

The resulting commercial spin-offs are the best way of turning to account the investments all Canadian taxpayers have made so far. This is why this government believes the time has come for the Canadian communications industry to take the lead in exploiting and marketing MSAT technologies.

Telesat Canada has already assumed a leadership role. They recognize that MSAT is a good business deal, one that can bring two advantages to Canada: large-scale economic opportunities and the best communications systems in the world. Now is the time for manufacturers, service providers and investors to seize these opportunities. □

## **DOC: Providing breakthroughs in MSAT technology**

To ensure that Canada's mobile ground and space technology stays a step ahead of the technical requirements of the rapidly developing MSAT system, a mobile satellite technology research program is in high gear at DOC's Communications Research Centre (CRC), just outside of Ottawa, Ontario.

The Program Office, part of DOC's Technology and Industry Sector, has been the principal driving force for MSAT technical requirements. Joe McNally, Project Manager for the MSAT program, explains that the Program Office's responsibility is to support Telesat to ensure that the MSAT system is technically viable, that it will meet Canadian requirements, and that Canadian industry will be ready to provide equipment for use with the MSAT system when required.

To meet this objective, the Program Office must identify and assess the proposed MSAT system's specific needs, the essential "nuts and bolts" — spacecraft components, receivers, antennas, etc. This, says McNally, presents the program with two options — to contract out the development of prototypes to industry, or, in the case of high-risk items, to pursue some parallel research and development in-house. Both options are now being employed. Behind the contracting-out activity is the goal of helping the space and ground segment of Canada's industrial sector

become competitive in supplying MSAT equipment in Canada and in the United States. Behind the in-house research and development (R&D) activity is the goal of ensuring in a few key areas that basic technological development is ready for industry to draw upon when conditions are appropriate for commercial exploitation.

The MSAT program's in-house applied research and development work is carried out by a team identified as the MSAT Technology R&D Office in the Space Technology and Applications Branch of the department's Research Sector. In fact, explains Bob Huck, Manager of Mobile Systems, his team undertakes in-house R&D and manages contracted-out research and development work necessary for the MSAT program. This issue of *MSAT News* focuses on some of the most recent internal work.

It has been a highly productive year for MSAT in the Space Technology and Applications Branch. Researchers worked on 18 separate topics that have produced results of considerable interest to potential equipment manufacturers, carriers and users of the MSAT system. These include new findings related to propagation studies, antennas and radios specifically designed to meet MSAT requirements, and the development of a unique and comprehensive satellite communications simulator for testing prototypes of satellite and terminal equipment.

### **Propagation work**

The MSAT Technology R&D Office carries out radio signal propagation work to ensure that MSAT technology will be designed to combine efficient operation with the lowest possible cost. Propagation studies are fundamental to these goals because they provide the designers with a thorough understanding of the environment in which radio signals generated in the MSAT system will be transmitted and received. Over the past year, the office has continued its world-class research to evaluate and characterize the propagation effects encountered with satellite mobile communications links in both the 800 MHz UHF band and in the L-Band (1.5/1.5 GHz).



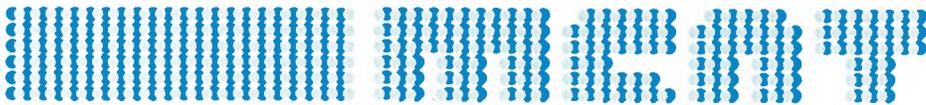
*CRC researcher John Butterworth is working with the mobile satellite communications link simulator.*

Using data both from actual satellite transmissions and from simulated satellite transmissions from helicopter-borne platforms, researchers such as John Butterworth, a Senior Communications Engineer at CRC, have studied signal strength variations in the fading and shadowing environment; correlation bandwidths that provide an upper limit on data transmission rates; phase perturbations affecting the transmission of digital signals; and polarization discrimination, important in view of the potential increase in spectrum efficiency made possible by use of two polarizations. Taken together, this work has received much international interest due to the planned satellite application of the two mobile bands.

### **Antennas**

The MSAT system will require two main types of land mobile vehicle antennas. Areas in which the transmission environment presents little or no interference will require only a low-gain, low-priced model that needs no pointing or other control mechanisms. High-interference and northern environments will require a directional model offering automatic, microprocessor-controlled tracking to maintain the beam pointing to the satellite as users move from one location to another.

In the past two years, DOC researchers have been developing prototypes of both versions at both the 800 MHz and L-Band frequencies. Concentrating first on the single-element, omnidirectional versions, the researchers



*A phased-array antenna is car-mounted for use in 800 MHz band.*

tested and subsequently used these inexpensive antennas in their own in-house experiments. They then began working on tracking antennas, testing out a variety of approaches to keep the antenna beam in line with the satellite.

One of the major accomplishments was researcher Robert Milne's development of an electronically steered phased-array antenna. By controlling the combination of signals to or from the various elements of the antenna, Milne achieved a high-performance antenna that can keep its beam pointed to the satellite. A beam-scanning circuit was devised by Stu Hitchcock.

Each of these antennas proved highly satisfactory when tested on signals generated from a helicopter at 800 MHz. Non-exclusive licence opportunities to produce the antennas commercially should be available soon to any private company through Canadian Patents and Development Limited (CPDL).

#### **Microprocessor-based mobile radios**

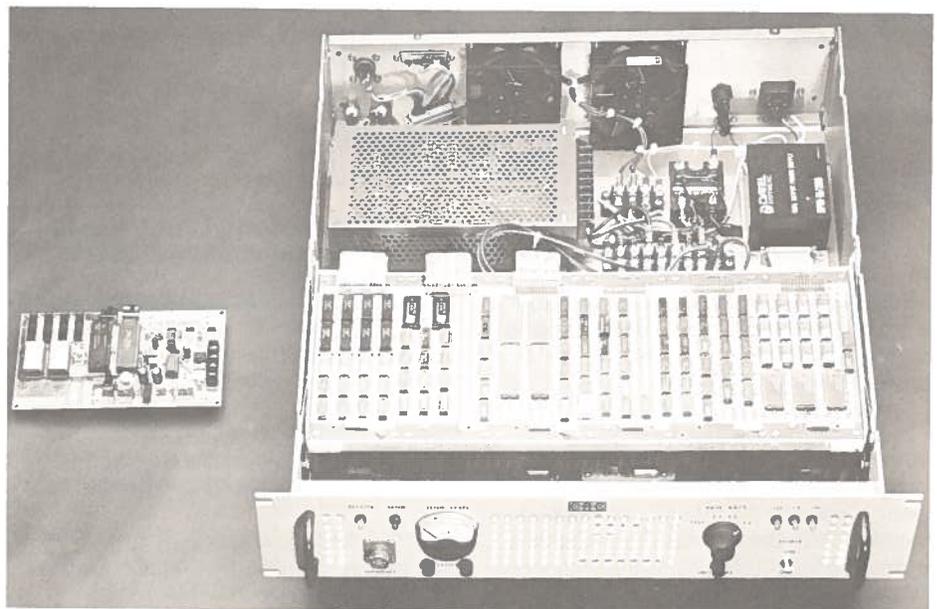
The first MSAT satellite services will utilize radios offering two types of voice modulation. Customers desiring the voice quality normally associated with telephone transmission will probably use radios with Amplitude Companded Single

Sideband (ACSSB) modulation, while those who prefer the more private, but slightly more synthetic sound of digital speech may choose radios using Linear Predictive Coding (LPC).

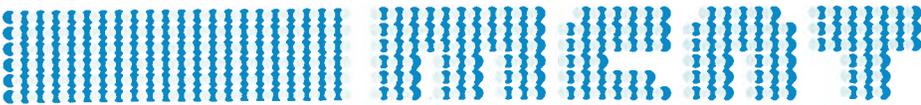
The Space Technology Branch undertook development programs on each type of voice coding and modulation with the objective of determining, by September 1985, the user acceptability of the radios' quality for

the service intended. A second objective is to develop, by March 1986, a functional prototype of each of the MSAT radios. This would enable a thorough test of the feasibility of using the planned 5 kHz channel spacing and also an evaluation of each radio's performance in environments of interference.

Researchers at the branch have achieved impressive economies of bandwidth and size, as well as improved performance, by using sophisticated signal-processing techniques and the newest microprocessor technology in the development of both prototypes. In the case of the LPC radio, for example, Brian Bryden and his staff have reduced the complex circuitry of an LPC voice processor, recently selling for up to \$20,000, to a prototype using between eight and 11 microchips on an 6" x 4" model costing approximately \$600. The companion modulation equipment (DMSK Modem), developed by the Space Technology Branch for this digital prototype, uses almost the same microprocessor board as is used in the LPC voice processor, potentially lowering manufacturers' costs still further. Non-exclusive licensing rights for the prototype LPC have already been transferred by CPDL to industry. Branch researchers are now working on incorporating all the functional components of a complete digital radio, including the voice



*Shown on the right is a digital voice encoder/decoder (PELPC circa 1982) and on the left is a new generation microprocessor-based encoder/decoder.*



processor and the companion modulation equipment, into a single transceiver that will form a completely functional prototype MSAT radio.

Dr. John Lodge has followed a parallel development program for the analogue radio, adapting ACSSB techniques originally developed by Dr. Bruce Lusignan at Stanford University in the United States, and more recently by Dr. Joseph McGeehan of Bath University in the United Kingdom. Using microprocessor technology in the two types of radios ensures that manufacturers will be able to produce both without having to acquire two sets of production equipment. The differences between the two radios will exist primarily in their software; that is, in the microprocessor instructions with which they are programmed. It will then be relatively simple to implement subsequent changes to their programs.

The staff is now completing software development for the prototype ACSSB radio, and is expecting to carry out voice-quality testing during August and September. A completely functional prototype radio should be available by the end of March 1986. As with the other developments, licensing opportunities will be available through CPDL.

#### **Satellite communications simulator**

Optimum design of a satellite system, particularly one as unique as the proposed MSAT system, requires a variety of test facilities. The Space Technology and Applications Branch has a number of simulation facilities, including computers that handle software simulations. However, branch researchers found they needed a specialized facility for testing such new MSAT communications hardware as ground-terminal and space-transponder equipment. This meant designing a satellite communications simulator, with significant contributions from Canadian industry.

In operation for the past six months, the equipment can simulate an 800 MHz UHF satellite system as conceptualized for MSAT, as well as a system for the L-Band, such as the INMARSAT system. In addition, using components built to CRC specifications by Miller Communications of

Ottawa, Ontario, it can simulate a large variety of signal propagation environments. A key component of the satellite communications simulator is the signal propagation equipment. This allows the researchers, through the use of measurements made during travel on specific roads, to reproduce in the lab actual propagation characteristics, such as multipath or shadowing effects caused by nearby trees or obstacles encountered on a particular section of road.

The \$500,000 satellite communications simulator is being used extensively to test all mobile terminal equipment under development and a portion of the transponder developed by Spar Aerospace, including the high-power UHF amplifier.

#### **Current projects**

Work in progress today also includes a number of smaller projects related to hardware development and systems studies. For example, researchers are now developing space-diversity antenna systems and phase-noise simulators to be tied in with the satellite communications simulator.

Looking ahead, Mobile Systems Manager Bob Huck says that future branch projects will focus on "examining new approaches to implementing radio systems, and continuing to study mobile satellite communications characteristics in order to optimize ground terminal and system design." This research, he adds, "will ensure that the technological groundwork for the MSAT program will be well advanced by the time MSAT implementation begins." □

#### **MSAT discussed at first Mobile Radio Communications Users Conference**

In addition to remarks made by Communications Minister Marcel Masse at the First Canadian Mobile Radio Communications Users Conference held in Ottawa May 12 to 14, eight of the conference's 38 sessions dealt directly with MSAT service.

Mr. Masse, who gave a dinner address at the opening of the conference, stressed that the initial

services offered by MSAT would be commercial ventures led by the private sector, and that these services represent an excellent business opportunity for the Canadian communications sector. He also noted that the government would soon be disclosing the policy and regulatory framework within which the MSAT system will develop.

In sessions dealing with the theme "Mobile Communications: More Than Spoken Words," DOC representative Demetre Athanassiadis, Manager of the Post Launch Communications Program and Policy for MSAT, described MSAT data applications; and Dr. John Belrose, Director of Radio Communications at CRC, described how CRC researchers are meeting "The Narrow Band/Digital Challenge."

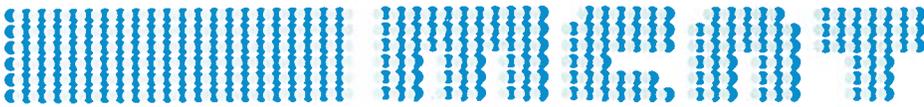
Conference organizers set aside one afternoon for the theme "Mobile Satellite: How to Stay in Touch in Rural Canada." Speakers representing the RCMP, the Canadian Petroleum Association, Thompson Transport Ltd. and Telesat Canada conducted sessions on MSAT's use in rural public safety, exploration and resources, trucking transportation, and in a national communications system. During the final session of the afternoon, speakers from the American firms Omninet Corporation, Skylink, Mobile Satellite Corporation, Geostar Corporation and Hughes Communications discussed their own plans for a mobile satellite system in the United States.

The conference's final theme, "Vision for the Future — The Road from Potential to Actual World Leadership" also included a session devoted to MSAT. Telesat's Dr. Mike Zuliani dealt with the world potential for mobile satellite services.

Most of the other conference sessions dealt with the new cellular radio services.

Over 100 delegates from Canada and the United States attended the conference, which was sponsored by Bell Cellular, the Canadian Radio Common Carriers Association, Cantel Inc., and KVA Communications and Electronics Co.

Conference organizer Michael Kedar, principal business partner and project manager with KVA Communications and Electronics of Toronto,



says he was pleased with the first conference and hopes it might be the first step toward the creation of a Canadian Mobile Radio Users Association "that could provide an ongoing focal point for promoting Canadian mobile radio user interests." Such an organization, he feels, would be welcomed by manufacturing and service providers as well as government policy-makers, who would "undoubtedly find it much easier to deal with one entity, representing the interests of all Canadian mobile radio user groups." □

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### **FCC receives large number of United States mobile service proposals**

The United States Federal Communications Commission (FCC) has received 12 applications in response to its January 1985 "Notice of Proposed Rulemaking" (NPRM) for licensing an American mobile satellite system.

The 12 applications are: Skylink; Mobilsat; McCaw Space Technologies, Inc.; MCCA American Satellite Service Corporation; Mobile-Satellite Services Inc.; Satellite Mobile Telephone Co.; Omninet; Global Land Mobile Satellite, Inc.; Globesat Express; Hughes Communications Mobile-Satellite Services, Inc.; W&B/TCI; and North American Mobile Satellite Inc.

The FCC has accepted these applications for filing, with a July 15, 1985 deadline for filing comments or petitions on these applications. □

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### **Telesat proposes co-operative arrangements for Canada-United States mobile satellite system**

On February 18, 1985, Telesat Canada issued proposals for co-operation between Telesat and the American companies intending to apply to the FCC for a licence to provide commercial land mobile communications services via satellite.

Telesat proposes that once Telesat and the successful American licensee finalize respective domestic arrangements, the two service providers prepare a co-operative business

agreement and begin common or co-ordinated satellite procurement activities. Either Telesat or the American firm would then launch the first operational MSAT spacecraft by about 1990. The satellite would serve both countries, with the company that did not own the satellite temporarily leasing service from the other until its own spacecraft is launched, within a year's time.

Dr. Mike Zuliani, Telesat's Director of Satellite Service Planning, says that Telesat's proposals are "preliminary; we are prepared to be flexible in negotiating arrangements with any potential U.S. service provider." He points out that the proposals are designed to keep costs to both countries at a minimum during the critical start-up years.

The proposals encouraged United States applicants to assume co-operation with Telesat in their submissions to the FCC, and outlined in detail Telesat's co-operative approach, including descriptions of the MSAT system and its requirements.

Telesat believes that a joint development program between Telesat and the American licensee would enhance MSAT's early commercial success in both countries. □

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### **Documentation**

Contact:  
Information Services  
Department of Communications  
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### **Conferences**

"Implementation of a Full Duplex 2.4 Kbps LPC Vocoder on a Single TMS-320 Microprocessor Chip" by Brian Bryden and Hisham Hassanein, to be presented at the Institute of Electrical and Electronics Engineers (IEEE) International Conference on Acoustics, Speech and Signal Processing, San Diego, California, March 1984.

"A Statistical Model for a Land Mobile Satellite Link" by C. Loo, to be presented at the International Conference on Communications, Amsterdam, The Netherlands, May 1984.

"MSAT — Plan for Implementation of Mobile Satellite Services in Canada" by Demetre Athanassiadis and P.M. Boudreau, Department of Communications; Institute of Electrical Engineers (IEE) Colloquium on Satellite Communications for the Mobile User, London, England, April 1985.

"Implementation of a Hybrid Pitch-Excited/Multipulse Vocoder for Cost-Effective Mobile Communications" by Brian Bryden and Hisham Hassanein, to be presented at Speech Technology 1985, New York, N.Y., April 1985.

"Antennas for a Mobile Communications Satellite" by L.A. Wegrowicz, Spar Aerospace Limited, to be presented at the 1985 International Symposium on Antennas and EM Theory, Peking, China, August 1985.

"The Canadian Mobile Satellite Service and its Socio-Economic Assessment" by P.M. Boudreau and John Braden, Department of Communications, to be presented at the 36th International Astronautical Congress, Stockholm, Sweden, October 1985.

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### **Speeches and News Releases**

"Interim Space Plan Announced," News Release, March 20, 1985. Outlines the Canadian Space Program for fiscal year 1985-86.

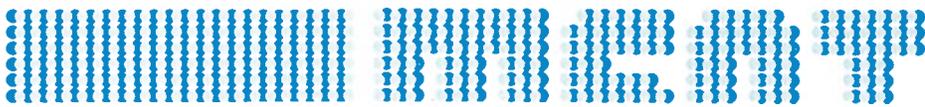
"MSAT — An Opportunity for Canada," News Release, March 20, 1985. Background information supporting Space Plan announcement.

"Mobile Communications," notes for a speech by Communications Minister Marcel Masse to the First Canadian Mobile Communications Users Conference, Ottawa, May 13, 1985.

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### **Program documents**

"Discussion Paper on the Industrial Strategy for the MSAT Ground Segment," MSAT Program Office, March 1985.



"MSAT Phase B Contract Study Reports, July 1982 - March 1985." List available from MSAT Program Office and any regional office of the Department of Communications.

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### Magazine articles

"Dialing for Distance," *Business North*, Yellowknife, N.W.T., March 1985.

"Mobiles: The inviolable Market," *Space Markets*, Geneva, Switzerland, May 1985.

"The Canadian MSAT Program," *Aerospace America*, New York, N.Y., June 1985.

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### Research papers

"Propagation Measurements for Land-Mobile Satellite Services in the 800 MHz Band" by John Butterworth, Communications Research Centre, CRC Technical Note No. 724, August 1984.

"Propagation Measurements for Land-Mobile Satellite Systems at 1542 MHz" by John Butterworth, CRC Technical Note No. 723, August 1984.

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### MSAT brochure

"MSAT — Reaching All Canadians," a new brochure describing the MSAT program. Available from Information Services or any regional office of the Department of Communications.

### Questions and answers

**Q** Early write-ups mentioned 1988 as the planned launch date of an MSAT satellite, whereas Telesat's Eldon Thompson, in *MSAT News No. 4*, refers to MSAT service by "the end of the decade." Has the launch date of the first MSAT satellite been postponed?

**A** No. There are several reasons for the different dates quoted. Initially, MSAT service was seen as a government-owned-and-operated demonstration system. As a result of its commercial viability study, Telesat decided to pursue commercial service right away. With the change to a privately owned system, the government ceased to have direct control of a planned launch date. In addition, as there are important economic benefits to be gained from a co-ordinated system with the United States, the Canadian government wants Telesat to negotiate cooperative development with American commercial firms. These negotiations can only be finalized when the U.S. Federal Communications Commission has selected the one commercial firm to which it will grant a licence to operate the first MSAT services in the United States.

**Q** If the Government of Canada is firmly committed to supporting the introduction of commercial MSAT services in Canada, why has it only approved MSAT funding to the end of the current fiscal year?

**A** The government's recent announcement of support for the introduction of commercial MSAT services in Canada was made in the context of an Interim Space Plan, in which only those decisions on the Canadian space program needed most urgently were made. Multi-year funding for MSAT beyond March 1986, and all other elements of the Canadian space plan will be considered by the government by the end of 1985. In the interim, all avenues of private sector support for the MSAT program will be explored by Telesat and by the Department of Communications.