 116°W to 142°W longitude for this purpose.*

Anik B pilot projects will continue through 1980/81, and DOC has an option on a further three years of Anik B 14/12 GHz service. Approved and proposed experiments exceed the satellite's available capacity and proposals for extending the program will be considered in 1979/80.

*Contact was lost with the Hermes satellite at 8:06 p.m. EST on November 24, 1979. The satellite performed for nearly double its design lifetime of two years.

Direct broadcast by satellite (DBS)

While Canadians in the densely settled southern urban regions can select from a wide variety of television programming, many Canadians have no access to television broadcasting. An even larger number in rural areas have only limited choice. TV transmission by high-powered satellites to very small low-cost earth stations would make high quality television reception accessible to all Canadians through the use of community or individual receivers. Programs beamed from high-powered satellites in geostationary orbit have the potential to reach any area in the country. The costs of program delivery by satellite are insensitive to distance. In addition, a more uniform quality of service is possible than with conventional terrestrial means of television distribution and transmission.

The technical feasibility of direct broadcasting by satellite has already been demonstrated successfully through Hermes. Direct broadcast satellite (DBS) systems are now being studied and advocated in several parts of the world. For example, Japan has launched an experimental Hermes-type direct broadcast satellite; France and Germany are discussing co-operation on a DBS system to begin operation as early as 1983; and the Scandinavian countries are conducting discussions on an operational DBS system (NORDSAT), with agreement expected within a year.

For several years, DOC has carried out studies, demonstrations and evaluations in this area. These activities include:

- development of 14/12 GHz satellite and earth station technology and transfer to industry. One result was major contracts awarded to Canadian industry in procurement of Telesat Canada's Anik B and NASA's tracking and data relay satellite system (TDRSS);
- development of small earth terminals suitable for direct-to-home TV broadcasting. One such terminal has an antenna only 60 cm in diameter. It is connected to a television set through a small outdoor unit mounted at the focus of the parabolic reflector and an indoor unit not much larger than some standard television converters. The small earth terminal has been demonstrated in Lima, Peru where it was used to receive one of the NHL final hockey games transmitted by Hermes from Ottawa;
- an experiment on Hermes (January to June, 1979) using small TV receive-only (TVRO) terminals in western Ontario and Labrador in a short-term demonstration of the feasibility of direct broadcasting by satellite;

As a result, the technical feasibility of direct satellite-to-home TV broadcasting is no longer in question. Studies and forecasts indicate that a DBS system would be a cost-effective method of delivering a multi-channel TV program package to the approximately six million Canadians in rural and remote areas who currently have limited access to TV and radio services.

In 1978/79, DOC completed planning activities for a major direct-to-home TV pilot project using the Anik B satellite. The demonstration, involving about 100 home TVRO terminals developed by Canadian industry will begin in 1979. It is backed by systems and economic studies intended to lead to the definition of a possible operational DBS system for Canada.

Earth terminal development is an essential feature of an operational DBS system. Such a system, operating in remote and rural areas of Canada, could require between 500,000 and 1,300,000 earth terminals over a 10-year period, representing a considerable market opportunity. Canadian industry could build on the capability developed for this market and achieve a significant level of export sales as DBS systems are implemented worldwide. Development and improvement of small, low-cost earth terminals and manufacturing techniques is continuing in co-operation with Canadian industry. The goal is to produce terminals whose cost to the consumer is comparable to that of other forms of program delivery, notably cable.

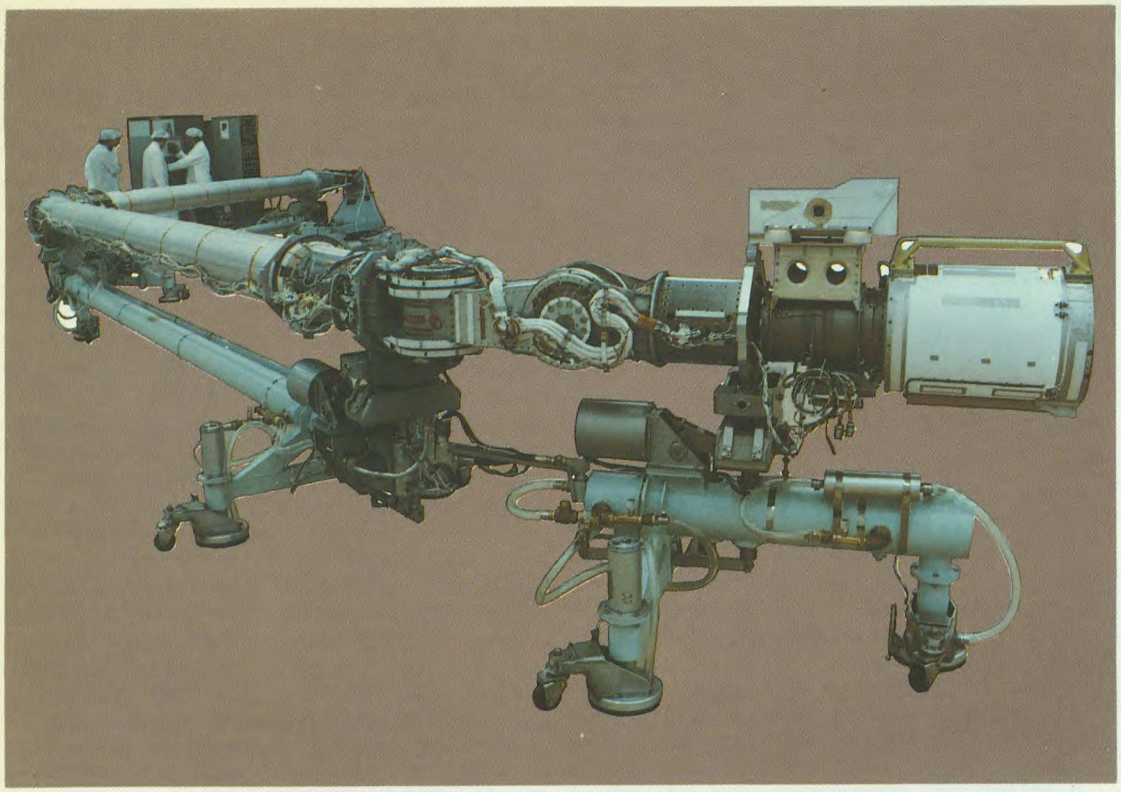
Space industry development

Background
Canada was the third country in the world to design and manufacture a complete satellite, the highly successful Alouette I, launched in 1962. Since then, and despite the far greater resources of such countries as the USSR and the U.S., Canada has won worldwide respect for the quality of its design and manufacture of scientific and communications satellites, all of which have met or exceeded design lifetimes. Canada's space industry has developed rapidly as a result of industrial initiatives and government support.

Following increasing participation by Canadian industry in the scientific satellites Alouette I and II, and ISIS I and II, Canadian suppliers were involved as sub-contractors in DOC's $60 million Hermes satellite, launched in 1976. Through such programs, the industry has become better qualified to participate in major space programs. Spar Aerospace Ltd. of Toronto is supplying the remote manipulator system (RMS) for NASA's space shuttle orbiter; while Spar Technology Ltd. of Montreal supplied the transponder and antenna systems for Canada's Anik B satellite and NASA's tracking data relay satellite system. Canadian industry's involvement in Telesat Canada procurements has progressed from supplying 13 per cent Canadian content on the Anik A series, to a planned 32 per cent on the Anik C series, and 50 per cent on the Anik D series.

The Space Sector of DOC has a specific responsibility to develop plans to provide for optimum participation by Canadian industry in the design, development and construction of Canadian satellite systems. DOC works closely with industry and other government departments to ensure maximum industrial participation in space activities.

Government support has been complemented by industrial initiatives. The leading company, Spar Aerospace Ltd. began operations early in 1968, with the acquisition of the special products and applied research division of de Havilland Aircraft of Canada Ltd. RCA Ltd. of Montreal's government and commercial systems division, including their space related activities, was acquired by Spar in 1977 along with the space electronics portion of Northern Telecom. Another company, SED Systems Ltd., grew out of the University of Saskatchewan's space engineering division in 1972. Currently, about 40 Canadian companies have acquired competence in space work at the component, unit and subsystem levels, and share sales of about $140 million annually.

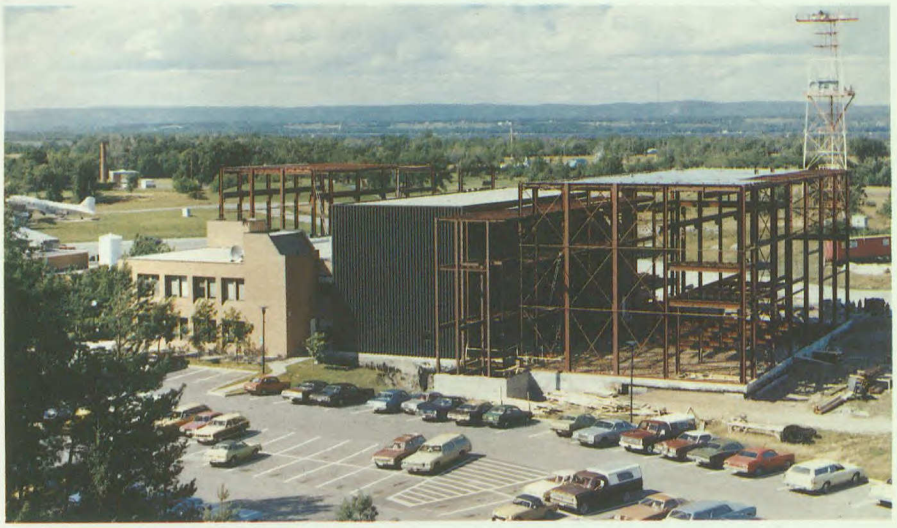


Shuttle remote manipulator system

DOC has helped the Canadian space industry to develop in three ways; first, the department negotiated with Telesat Canada to optimize Canadian content in commercial satellite procurements; second, it provided suitable integration and test facilities; and finally, it encouraged industry to develop components and sub-systems required for future programs through an industrial contract program supported by the transfer of space technology to industry.

1978/79 activities

In 1978/79 the government made landmark decisions on the future of the Canadian space industry, leading directly to the establishment of a Canadian prime contractor for satellites. In particular, the government approved a program designed to support Canada's space endeavours by: providing the required integration and test facilities at the David Florida Laboratory; by directing the Minister of Communications to seek the co-operation of Telesat Canada in placing the prime contract for the Anik D satellites with Spar Aerospace Ltd.; and by authorizing the Minister of Communications to enter into contracts to provide for the integration and partial testing of the third Anik C spacecraft in Canada.



An $20 million program to expand the David Florida Laboratory (DFL), provide Canada with the capability for assembly and testing of large, complete communications satellites and other aerospace systems and components during the 1980s.

David Florida Laboratory

The David Florida Laboratory (DFL) at the Communications Research Centre is a national facility for the integration, assembly and environmental testing of space components and communications satellites. The facilities include provision for vibration, thermal vacuum, RF antenna testing and spacecraft integration at both the component and system level. These facilities were originally intended for the testing of space hardware at the component and system level. They have been used in the past for the integration and testing of space hardware for Canadian industry for the Hermes satellite program and the Anik B satellite program. In 1978/79 they continued to be used for the shuttle remote manipulator system (SRMS) program and the TDRSS satellite program.

In 1978, the expenditure of $20 million was approved to expand the integration and test facilities at the DFL to test complete satellites, rather than merely components and sub-systems. The planned expansion began in 1978/79, and building modifications will be complete in 1979/80. Major items of equipment will be installed in 1979/80 and early 1980/81. These include a 22-foot diameter thermal-vacuum chamber, capable of accommodating satellites compatible with the U.S.Space Shuttle.

Anik D Prime Contract
Telesat's Anik D satellites will be needed from 1982 on to continue and expand the 6/4 GHz service currently provided by the Anik A satellites. In early 1979, Spar made a contract proposal to Telesat to act as prime contractor in the manufacture of the two Anik D satellites and the parties have now signed a contract. The government agreed to partially reimburse Telesat for the additional cost of using a Canadian prime contractor. These added expenses arise from non-recurring start-up costs associated with the first prime contract.

Anik C Integration and Test
Telesat's three Anik C satellites will operate in the 14/12 GHz band, providing heavy-route message services, broadcasting to cable head-ends and other possible new services beginning in 1981. In 1978/79, the government approved a plan for Spar to integrate and partially test the third Anik C spacecraft in Canada. Hughes Aircraft Co. of the United States will be building the first two Anik C satellites. This exercise is a valuable and necessary learning experience for the industry as it gears up to become prime contractor for the Anik D program.

Industrial Technology Development
DOC also administers an industrial contract program, begun in 1976, to encourage industry to develop components and subsystems for future Canadian and export satellite programs. Industry participation during the first three years of the program has been highly successful. About $1.5 million was contracted to Canadian firms during 1978/79, with program funds budgeted at $2 million for 1979/80.

The program, which is consistent with the government's contracting-out policy, includes:
- an SHF space technology development effort, to help Canada maintain its competitive position in 14/12 GHz satellite components and subsystems together with an extension of this work to higher frequencies (20-30 GHz) likely to be used in the future;
- development of new technology applicable to small SHF earth terminals for direct-to-home TV, cable and radio and telephony applications;
- spacecraft power systems technology, including new electronic battery management systems;
- feasibility studies and development of advanced electronic components, including GaAs FET's (gallium arsenide field effect transistors), for use in satellite transponders, earth terminals, and emergency locator transmitters;
- work on dynamics and control systems technology required for future commercial communications satellites and other Canadian spacecraft.

The Future
In the immediate future, DOC will be heavily committed to supporting the Anik C-3 and Anik D procurement programs by providing specialized technical support to the contractor in reliability analysis and spacecraft testing.

In the longer term, in order to justify the expenditures made to date for a prime contractor capability, international markets must be developed. Opportunities exist and Canadian industry has a reasonable chance of success in international marketing of satellite technology. DOC, in cooperation with the Department of Industry, Trade and Commerce, is making special efforts to identify international opportunities and to support Canadian industry in international marketing activities.

The combination of government support and industrial initiative has been successful in developing the Canadian space industry to the point where it can undertake a spacecraft prime contract. The industry now has access to excellent facilities for integration, testing and reliability assessment. Canadian industry must compete for the international business it requires to remain healthy. The benefits to Canada are not solely in the creation of jobs and improvement in the balance of payments, but include high technology spin-offs and an increase in sovereignty and control over Canadian communications systems.

Computer terminals in motion

With the explosion in computer terminal technology, many potential applications are also foreseen for mobile computer terminals.

Two DOC developments introduced during 1978/79 provide computer link-ups for users on the move. They consist of advanced video terminals and software designed specifically for use by police and taxis but with many other potential applications.

The first is a mobile data terminal for use in computer-aided police dispatch systems and in accessing centralized police department data banks. An operational system was turned over to Vancouver city police on January 29, 1979.

Funded principally by DOC, the terminal was developed as a model system under agreements with the Royal Canadian Mounted Police and the City of Vancouver. Through industrial contracts, DOC provided systems design and engineering, software, specialized hardware and hardware support.

The terminal uses a base-station minicomputer to help link police cars in the field with headquarters. The system enables patrolling officers to bypass police radio dispatchers and obtain data on such matters as stolen cars and missing persons directly from the computer. In addition to providing instant information on demand, the terminal increases the information-carrying capacity of voice channel allocation.

Design for a similar terminal for use in taxis was completed in November 1978 and will be given field trials during 1979. Other versions of the new terminal can be adapted for use in fire, emergency medical, utility, service, trucking and other vehicles.


UMCT OPERATIONAL FEATURES ARE:
ALL CALL, GROUP CALL
PRIVATE COMMUNICATIONS
BIG MESSAGE CAPABILITY
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DOC advisory groups look forward – and back

The complexity of the issues with which the department must deal requires maximum feedback from various segments of the community so that informed, constructive decisions can be made with regard to policies and strategies. Two specialized groups, in particular, continually review communications issues and make recommendations for future action. They are the Communications Research Advisory Board (CRAB), an independent body with a formal responsibility to advise the Deputy Minister of Communications, and an organization called Project Delta.

Communications Research Advisory Board

The Communications Research Advisory Board (CRAB) was established in 1972 to examine departmental research policies and programs, criticize where criticism is due and make recommendations for current programs as well as for long-term strategy. The group consists of some 20 people with long experience in various areas of the communications field.

In April and May 1978, the board reviewed the department's efforts to transfer technological advanced developed in DOC laboratories to industry. Programs considered in some detail included new home and business services, fibre optics, field trials and the space communications program.

The board's published report made three major recommendations: that a clearer policy framework is needed for DOC; that the department should more forcefully direct its resources and institutional clout to fostering development of Canada's domestic communications industry; and that DOC should ensure a closer interaction between its natural and human science activities.

The report also recommends that greater emphasis be placed on social and human considerations in setting research priorities. A shortage of entrepreneurs in Canada was identified as a fundamental problem in expanding the domestic communications industry.

CRAB advocated policies to encourage the formation of new companies and the strengthening of existing organizations to make them more competitive.

Recommendations concerning new home and business services included initiatives to expand software development in Canada because of the central importance of this field in the burgeoning information economy. The committee stated that the now relatively small fibre-optics industry should be stimulated and expanded, particularly as glass fibres start replacing conventional metallic wire and cable on a large scale.

Project Delta

Project Delta is a forum for the discussion of issues in Canadian communications. It brings together representatives of government, industry, labour and various citizens' groups in periodic seminars. The objectives of these meetings are to clarify issues, examine policy options and identify research and development priorities. Project Delta is carried out under the aegis of the GAMMA group at the Université de Montréal and McGill University. It is funded by its members through annual subscriptions.

During fiscal 1978/79, the opening seminar focused on the future of Canadian communications to 1991, ranging over a wide variety of technological, economic, regulatory and social issues. Subsequent seminars dealt with ethical aspects of telecommunications in Canada, group needs in Canadian communications, the information society, fibre optics, new home services, the Manitoba Telephone System inter-city broadband network, new services distributed by cable, the Syracuse experiment in home monitoring and switched video services, a domestic terminal project, and a review of projects in future communications services. Two final seminars held under the title "Plans for Action: Untangling the Canadian Telecommunications Web", discussed papers on the future system architecture of Canadian communications and the development of cable television.

Communications for the handicapped

The Department of Communications, in co-operation with the National Research Council, associations for the handicapped and private industry, is helping develop products to meet the communications needs of the hearing, sight and speech impaired. One such product went into production during fiscal 1978/79. Preliminary design work began on another.

Visual Ear
DOC acted as project manager and scientific authority in the development of a portable terminal called the Visual Ear. This device is designed to be acoustically coupled with a telephone handset for communication with other similar units. It is also compatible with the existing teletype network used by the deaf and orally handicapped in Canada and the U.S. The total unit weighs about 1 kg including batteries and measures 230 mm by 190 mm by 55 mm. The Visual Ear can be slipped readily into a briefcase or large purse and has its own carrying case.

The Visual Ear has a standard keyboard and operates on a small rechargeable battery for several hours at a time or with an AC adapter. The visual readout consists of a single line of up to 24 characters using light-emitting diode displays.

The transmission is made by frequency shift keying (FSK) carriers in the audio band. The transmit and receive modes are switch-selectable to operate: on the deaf teletype network (45 baud, 5-level code, non-standard tones) or with commercial 110 baud and 300 baud telex and computer terminal 8-level ASCII encoding. The unit can double as a small portable computer terminal.

This dual compatibility distinguishes the unit from other terminals for the deaf which are only compatible with the deaf teletype networks.*

Research and design was handled under contract from DOC by Bell-Northern Research Limited, Ottawa, and completed by the end of 1978. Production began in early 1979.

Braille Terminal
This low-cost computer terminal will expand communications opportunities for the blind, particularly those with both sight and hearing or speech impairments. It is intended to develop a unit with a keyboard for transmitting and a Braille embosser for recording messages. Connection to the telephone network will be provided by an acoustic coupler. A prototype is under development at the National Research Council with DOC acting as adviser on the communications aspects of the project.

*The first Northern Telecom version of the Visual Ear will be compatible only with the teletype network for the deaf.

By typing out messages, hearing- and speech-impaired people will be able to "talk" to anyone who has a Visual Ear or compatible device. Messages appear electronically on the display unit, much the same way news is spelled out on cable TV sets, with a maximum of 24 characters shown at once.

Spectrum: A vanishing resource

With ever-increasing use, the radio frequency spectrum is becoming more and more congested. Already certain frequency bands, especially those allocated to mobile radio services, are reaching saturation. We are approaching the limits of the capacity of the spectrum. As a result, increasing effort is aimed at finding ways to expand capacities of frequencies currently in use, to open new portions of the radio spectrum to communications and, to evolve policies that offer the most satisfactory compromises between demands of actual and potential users. Development of such policies is complicated by the fact that the spectrum is a resource that cannot be contained within political boundaries but must be shared with neighbouring countries and, depending on the specific technical parameters, with countries around the world.

During the year, the department began a study to determine the distribution and size of the Canadian public's capital investment in mobile radio equipment. The data will be of assistance in the development of possible future regulatory policy in this area.

During 1978/79 a primary focus for spectrum related activities at DOC was the World Administrative Radio Conference (WARC) to be held at Geneva, Switzerland, beginning September 24, 1979. WARC is sponsored by the International Telecommunication Union (ITU), the United Nations agency responsible for co-ordinating international telecommunications. This will be the first general WARC held since 1959.

In preparation, an interdepartmental committee held extensive consultations with other federal departments and agencies, the private sector and provincial governments. A 200-page document recommended that:

- additional spectrum be allocated internationally for mobile communications in the UHF band;
- the standard AM broadcasting band be extended to provide for additional broadcasting operations in Canada
- the amount of shortwave spectrum employed for international broadcasting be substantially increased;
- additional radio spectrum be provided for Canadian and international requirements for radiocommunications by satellite;
- additional spectrum be made available to the amateur radio service.

As a prelude to WARC, DOC representatives attended ITU regional conferences in Nairobi, Kenya, Panama City, Panama and Sydney, Australia, where discussions centred on the use of the high frequency spectrum, the 12 GHz band for space services, communications problems of developing nations and planning for future allocations of stationary satellite orbital positions.

Spectrum research

Cellular radio systems
DOC and Alberta Government Telephones (AGT) have begun research on a cellular radio project which AGT is interested in introducing in Alberta. The project has the potential for relieving severe congestion problems now occurring in frequencies allotted to mobile radio and radiotelephone. The cellular radio system would allow for better use of the spectrum, particularly with regard to the mobile telephone bands recently allocated by DOC.

Single sideband
DOC researchers are in the early stages of development of a sophisticated single-sideband (SSB) technology to overcome noise problems and improve the quality of voice transmissions on high-frequency radio systems, and to permit automatic connectivity to other radio systems, to private lines or to the switched public telephone system. Selective calling will relieve the user of the need for radio listening skills and the fatigue caused by manual monitoring of HF channels. In addition, it will improve HF circuit reliability and extend circuit availability to 24 hours per day.

While this technological research is for the purpose of improving HF communications, features of it may also be applicable at VHF and UHF. At these frequencies and, particularly in the land mobile bands, FM is used, and although it provides higher quality service, FM transmission requires larger bandwidths than SSB. SSB technology, now in development at CRC and in the United States, offers hope that "companding", or signal compression expansion, and other techniques will provide more efficient alternatives than FM. In addition to the technical problems, one obstacle to a rapid conversion to single sideband is the huge current investment by Canadian users in FM mobile equipment.

TV/mobile interference tests
Tests have been carried out by DOC to investigate possible TV/mobile problems. The DOC studies established median signal strength at frequencies in the 806-990 MHz band for mobile stations with assumed average technical parameters and used this information to establish an interim "buffer zone" beyond which U.S. mobile systems could operate without causing interference to reception of operating television stations in Canada. The width of this zone was somewhat extended when researchers pointed out that under some weather conditions, signal enhancements in excess of the long-term median could occur.

The Communications Research Centre has a computer which should soon know every hill and dale in southeastern and central Ontario.

The computer will be able to tell you in an instant how big an antenna you'll need to pick up a local TV station, and how well you'll receive it.

Power line interference
The department has for several years been engaged in a measurement and study program of radio noise, particularly ignition noise and power line noise at frequencies in the 100 to 1000 MHz range. Power line noise is of particular concern, since it affects TV signal reception and land mobile radio communications, and it is therefore important to measure and control the levels of power line noise interference. The work has also involved contracts with the University of Manitoba and Nova Scotia Technical College to measure noise levels in two very different environments: near the sea and in the prairies.

Measurement of power line noise at 2, 4 and 6 GHz has been identified as an urgent requirement, since these frequencies are used by power companies for radio communications to provide network control and monitoring. Work in this area will commence as soon as suitable instrumentation can be acquired or developed.

High speed point-to-point data communications
Interference is particularly serious when it affects data transmission. Since the volume of data traffic has been rising at an accelerating rate, the department is investigating the feasibility of using radio for high speed point-to-point data transmission. On-going studies are investigating propagation, radio noise and interference on high speed transmissions.

Spectrum occupancy in mobile bands
The department is developing a spectrum management system for frequency selection and assignment for land mobile equipment. Though many licences have been issued, individual licence holders often make relatively small and sporadic use of the spectrum, leaving significant blocks of "empty air" during the day. This offers possibilities for increasing the number of users in various frequencies but careful analysis is needed before any expansion can take place. An automated program for monitoring occupancy by geographic region and for issuing licences has been developed by the department and is being tested in the Montreal area. In this system, a central computer analyzes data, calculates frequency usage for a given district and then assigns the most suitable frequencies to new licence applicants.

Broadcast signal reradiation studies
The radiation patterns of MF AM broadcast antennas are carefully shaped to avoid interference with other stations' service areas. The pattern shapes are determined by international treaty rules and are under federal government regulation. These patterns can be severely distorted when power lines or highrise buildings are constructed close to transmitting antennas, and such illegal situations of re-radiation from large objects are arising more and more frequently while, at the same time, new broadcast stations are going into operation with more and more tightly restricted radiation patterns. In 1977, this situation was recognized in Canada by the formation of a co-ordinating committee or Working Group comprising members from government and industry (DOC, CRTC, CABC, CAB, CBC, and CEA), and the start of a comprehensive research effort. This involves research by two government departments (CRC and NRC), two universities (University of Toronto and Concordia University), and two industries (Ontario Hydro and Elder Engineering Ltd., a broadcast consulting firm).

The research will result in the more timely development of standards for the relocation of powerlines, highrise buildings, and broadcasting transmitters. Such standards do not now exist and cannot be developed as yet due to the present state of knowledge in this field. In view of the huge expenditures on new power lines, highrise buildings and broadcast station plants, it is of utmost importance that adequate standards be developed as quickly as possible. This will avoid lengthy and costly litigations and avoid even more expensive relocation or redesign of electronic and energy distribution systems.

Precipitation Attenuation and Depolarization
Since the 12 and 14 GHz bands are exclusively allocated to satellite communications, systems using these bands can communicate directly with major centres without interfering with terrestrial microwave systems. For the same reason, considerable power can be transmitted from the satellite and earth terminals with small antennas suitable for community or individual reception are practical. However, satellite communications systems at these frequencies can be adversely affected by signal loss due to heavy rain. The frequency of occurence of these outages and their duration will depend on geographic location, elevation angle to the satellite, and the system margin available for this loss. Studies have been carried out at several locations across Canada to determine the characteristics of precipitation attenuation at these frequencies.

The capacity of a given satellite communication system can be increased by transmitting two signals at the same frequency with differing polarizations so that one signal can be received independently of the other. Heavy rain, however, can couple power from one polarization to the other, causing interference between the two signals. In co-operation with the Trans-Canada Telephone System and Bell-Northern Research, CRC has studied this depolarization and its correlation with precipitation attenuation at several locations in Canada.

Earth station site-diversity
Rain which is sufficiently intense to cause an outage is localized. Thus, the reliability of a satellite communications system can be considerably improved by using two stations spaced so that the probability of both stations suffering an outage simultaneously is substantially reduced. On behalf of Teleglobe, DOC has investigated characteristics of site-diversity using a pair of sites in Western Quebec and another pair in southwestern Ontario. The results of these studies will be used in the design of the Intelsat V system.

Terrestrial Microwave Propagation Studies
Terrestrial microwave radio links suffer from similar propagation problems to those on earth-space links. At frequencies above about 10 GHz, rain attenuation is a major cause of outages, and depolarization due to rain will also be a problem for future systems utilizing dual polarizations in the same band. Although there are as yet few systems in Canada operating in bands above 10 GHz, the Department of Communications supported experimental programs at 11, 15, 18, 37, and 74 GHz to investigate their potential. Parallel work to determine the rain attenuation climatology for the country was also carried out.

Over a range of frequencies above and below 10 GHz, outages due to multipath propagation (caused by destructive interference between components of the signal arriving via slightly different paths) are also a problem. Fundamental measurements to analyze this phenomenon were carried out in the 8-10 GHz band.

Rural Communications

The formidable quantities of cable and line hardware needed to reach relatively few subscribers have always made it expensive for telephone companies to serve rural areas. Despite cost-cutting measures such as eight- and ten-party lines, rural service has never been profitable nor has the quality of service been generally acceptable to subscribers themselves.

The flexibility and high capacity of digital systems and microprocessor-based switching equipment are turning out to be particularly helpful in improving the economics of service to communities with small, scattered populations. Fibre-optic transmission systems, with their huge traffic-carrying potential, promise even greater advances in the future.

There are already highly successful, digital multiplex subscriber carrier systems, designed in Canada, that greatly increase the number of customers that can be handled by one cable, make it possible to eliminate party lines and provide rural telephone users with a range of modern services. The systems now on the market are generally most economical for use in rural pocket communities where houses are clustered together.

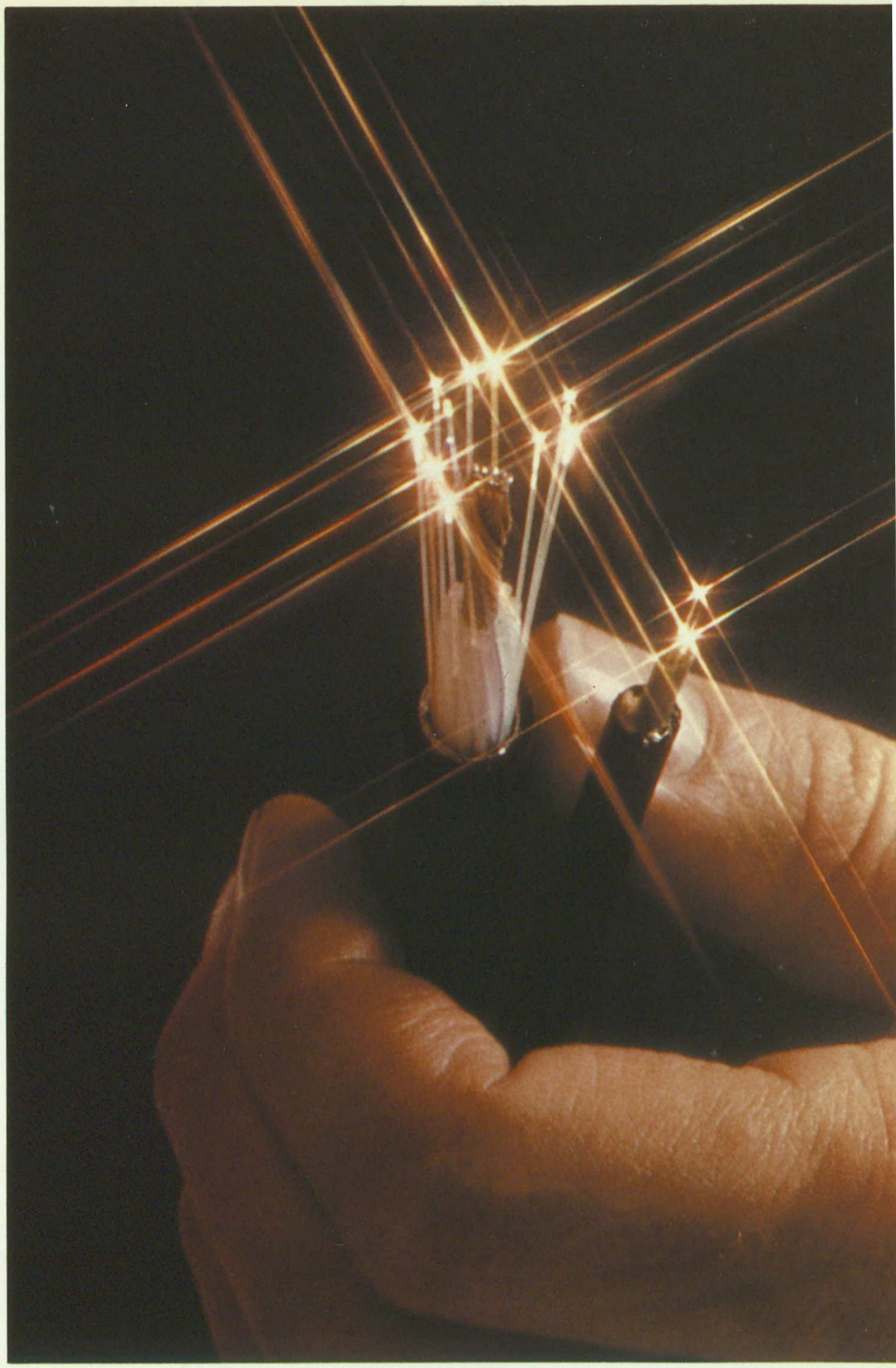
In 1978/79, DOC began development of a digital subscriber carrier suitable for areas where houses are spaced widely apart and strung out along country roads. The basic system being designed under contract by a Canadian manufacturer will have 32 channels which can be dropped off from a cable one at a time. The system will provide single-party service to each subscriber and could be linked directly to digital central office switching systems, as they come into use.

Another possible solution to rural service problems is the rural interface device (RID) for use on party lines. Now in an advanced development stage, RID will restrict ringing to the telephone called and will prevent third parties on multi-party lines from listening in on conversations. However, in case of emergencies, a third party will be able to activate a warning tone and then interrupt to request help from neighbors using the line.

During 1978/79, a prototype for a line-of-sight 18 GHz pole line or light route radio system was built under contract with a private laboratory. A six-mile trial network was set up to establish its feasibility for rural applications.

Several studies were carried out to supplement these hardware system developments. Included were an investigation of the commercial viability of cable TV in small Newfoundland communities, rural service financial feasibility studies comparing data supplied by two telephone companies, and a demographic study to establish distribution patterns of rural households, estimate the cost of various service improvements and devise incentive programs encouraging telephone companies to accelerate rural development.

The department is also investigating the potential of fibre optics to improve rural communications services and is planning a major field trial of this technology in and around Elie, Manitoba, a small town near Winnipeg. Details of the trial were given in the *1977/78 Research and Development Report.*



A single optical fibre provides up to 500,000 one-way voice circuits.

Integrated remote communications

Until recently, most telecommunications to small remote communities in Canada's North were provided by HF radio. However, this relatively inexpensive mode of communications has proved unreliable.

A modern and reliable alternative is satellite communications. However, terminals needed for use with the current generation of low-powered satellites are costly and bulky, especially for a small community, for marine communications or for temporary services such as those required by an exploration party.

The DOC integrated remote communications system is designed to overcome these disadvantages. It integrates modern high frequency radio, voice processing and telephone technologies in an automatic system that permits users to dial directly into the Trans-Canada Telephone System as well as providing a local communications service that is reliable and suitable for both fixed and mobile applications.

A fully automatic high-frequency radiotelephone operated simply by dialling a long distance number, will be used between small communities and to connect these small communities to the nearest available access to the long-distance telephone network. Use of a small local automatic switch will permit local community distribution and a potential link to trail radios used for mobile communications.

Researchers at the Communications Research Centre are working on a new voice-processing technique that should improve intelligibility over the radiotelephone. The technique reduces radio channel noise effects.

The integrated remote communications system is being designed by CRC with equipment being developed by several Canadian companies. A pilot system will undergo local evaluation in 1979 with a field trial scheduled for 1980 in British Columbia.

Research and Space Sector Activities

The following pages comprise a comprehensive, alphabetical listing of major research and development-related activities of the federal Department of Communications.

You are invited to write or telephone the research managers, project leaders and other officials named for more details. Telephone numbers (Area Code 613) are included for those associated with each project or activity listed.

The department's general mailing address is:

Department of Communications
300 Slater Street
Ottawa, Ontario
K1A 0C8

Advanced Device Technology
Dr. A.R. Molozzi 996-9403
Dr. M. Palfreyman 596-9410

Studies to evaluate feasibility of applying advanced electronic components to use in satellite transponders, earth terminals, and emergency locator transmitters; assess their use in prototype hardware, and establish Canadian sources for components. Current activities include investigation of the possibility of developing GaAs FET fabrication capability within Canadian industry.

Anik B Communications Program
Dr. R.W. Breithaupt 995-7783
N.G. Davies 596-9215

This program continues exploration and development of new satellite communications services begun with Hermes (see Hermes abstract) which demonstrated the technical feasibility and created a user awareness of such services. The program will test their utility, desirability and cost effectiveness through a number of pilot projects. Seventeen projects have been approved in telehealth, teleeducation, television program delivery, public telecommunications applications and advanced technology experiments. Telesat's Anik B satellite, launched in December 1978 will be used. The spacecraft provides Telesat Canada with 6/4 GHz replacement capacity, plus four 14/12 GHz channels leased to DOC for at least two years.

Broadband Rural Networks
Dr. Y.F. Lum 996-8871
A. Lillemark 593-6460

Intention is to establish an engineering framework for development of federal policies regarding broadband communications in rural areas and to stimulate related Canadian industry development. Technologies being considered include stacked rebroadcast systems, direct broadcast satellites including novel modulation scheme, fibre-optic distribution systems and terminal equipment requirements.

Broadcasting: Small Format Video and Audio
David Gillick 996-5722
Gilles Desjardins 995-9936

Recent developments in communications technology such as compact, lightweight and affordable recording equipment and "black boxes" which process and correct signals for broadcasting purposes are rapidly changing radio and television. This survey of small-format audio and video production equipment examines how communications technology might be used to encourage more local Canadian programming.

Carriage and Content in Telecommunications

Michael Tiger 995-9942

Investigation of concept of separating content and carriage in telecommunications, defining terms, offering an historical analysis of concept development with respect to carriers, cable companies and broadcasters and speculating on future applications in new telecommunications services.

Communications and the Handicapped
Bob Lucyk 995-9943
Dan Rainboth 995-6763

Expansion of a 1976 pilot study. 401 disabled individuals in Ottawa and Montreal were interviewed about their mass media and interpersonal communications habits. Also included are results of a workshop attended by 70 handicapped persons. Major findings: the disabled have limited variety and quantity of social contacts, use mass media essentially as time-fillers, are not well served by mass media, and send more than they receive. Existing devices such as the telephone, General Radio Service, teletype, closed circuit TV, ham radio and home movies are underutilized compared to their potential to give the handicapped more control over their lives. Study carried out by Dr. Paul Licker of St. Paul University.

Communications Processing Research and Development
Dr. A.R. Molozzi 996-9403
L.A. Maynard 596-9348

The project supports applied research and development related to processing techniques for digital communications systems and is intended to define future civilian and military requirements for cost effective voice/data/video networks. Techniques researched are also being applied to other communications systems such as UHF/Anik, military tactical satellites and terrestrial mobile systems. Development of subsystems is initiated through industry contracts.

Data Networks and Standards
Dr. Y.F. Lum 996-8871
B.H. Ho 996-8871

Activities aimed at developing national and international standards for networks and systems are continuing to increase with emphasis on service integration in digital networks. Project involves standards development in conjunction with CCITT and ISO (International Standards Organization) and recommendations for national policies as prelude to introduction of new services such as videotex, office-of-the-future, and electronic mail. Research focuses on current issues on evolution of data and computer networks.

David Florida Laboratory
Dr. A.R. Molozzi 996-9403
W.F. Croskery 596-9593
The David Florida Laboratory (DFL) at the Communications Research Centre is a national facility used to integrate, assemble and environmentally test space components and communications satellites. The facilities include provision for vibration, thermal vacuum, RF antenna testing and spacecraft integration at the component and system level. Major portions of the Hermes and the Anik B satellite programs were carried out at DFL. In 1978/79 the facilities were used for the shuttle remote manipulator system (SRMS) and the TDRSS satellite programs. During the year the government approved the program to develop a Canadian prime contractor capability for satellites and a $20 million expenditure to expand integration and test facilities at DFL so that complete satellites could be tested. Building modifications should be completed in 1979/80. Main items of new equipment will be installed in 1979/80 and early 1980/81 in time to handle the integration and test requirements for Telesat's Anik D procurement from Spar. Equipment wil include a 6.8 m diameter thermal-vacuum chamber capable of accommodating satellites compatible with the U.S. Space Shuttle; upgraded (40,000 lb. force) vibration facilities; and improved RF test facilities and data handling equipment.

Demand for Rural Communications Services in Canada
S.Serafini 995-8181

Objective is to provide means to assess level of satisfaction, perceived needs and determinants of demand in short and longrun for improved rural communications services. Main activities consisted of a review of the literature, development of demand model, focus group discussions in each region of Canada and draft questionnaire for a national study. R. de Camprieu, J.C. Bourgeois, University of Ottawa, May 1979.

Direct Broadcast Satellite Studies
Dr. J.C. Chambers 996-6436
N.G. Davies 596-9335

The Hermes program demonstrated the feasibility of direct broadcast satellite systems. Such systems are now being studied and advocated in several parts of the world. Studies, demonstrations and evaluations carried out by the Space Sector in this area include: development of 14/12 GHz satellite and earth station technology and transfer to industry; development of small earth terminals for direct-to-home TV; experiment of Hermes (January-June 1979) using small TV receive-only (TVRO) terminals in western Ontario and Labrador in a short-term demonstration of the feasibility of direct broadcasting by satellite. Studies and forecasts indicate that a DBS system would be cost-effective for delivering a multi-channel TV program package to the approximately six million Canadians in rural and remote areas who currently have limited access to broadcast services. In addition, DOC completed advanced planning for a major direct-to-home TV pilot project using the Anik B satellite.

Earth-space propagation
Dr. K.S. McCormick 596-9395
Dr. J.I. Strickland 596-9698

Research project to obtain propagation information required for the design of satellite communications systems and spectrum management. Studies the precipitation attenuation and depolarization of signals using the Anik B satellite at 12/14 GHz and the COMSTAR beacon at 28 GHz. Another investigation jointly funded with Bell Northern Research, studies attenuation and depolarization at several Canadian locations using the Hermes beacon at 11.7 GHz. Under contract with Teleglobe, studies the statistics of precipitation attenuation at 11/14 GHz and the benefits of site diversity. In co-operation with Telesat, investigates the characteristics of site diversity at 28 GHz. Investigates the fading experienced by systems using geostationary satellites for communication at low elevation angles to high latitudes, and the improvement in performance using various site-diversity configurations.

Effects of the Radio Environment
Dr. J.S. Belrose 596-9362
Dr. T.N.R. Coyne 596-9288

Investigation of effects on communications systems and consumer electronic equipment, including error rate performance of digital systems in the presence of man-made radio noise and quantitative assessment of power line and ignition noise effects on TV reception. Detailed survey of current technology and practices was made as a prelude to developing a test and simulation capability. Follow-up evaluation of the trail radio system tested at Koartak, in northern Quebec, is being carried out. An MF/HF SSB transceiver designed for this type of communications environment is now under development. Project 15002.

European Space Agency, Co-operative Agreement
Dr. J.G. Chambers 996-6436

A co-operative agreement between Canada and the European Space Agency (ESA) was signed on December 9, 1978 and came into force January 1, 1979. It provides for Canada's involvement in long-term planning through participation in ESA's Central Studies Program. An ESA mission to Canada in January briefed Canadian industry and registered several companies, making them eligible to receive Requests for Proposals in General Studies and Technological Research. DOC is identifying and co-ordinating possible contracts and new co-operative activities with ESA. New working relationships between Canadian and European companies may follow because major ESA contracts are bid on a consortium basis.

Evolution of the Canadian Broadcasting System: Objectives and Realities, 1928-1968
David Gillick 996-5722
Gilles Desjardins 995-9936

Analysis of main themes that dominated policy debate on Canadian broadcasting from establishment of the Aird Commission in 1928 to proclamation of the Broadcasting Act in 1968. Traces growth of the Canadian Broadcasting Corporation, examines regulatory questions, indicates tensions that emerged between public and private sector, reviews major inquiries and outlines positions of various governments. Many of the key problems discussed remain unresolved today.

Financial Impact of Bill C-58
Michael M. Tiger 995-9941
Gilles Desjardins 995-9936

Summary of an economic study on border broadcasting by Arthur Donner and Fred Lazar, an independent Toronto consulting team. Includes chapters from the January 1979 report entitled, "An Examination of the Financial Impacts of Canada's (1976) Bill C-58 on U.S. and Canadian TV Broadcasters." The summary also deals with objectives of Canadian broadcasting in Canada and the U.S.; overview of television advertising markets; three estimation techniques for assessing effects of the amendment to Section 19.1 on the Income Tax Act (Bill C-58); and the impact of the legislation on U.S. and Canadian broadcasters.

Forecasting Model for Television Advertising Expenditures in Canada
Leonard Bellam 995-9945
Gilles Desjardins 995-9936

Joint project with francophone universities under direction of Professor Alain Lapointe of University of Quebec at Montreal. Designed to create a model to aid understanding dynamics of the television advertising market and expenditures. Report has three main sections: analytical description of structure and evolution of advertising expenditures; concept and detail of a forecasting model; and development of a specific model.

Hermes Communications Experiments
Dr. R.W. Breithaupt 995-7783
N.G. Davies 596-9215

Hermes, the most powerful communications satellite in orbit, continued operating beyond its two-year design life. Its mission has now been extended to November 1979. Experiments conducted include telehealth, tele-education, advanced technology, community interaction, TV broadcasting, and government services with participants including universities, hospitals, federal and provincial government departments, native organizations and private industry. Earth station antenna sizes range from 60 cm receive-only to 3 m for two-way television, voice and data.

Hermes Technology Experiments
Dr. A.R. Molozzi 996-9403
Dr. S.P. Altman 596-9281

Continuing project to flight-test new stabilization system for a spacecraft (i.e., Hermes) with flexible appendages and unfurlable, 1 kW solar power arrays. Co-operating experimenters include Spar Aerospace Ltd., Telesat Canada and NASA. Data is being made available to the European Space Agency.

High-Reliability Laboratory
Dr. A.R. Molozzi 996-9403
Dr. M. Palfreyman 596-9410

The High-Reliability Laboratory, located at the Communications Research Centre, investigates and establishes quality and reliability standards for spacecraft electronics needed to withstand hostile outer space environments, develops and applies techniques for reliability assessment of electronic subsystems, designs new devices and provides reliability analyses to DOC, other departments, agencies and Canadian industry on high priority projects (currently including SRMS, SARSAT and Telesat's Anik C and Anik D procurement).

Impact of Telecommunications on Socio-Economic Development
J. Kostash 593-7322

Joint study by DOC and Canadian International Development Agency to analyze role of telecommunications in international development. To be managed by DOC with discussions and input from other government departments and industry organizations.

Importance of Telecommunications to Regional Development
E.E.R. King 995-7079

Report examines the importance of telecommunications to regional development at the conceptual level. It identifies ways telecommunications has influenced or might influence regional economic development in Canada; describes and discusses methodologies to test these effects and suggests case studies that might serve as test vehicles. The purpose of the report is not to measure the importance of telecommunications but to set out rationale and research required to conduct such measurement. B. Lesser, Dalhousie University, Halifax, March 1978.

Information Sector Growth Statistics
S. Serafini 995-8181

Showing trends in growth of information labour force in Canada from 1931-1971. Additional 1971 statistics show industrial distribution of information labour force, age, sex and income profiles of information workers.

Information Society Issues
M. Estabrooks 995-8181

Project explored scope and issues and significance to Canada. Seven reports analyze social and economic impact of the information society, role of technology push and research and development. Studies identified several major problem areas and examined policy options. GAMMA, Montreal.

Integrated Remote Communications
Dr. R. Kaye 596-9341
G.W. Irvine 596-9357

Objective is to provide improved method for linking remote settlements to switched telephone network by integrating HF radio telephone to conventional telephone exchanges. System is to employ automatic real-time channel evaluation and selection to accommodate changing radio propagation conditions. Syncompex, a new HF/SSB voice processing system designed to improve intelligibility in noisy environments, is being developed. Hardware delivery in fall 1979, with evaluation trials in 1980/81.

International Commitments
Dr. K.S. McCormick 596-9395
Mr. D.B. Ross 596-9227

This project provides scientific and technical support for DOC participation in several international programs. These include the planning of experiments and dissemination of data from the ISIS II satellite, for the ISIS Experimenters Group; the planning of new space missions and facilities, e.g., for Spacelab; active membership on CNO/CCIR Study Groups 4, 5, 6 and 7; and work on the preparatory committees and delegations for the 1979, 1980/81 and 1982 ITU Radio Conferences.

These activities are complemented by a program of research on radio-wave propagation in the VLF to HF bands, with current emphasis on MF broadcast, ionospheric emissions, and the development of an ionospheric model for use in transionospheric propagation prediction.

International Maritime Satellite Communications
Dr. R.W. Breithaupt 995-7783
L.A. Maynard 596-9348

Project covering DOC technical and management support for Department of Transport-led Canadian participation in the INMARSAT program. DOC activities include experimental assessment of small shipboard terminal performance studies for propagation margins and evaluation of multipath effects and requirements for transmission and reception of voice, data and ranging information.

ITU 1982 Plenipotentiary Conference
G.I. Warren 992-0220

Preparatory study reviewing Canada's past and current role in plenipotentiary conferences, identifying Canadian interests and relating them to actual or potential ITU functions, thereby assessing importance of the ITU to Canadian interests. Edited version to be made available through the International Institute of Communications.

Jurisdiction and Decision-Making in Canadian Broadcasting: Review of Present Configurations and Analysis of Future Possibilities
Gilles Desjardins 995-9936

Study examines options for dividing authority over broadcasting between federal government and provinces. It looks at selected social, cultural, political, economic and technological trends during the next 10 to 15 years. Scenarios were constructed to forecast positive and negative consequences of centralizing, sharing or decentralizing responsibilities. Project carried out under University Research Program by a team from University of Windsor and a team of Quebec City consultants.

Labour Market Implications of Telidon
David McKendry 996-5723

Research identifies and evaluates social policy issues arising from introduction of computer/communciations technology to provide a preliminary indication of labour market implications of videotex. Analysis indicated that effects will be both positive and negative, affecting certain classes of workers and jobs and labour market adjustment processes.

Launch-Vehicle Optimized Spacecraft System Studies
Dr. A.R. Molozzi 996-9403
S.P. Altman 596-9281

Project examines the impact of new launch systems (e.g., the U.S. Space Shuttle and the European Ariane rocket) on satellite system design. This information is required in support of cost-effective planning of missions and satellite system selection by Canadian industry and government departments.

Microwave Remote Sensing
Dr. D.F. Page 596-9412

A program of research on the use of microwaves for remote sensing of the earth's surface from satellites and aircraft. Radar methods of imaging the surface, especially the synthetic aperture radar (SAR) technique, are being investigated. Projects include the development of optical and digital methods of processing SAR signals to obtain the image, an investigation of limitations on the performance of satellite-borne SAR imposed by the passage of the radar beam through the northern ionosphere, and an investigation of how ocean waves affect the ability of the radar to detect and classify objects such as small ships on the surface of the sea. Among other applications, this work is relevant to the surveillance of Canada's coastal waters (the 200-mile economic zone). The use of radar offers several advantages over alternative methods, such as optical imaging, for this application; these include the ability to "see" at night or through cloud or fog. The microwave remote sensing program is carried out by DOC in support of other government departments.

Military Communications Technology: Non-Satellite
G.W. Irvine 596-9357
J.L. Lyrette 596-0727

On-going research to help Canadian Armed Forces solve problems in terrestrial communications technology, including fields of propagation, display and antennas. Major efforts are being devoted to communications systems for ships.

Military Satellite Communications Technology
Dr. A.R. Molozzi 996-9403
L.A. Maynard 596-9348

DOC provides technical support and advice to the Department of National Defence on advanced satellite communications. This includes feasibility studies for future facilities, help in specifying and developing ground stations, systems studies for patrol frigate communications, development work on a small portable terminal for use with NATO satellites and a project to study satellite communications for Canada's new fighter aircraft.

Mobile Radio Data Systems
E.A. Walker 596-9526
R. Hutchison 596-9666

Project to foster development of mobile radio data systems for manufacture by Canadian suppliers. Pilot system for Vancouver Police Department was upgraded to become the first operational mobile data terminal for Canadian police forces. Program produced an advanced mobile radio data terminal for police and other users plus a simple terminal for transportation industry and a communications controller to manipulate data flows to and from all terminals and from all terminals and data bases. A new company, International Mobile Data Incorporated, was formed to manufacture and market the product line.

Mobile Radio Telephony
Dr. R. Kaye 596-9341
E.A. Walker 596-9526

Project to evaluate various options for future development of general mobile service and radio telephony integrated with the national telephone system. Particular attention focussed on national use of newly allocated 800 MHz band and development of related equipment by Canadian industry.

Mobile Satellite Communications Studies
Dr. R.W. Breithaupt 995-7783
L.A. Maynard 596-9348

Technical studies of satellite communications for ships and aircraft and technical support for Canadian participation in INMARSAT, AEROSAT, and GPS/NAVSTAR. (See individual headings for more detail.)

Multiple Purpose UHF Satellite (MUSAT)
Dr. R.W. Breithaupt 995-7783
Dr. M. Palfreyman 596-9410

MUSAT is a proposed domestic UHF satellite communications system designed to meet government mobile and data-readout needs. It would be used for government users such as ships, aircraft, environmental monitoring platforms, field parties and others requiring narrow-band communications services. Activities include interpretation of user needs, preparation of system specifications and definition of the communications control station. Transponder studies and demonstrations are underway along with development and production of a portable low-cost earth terminal.

NAVSTAR/Global Positioning System (GPS) Studies
Dr. A.R. Molozzi 996-9403
L.A. Maynard 596-9348

Research and technical support for Department of National Defence's participation in USAF/SAMSO Global Positioning System (GPS/NAVSTAR). DOC participation involves: consultation with the Department of National Defence in industrial development of user equipment, research into possible errors due to propagation effects, research to improve performance of aircraft antennas; simulation and development of inertial strapdown system integrated with the GPS receiver.

New Home and Business Telecommunications Services: Pilot Study to Forecast Canadian Demand, 1980 to 1990
M. Estabrooks 995-8181

Designed to explore and recommend appropriate methodologies to DOC for forecasting demand. It surveys scope of new service possibilities and reviews activities and experiences in other countries with new services. Methodologies of a field trial and non-field trial are reviewed and recommendations to DOC on specific services and methodologies are presented. Roger W. Hough and Associates Ltd., Ottawa; Communications Studies and Planning Ltd., London, England.

Orbit/Attitude Determination Techniques
Dr. A.R. Molozzi 996-9403
S.P. Altman 596-9281

Program develops orbit determination and prediction software necessary to support planning and implementation of Canadian satellite programs, studies satellite re-entry problems, and supports Canadian participation in the United Nations Committee on Peaceful Uses of Outer Space. University and industry contractors participate.

"Other Voices in Broadcasting; The Evolution of New Forms of Local Programming in Canada"
David Gillick 996-5722
Gilles Desjardins 995-9936

Study of new forms of local programming developed over the past ten years in radio, cable TV and television. Study had three main objectives: produce a set of statements about the nature of new local programming activities, describe functions of groups and individuals in these activities, and make recommendations for strengthening and developing the programming.

Ownership in the Broadcasting Industry
Gilles Desjardins 995-9936

Study supported by DOC grant, carried out by professors MacFadyen, Hoskins and Gillen of University of Alberta, covering economics of radio, television and cable industries of Canada, current ownership patterns, profitability and diversity of programs offered. Particular concerns were control over program content and effect of this control on strictly economic issues providing useful background data for current debate on corporate structure of the Canadian broadcasting industry. To be co-published by DOC and the Institute for Research and Public Policy.

Productivity, Employment and Technical Change in Canadian Telecommunications: The Case for Bell Canada
S. Serafini 995-8181

Major current concern is impact of information technology on productivity and employment. Study measures total factor productivity growth for Bell Canada from 1952-1976 within framework of economic model of the firm's technology. Effects on employment from introduction of direct distance dialling and conversion to modern switching facilities were analyzed, showing substantial reductions in employment opportunities for operators. Michael Denny et al., Institute for Policy Analysis, Toronto, March 1979.

Profitability and Value of Licences in Radio, Television and Cable TV
S. Serafini 995-8181

Econometric investigation of determinants of profitability and resulting market value of a radio or TV broadcasting station or CATV system. First phase of longterm research to examine value of electromagnetic spectrum in competing uses. Methodology developed may be used with suitable additional data to examine various regulatory and policy questions. S. Perakis and J. Silva-Echenique, University of Ottawa, June 1979.

Propagation Studies for Broadcasting and Mobile Services
Dr. K.S. McCormick 596-9395
Dr. F.H. Palmer 596-9462

Entails development of computer-based propagation models and topographic data bases for more accurate prediction of potential coverage and mutual interference in the VHF and UHF broadcasting and land mobile bands. Has included arctic propagation studies and co-operative work with the U.S. Federal Communications Commission to measure and assess anomalous long-range propagation in these bands in the Great Lakes and West Coast border areas. The latter studies are being extended to include the East Coast. Results should enable more effective channel assignment in these areas. A program to measure radio wave amplitude statistics in urban areas is being extended to include study of the multipath statistics of both urban and non-urban areas. Data is used to improve and extend the prediction program. Assistance and advice is provided to the Department of National Defence and other clients upon request.

Radar Research
Mr. D.J. Mabey 596-9618

The CRC Radar Laboratory carries out a program of research on new radar techniques, including the application to radar of new advances in electronics generally. Two of these developments are particularly significant: the electronically scanned antenna, which enables the radar to adapt its parameters to meet differing target and background conditions; and the digital integrated circuit, which makes complex signal and data processing economically feasible. An experimental adaptive radar system incorporating an electronically scanned antenna and digital processing has been built at CRC, and is undergoing further development. The system is being used in experimental investigations of adaptive antenna control. The program includes theoretical studies and computer simulations of advanced processing techniques, such as the automation of target detection and tracking which it is planned to incorporate in the radar for future experimental study. This program is carried out under Department of National Defence sponsorship and support.

Radar Technology
Dr. D.F. Page 596-9412
Mr. D.J. Mabey 596-9618

This program covers a number of analytical and experimental investigations in radar technology, carried out for and specified by the Department of National Defence. Individual tasks include investigating problems in operational radars; providing technical advice and assistance in the specification, selection, procurement, and evaluation of new radar equipment; carrying out theoretical and experimental studies to determine the feasibility of meeting new operational requirements; and investigating new technical approaches to old problems. The work covers the traditional applications of military radar: airborne, shipborne, and ground-based. Some work has also been done on the performance and problems of radar in space.

Radio Noise Studies
Dr. J.S. Belrose 596-9362
Mr. W.R. Lauber 596-9438

The objective is to develop technology for and carry out measurements of meaningful noise parameters to help predict performance of communications systems in the 0.5 MHz and 1 GHz and above region. Growing levels of man-made radio noise degrade system performance and limit efficient spectrum usage. Results of CRC work could help set noise radiation limits, develop better design and performance specifications and aid in surveys of potential radio communication sites. This year work was carried out on high voltage DC transmission line noise and noise affecting landing and other aeronautical communications. Project 15102.

Regulatory Experience in the U.S. and Public Policy Implications: Recent Trends in the Theory and Practice
S. Berger 996-3058

Report analyzes technical aspects of U.S. experience resulting from introduction of competition in telecommunications in recent years. While recognizing differences between the U.S. and Canadian institutional and economic environments, the analysis is a first step towards determining the extent and manner in which this experience might be relevant to Canada. G. Leblanc, Laval University, Quebec, March 1979.

Re-radiation Problems in AM Broadcasting
Dr. J.S. Belrose 596-9362

Project aimed at evaluating magnitude of, and developing the means of reducing, re-radiation from highrise buildings, power lines and other structures in the vicinity of AM broadcast directional antenna arrays. Re-radiation distorts the radiation pattern of the arrays and can lead to serious interference problems. Analytical studies are being carried out in parallel with simulations on an antenna model range to make it possible to predict pattern distortion effects. The next phase will involve investigating ways to reduce or eliminate re-radiation. Project is in response to representations from the Canadian Association of Broadcasters. A working group including industry and government representatives has been set up to co-ordinate activity. Project 15010.

Role of Information Labour in Total Canadian Manufacturing: 1948-1973
S. Serafini 995-8181

Research addresses issues associated with the rise of the information economy, namely, relevance of National Accounts which separate and aggregate information activities for policy and economic analysis; productivity of information work; and differential employment impact on information and non-information workers. Data supplied as Canadian contribution to work of OECD Expert Group on Economic Analysis of Information Activities and the Role of Electronic/Telecommunications Technologies. G. Warskett, Ottawa, December 1978.

Rural Telephone Systems
Dr. Y.F. Lum 996-8871
K. Richardson 593-6460

Project to establish technological and economic feasibility of improvements in narrowband telephony in rural areas. DOC is providing telephone companies and other Canadian firms with consulting and economic assistance for exploratory development, fabrication and field trials of low-density digital subscriber carrier, rural party line privacy equipment and new energy sources for rural and remote sites.

SARSAT
Dr. A.R. Molozzi 996-9403
L.A. Maynard 596-9348

Canada-U.S.-France-USSR program to demonstrate experimental search and rescue satellite system by 1981. The program will use transponder packages designed and built in Canada and placed on U.S. polar-orbiting weather satellites. The system is intended to reduce time needed to locate survivors of air crashes and other disasters, providing quick alarm alerts and position fixes when aircraft or other emergency locator transmitters (ELTs) go off. Technical management and support to the Department of National Defence is supplied by DOC. A SARSAT ground station will also be developed in Canada.

Satellite and Antenna Control and Pointing
Dr. A.R. Molozzi 996-9403
S.P. Altman 596-9281

Work on dynamics and control system technology required for commercial communications satellites of the 1980s and other future Canadian spacecraft. Objectives include establishment of a viable Canadian supplier of such systems for domestic and export markets. "Strapdown" technology for guidance and control is involved. Basic sensors are rigidly attached to vehicle mainframes and onboard systems compute functions now performed electromechanically in gimballed systems.

Satellite and Antenna Structures Development
Dr. A.R. Molozzi 996-9403
S.P. Altman 596-9281

Project seeking to maintain familiarity in Canada with and industrial capability for design and supply of critical mechanical systems and structures for future communications spacecraft, including sponsorship of industry and university activities, checking of designs, analytical models, technologies and models. Current activities include development of solar array structures, thermal control components and evaluation of new composite materials.

Satellite Control Station Operations
Dr. R.W. Breithaupt 995-7783
N.G. Davies 596-9215

On-going monitoring, control and maintenance of orbiting Canadian government satellites, carried out from Satellite Ground Control at CRC, including scheduling of operations, and provision of data. Hermes and the ISIS program spacecraft are involved.

Secretariat of the Interdepartmental Committee on Space (ICS)
J.R. Marchand 593-5590

Reporting to the Minister of Communications, the Committee promotes liaison and co-ordination between government departments and agencies involved in space-related activities, works to promote orderly growth of a healthy Canadian space industry, liaises with foreign space agencies, coordinates studies, and publishes reports. Established and maintained by DOC.

SHF Spacecraft Technology
Dr. A.R. Molozzi 996-9403
Dr. M. Palfreyman 596-9410

SHF satellite systems can provide cost-effective satellite communications services. On-going project to develop components and solid-state devices for SHF subsystems and support Canadian industry through consultation and technology transfer. With Canadian industry already competitive in 14/12 GHz technology, further development is planned in frequencies up to 40 GHz. Current work includes RF circuitry and antenna feed network studies for broadcast satellite systems.

Shuttle Remote Manipulator System (SRMS)
Dr. A.R. Molozzi 996-9403
S.P. Altman 596-9281

Under agreement between the National Research Council and the U.S. National Aeronautics and Space Administration (NASA), a Canadian industrial team is developing the Shuttle Remote Manipulator System for the NASA space transportation system (space shuttle), used to place spacecraft in orbit and retrieve payloads. DOC provides technical assistance and facilities for environmental testing of components at the David Florida Laboratory

Signal Environment Studies
Dr. J.S. Belrose 596-9362
Dr. Jules LeBel 596-9695

Project complementing the radio noise studies aimed at measuring and categorizing emissions arising from deliberate, intelligent transmissions and from natural phenomena (lightning, galactic noise). The ability to measure both noise and signal environments will provide data to resolve electromagnetic interference problems, better manage the radio spectrum and test consumer electronics for electromagnetic immunity. The CRC has been developing an automatic 0.5 MHz to 1,000 MHz system for measuring features of the radio signal environment. When complete, a program of measurements in urban and suburban areas will begin. Needs for monitoring capabilities above 1 GHz will also be identified and developed. Project 15001.

Small SHF Earth Terminals
Dr. A.R. Molozzi 996-9403
Dr. M. Palfreyman 596-9410

Studies aimed at requirements for domestic space communications and technology transfer to industry. Current work includes investigation of hardware and trade-offs associated with cable, direct-to-home TV, radio and telephony applications of medium power (Anik B,C) and high power (DBS) satellites. Work has concentrated on 14/12 GHz applications but is being extended to include feasibility studies of components for future 20/30 GHz systems. Consultation and support to Canadian industry is provided through initiation and management of development contracts.

Space Industry development
Dr. A.R. Molozzi 996-9403

Development of a Canadian prime contractor for communications satellites is esential to capturing a greater share of the domestic and export markets for satellites. In 1978/79, the government approved a program to upgrade integration and test facilities at the David Florida Laboratory and encourage Telesat Canada to place the prime contract for the Anik D satellites with Spar Aerospace Ltd. During the Anik C-3 and Anik D procurements, DOC will provide technical support to the prime contractor in specialized areas such as reliability analysis and testing. In co-operation with the Department of Industry, Trade and Commerce and other departments, DOC is making special efforts to identify international opportunities and offer international marketing support for Canadian industries.

Spacecraft Charging Studies
Dr. A.R. Molozzi 996-9403
Dr. M. Palfreyman 596-9410

Project is aimed at understanding physical phenomena involved in failures of orbiting communications satellites due to spacecraft charging with high negative voltages. Work covers studies of charging effects on components and on communications performance. Engineering guidelines and spacecraft test specifications will be devised to minimize these effects. A transient event counter (TEC) will be developed to collect in-flight data.

Spacecraft Power Systems Technology
Dr. A.R. Molozzi 996-9403
Dr. M. Palfreyman 596-9410

Project aimed at developing Canadian industry capability for building the power subsystems needed on future, long life communications satellites, particularly long life battery cells. Project to employ studies in Canadian industry to develop new electronic battery management systems and conduct longterm tests. High-efficiency power conditioning units are under development.

Space Industrial Contracts Program
Dr. A.R. Molozzi 996-9403

Program involves an industrial contract fund intended to foster strong, independent capability in design, development and construction of future Canadian satellites, earth stations and components to supply domestic and export markets. Concentrating on development of systems, subsystems and components and emphasizing technology transfer while maintaining close liaison with Interdepartmental Committee on Space, Department of Industry, Trade and Commerce and other departments.

Spectrum Systems Research
Dr. R. Kaye 596-9341
E.A. Walker 596-9526

Systems analysis of policy options for the radio spectrum as a basis for DOC policy formulation. For example, a land mobile inventory study will provide the basis for assessing economic impact of proposed changes in spectrum management for mobile applications.

Subscriber Loop Facilities in the Telecommunications Industry, a Capital Budget-Optimization Model
S. Berger 996-3058

Model incorporates forecasting algorithms and translates demand into terms of planning units for extending existing or constructing new subscriber plant on a practical optimum basis, taking into account emerging new technologies and timing and size of investments. J.S. Sprague, University of Alberta, March 1979.

Support for Spectrum Management
Dr. J.S. Belrose 596-9362
Dr. T.N.R. Coyne 596-9288

Development of a sophisticated, computerized spectrum management system (SMS) to control licensing of land-mobile bands, including ability to monitor usage (by channel) of land-mobile bands and provide data required to allow acceptable sharing of channels and optimal usage. Work to date has involved development of monitoring strategies and analysis software, monitoring in the Montreal district where the SMS system will be tested, investigation of improved parameters for the quantitative description of channel usage, capacity and quality of service. DOC spectrum managers will have CRC help in determining equipment requirements for an effective nationwide monitoring capability. Project 15009.

SURSAT Experiments
Dr. A.R. Molozzi 996-9403
L.A. Maynard 596-9348

DOC is providing support to the Canada Centre for Remote Sensing (CCRS) in the planning of a surveillance satellite project, to carry out a variety of environmental surface detection, scientific research and territorial surveillance experiments. A DOC scientist is attached to CCRS as project leader.

Symphonie Communications Experiments
Dr. R.W. Breithaupt 995-7783
L.A. Maynard 596-9348

Program of experimental, cultural and technical exchanges between Canadian experimenters and similar groups in France and Germany, using Symphonie, the experimental Franco-German satellite. Proposed experiments are evaluated and recommended by a joint DOC, External Affairs and Teleglobe Canada working group. DOC and Teleglobe maintain earth terminals, co-ordinate use and advise users on interface problems.

Systems and Services Studies
Dr. R. Kaye 596-9341
Dr. G. Jull 995-0421

Studies to provide technological and cost information for systems and policy development by DOC for urban communications. The evolution of local distribution plant for carrying basic and future services to home and business is being assessed. Integrated plant (using optical fibre or coaxial cable), hybrid plant (using telephony/off-air broadcast) for various services plus future services including pay-TV, videotex and alarms are also being investigated.

TDMA Anik B Pilot Project
Dr. R.W. Breithaupt 995-7783
L.A. Maynard 596-9348

The time division multiple access (TDMA) project being developed with an industrial co-sponsor (CNCP Telecommunications) will use the Anik B satellite to demonstrate the feasibility of slim-route digital satellite communications. Current activities are concentrated on earth terminal development with field trials using the satellite to take place in 1980/81.

Television and Culture, Phase I and II
Jacques Langlois 996-5614
Gilles Desjardins 995-9936

Analysis of viewing patterns of English and French-speaking Canadians in terms of American versus Canadian programming and English versus French programming, patterns of interchangeability between types of programming. Then data was compared with Canadian demographic and geographical data. A key objective was to estimate potential for program exchanges between English and French Canadian broadcasters.

Terrestrial Microwave Propagation
Dr. K.S. McCormick 596-9395
Dr. R.L. Olsen 596-9697

Research activity to obtain propagation data needed for planning and designing terrestrial radio relay systems and for spectrum management. Includes a major effort, scheduled for completion in 1979, to present the precipitation climatology of Canada in the form of rain rate and attenuation atlases. Also a continuing effort to develop and refine models for use in microwave propagation predictions. Experimental work includes in-house studies of the limitations imposed on dual-polarized 7,11, and 18 GHz systems by precipitation and multipath transmission. DOC policy-making on 15 GHz CATV relay systems is being aided by a program of monitoring TV transmissions over a 33 km path. Co-operative experimental studies being undertaken with the Maritime Telegraph and Telephone Co. to determine the performance of 8 GHz digital radio across the Bay of Fundy. Another co-operative program with the British Columbia Telephone Co. and the University of British Columbia will provide propagation data between 4 and 11 GHz for several operating links in British Columbia. Fundamental work on rain and multipath effects being supported at Carleton University and the universities of Western Ontario and British Columbia.

Vertical Integration and Cross-Subsidy in the Canadian Telecommunications Industry
S.Berger 996-3058

Report provides operational framework for measuring cross-subsidy in a vertically integrated industry, describes institutional and industrial structure of Canadian telecommunications sector and examines issues such as product specialization, R&D expenditures, technological innovation and possible forms that relationships may take between a common carrier and its vertically integrated supplier. M.C. Autin, Laval University, Quebec, March 1979.

Research and Space Sector Expenditures 1978/79

Total departmental expenditures	**$101 151 772**
Space sector expenditures % of total expenditures	35 168 249 35%
Research sector expenditures % of total expenditures	9,895,538 10%
Total research and space sectors % of total departmental expenditures	45,063,787 45%
Contracts	
Space sector contracts % contracted	27,045,000 77%
Research sector expenditures % contracted	4,518,000 46%
Total research and space contracts % of research and space expenditures contracted	31,563,000 73%

Proposed Research and Space Sector Budgets 1979/80

Proposed departmental budget	**$103,199,578**
Proposed space sector budget % of total budget	36,458,578 35%
Proposed research sector budget % of total budget	12,277,000 12%
Total space and research sectors % of total budget	48,735,578 47%
Contracts	
Estimated space sector contracts % contracted	30,443,600 84%
Estimated research sector contracts % contracted	6,553,000 53%
Total estimated space and research contracts % of research and space budgets contracted	36,996,600 76%

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