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program and to the principles enunciated in the Joint Endeavour Agreement which was signed between the Government and Telesat in February 1987. This lease agreement can be used as collateral that will assist TMI to influence the amount of outside debt and equity financing and to conclude other business arrangements that will make MSAT a reality.

Mobile satellite communications comes to Ontario's Air Ambulance

by R.W. Huck

The Ontario Air Ambulance Service has recently become the world's first commercial user of aeronautical mobile satellite communications. On April 8, 1988, the Minister of Communications Flora MacDonald, the Ontario Minister of Culture and Communications Lily Munro, and on behalf of the Ontario Ministry of Health, Assistant Deputy Minister Dennis Psutka inaugurated a mobile satcom voice service. This service will provide a reliable voice link between a five passenger Cessna Citation I jet air ambulance and a ground telephone network.

Since 1976 the Government of Ontario has operated an air ambulance service from northern Ontario communities and, more recently, from remote accident sites to larger medical centres in the southern part of the province. The air ambulances were staffed by attendants trained to initiate and maintain basic life support procedures only. For the transfer of critically ill patients, a medical doctor was needed on board the aircraft to provide continuous patient care. This procedure resulted in northern communities often losing their medical services until such time as the doctor returned to the community.

In 1986, the Ontario Ministry of Health, following an assessment of the air ambulance service, decided to upgrade this service by training its attendants as paramedics who could provide more extensive life support services. The result of this decision was the need for a reliable communications link, during the flight, between the paramedics and the physician responsible for the patient.

Minister signs MSAT Communications Service Agreement



MSAT Communications Service Agreement signed. Seated from left to right Dr. R.W. Breithaupt, Department of Communications; Flora MacDonald, Minister of Communications; Mr. M. Bryan, Telesat; standing Mr. D.C. Buchanan, Department of Communications.

Historic landmark for MSAT

On September 14, 1988, Communications Minister Flora MacDonald signed a \$126.5 million agreement with Telesat Mobile Incorporated (TMI), a subsidiary of Telesat Canada, to lease capacity on the MSAT mobile communications satellite for government use over a ten-year period.

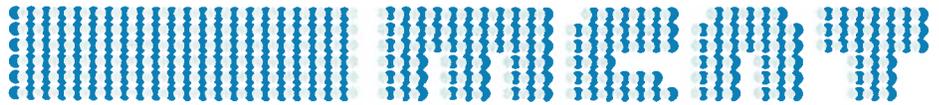
"This agreement is the next important step in an effort that began almost ten years ago in the Department of Communications," Miss MacDonald said. "This is in keeping with the proud tradition of Canadian firsts in satellite communications." Beginning in 1979 with the development of a new concept for mobile communications by the Department, the project has evolved into a commercial venture to be headed up by TMI.

The federal government will likely account for 10 percent of MSAT's business. The MSAT service will be used in such areas as coast guard service, law enforcement, emergency

medical services, fire fighting, disaster relief, resource management and pollution monitoring.

The \$126.5 million bulk leasing agreement is for the lease of capacity on MSAT for government use over a ten-year period. In keeping with the risk that the Government is sharing with TMI, the Government has secured a most favored rate from TMI for the use of their satellite. "It is one that will assure the Government of effective, efficient mobile communications at a very reasonable cost into the next century," Miss MacDonald said.

This leasing agreement is the final step in a government MSAT program support package worth \$176 million which includes various elements of technology and industry development support. Its importance for TMI, and for the future of MSAT, cannot be overstated. This contract is a firm indication of the Government's resolve, and of its commitment to the



Ontario Air Ambulance Cessna Citation I

In this way the physician, generally located in a southern hospital, could continuously monitor the patient's status and advise and authorize the paramedics to perform any necessary treatment.

In spite of the fact that the aircraft carries both VHF and HF radios, terrestrial radio coverage is not adequate to accommodate this requirement, particularly when flying in the more remote regions of Ontario north of 50° N latitude. When the Government of Ontario became aware of experiments and equipment development underway at the Communications Research Centre (CRC) for the MSAT program, it recognized a unique opportunity to evaluate a mobile satellite voice service that could meet all of their air ambulance communications requirements.

Subsequently, a co-operative experimental program was established between the CRC; the Ontario ministries of Health, Culture and Communications, and Government Services; Telesat; Teleglobe; and INMARSAT to test the feasibility of providing voice service to the Cessna Citation I aircraft shown in the photo.

The space segment

Currently the only agency operating a space segment capable of L-Band mobile communications is

INMARSAT, an international consortium of 55 nations that provides global coverage principally for maritime oceanic users. It leases a satellite, MARECS-B, located in geostationary orbit at 26° W longitude providing maritime oceanic communications services over the Atlantic Ocean by means of a global coverage beam.

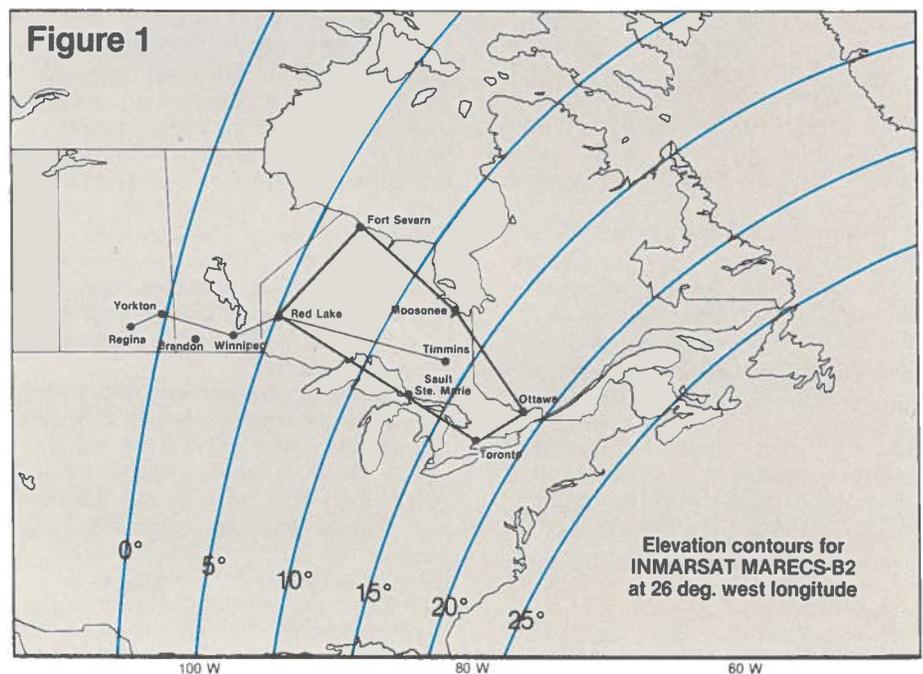
Luckily, this coverage from MARECS-B extends inland in Canada, as shown in the contour drawing of the elevation look angle, Figure 1. The CRC has taken advantage of this

coverage in the past during successful experiments conducted in eastern Canada. Even though the elevation look angles of this satellite from Ontario locations are significantly less than those expected to be provided by MSAT, CRC was able to successfully use the MARECS-B coverage when conducting the air ambulance experiment.

The agreement with INMARSAT allowed for a carrier power of 21 dBW, a power level less than one tenth the power level under consideration for MSAT. Satisfactory operation at this power level, however, may be achieved by use of a higher gain mobile antenna and by the fact that no margins need to be provided for shadowing as in land mobile service operations.

The link budget

Table 1 provides an approximate link budget for the experiment. For purposes of the air ambulance experiment, INMARSAT allowed the use of the MARECS-B search and rescue channel for the return link. This link has a higher transponder gain, with the subsequent benefit of lower power requirements for the aircraft radio transmitter. However, future operational use will necessitate entry into the current Marine Mobile Satellite Service band and require a linear power amplifier, with an average output power of 30 watts, in the aircraft.



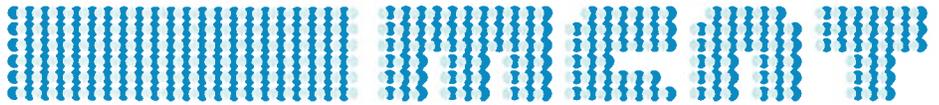


Table 1 Link budget

uplink	to aircraft	return
Frequency (MHz)	6423.9	1644.4
Transmit power (W)	6.0	9.5
Feed loss (dB)	1.0	3.8
Transmit gain (dB)	54.2	12.3
EIRP (dBW)	61.0	18.3
Path loss (dB)	200.6	189.0
Polarization loss etc. (dB)	1.0	1.0
Satellite G/T (dB/K)	- 13.0	- 11.0
Uplink C/N ₀ (dB-Hz)	75.0	45.9

downlink		
Frequency (MHz)	1541.4	4200.4
Satellite EIRP (dBW)	21.0	- 8.0
Path loss (dB)	188.4	196.9
Polarization loss etc. (dB)	1.0	1.0
Earth station G/T (dB/K)	- 15.0	31.0
Downlink C/N ₀ (dB-Hz)	45.2	53.6
Overall C/N ₀ (dB-Hz)	45.2	45.2

The ground network

While the aircraft communicated with the satellite at L-Band, interfacing with the satellite from the ground was done via a C-Band backhaul earth station located at CRC. A second L-Band station was co-located to provide a monitoring capability. The backhaul station was connected to the Central Air Ambulance Communications Centre (Medcom) in Toronto via leased land-lines. From this point, through a bridging facility, telephone calls could be routed to doctors' offices, hospitals, other ambulance dispatch centres, or to ambulances via VHF radio; in fact, a call could reach anywhere accessible to the public switched telephone network (PSTN). With this facility, calls may originate from either end, that is, from the aircraft or from within the PSTN.

The aircraft equipment

The experimental equipment currently on board the aircraft is a full duplex L-Band radio that is essentially a forerunner of future MSAT radios. In order to provide a functional communications link via the MARECS-B satellite, three essential components were developed. First, as a result of several years effort in developing modulation and coding

schemes for MSAT, both highly efficient amplitude companded single sideband (ACSSB) and pitch-excited linear predictive coding (PELPC) with differential minimum shift keying (DMSK) modulation schemes were provided in the radio. Suitable assemblies were purchased from Skywave Electronics, Ottawa, who have licensed the technology from CRC.

Second, an antenna was required that provided approximately 12 dB gain and which could be installed easily in the aircraft for test purposes. Canadian Astronautics Ltd., Ottawa, built and delivered two antennas designed to fit into the window of the Cessna Citation and function through glass. This design was particularly useful since it avoided both the enclosure/radome design and the stringent airworthiness certification requirements for externally mounted equipment.

Finally, a linear high-power L-Band amplifier was required. Spar Aerospace Limited, St. Anne de Bellevue, Quebec, was able to take advantage of development work already completed for a spacecraft amplifier and adapt it to this terminal requirement. Spar delivered a linear power amplifier capable of providing 50 watts average output power. The radio, together with the corresponding hub station equipment, were designed and assembled at the CRC labs and

tested in the thermal-vacuum chambers and the vibration facilities at the David Florida Laboratory at CRC.

Aircraft installation

Figure 2 illustrates the placement of the various radio components in the aircraft. The main equipment is located under the baggage compartment, outside the pressure hull. This placement requires the radio to be capable of withstanding large pressure and temperature variations throughout each flight. A separate power converter, also located in this area, provides isolation from the aircraft instrumentation and a well regulated stable power source for the L-Band radio. A diplexer, LNA, and an antenna selection switch are installed under the cabin floor. The antennas are mounted in a window on either side of the aircraft and provide azimuth coverage $\pm 45^\circ$ normal to the longitudinal axis of the aircraft and 0° to 35° in elevation. No coverage is available directly fore and aft of the aircraft. Finally, a headset, with a noise-cancelling microphone, is plugged into a small control box installed near a paramedic's workstation.

Flight experience

Test flights have been underway since 24 November 1987. These flights proved the technical feasibility of the service. One flight in particular followed the perimeter of Ontario to ensure coverage throughout the entire province. As a demonstration of the system's capability, it was possible to dial from a telephone in the aircraft at an altitude of 10 km above Fort Severn on the west coast of Hudson's Bay to anywhere in the world.

Both ACSSB and PELPC/DMSK modulation schemes were tested even though ACSSB was initially identified as the primary candidate. A decision to stay with ACSSB was confirmed for the following reasons:

- a) it provided a natural sounding voice;
- b) it was extremely robust in the presence of background acoustic noise in the aircraft as well as with very weak signals which occurred when flying non-optimum courses or when banking during aircraft turns;

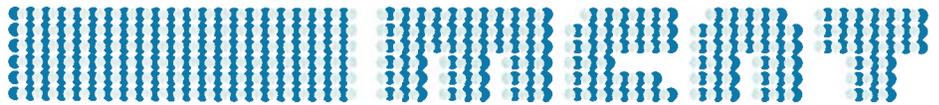
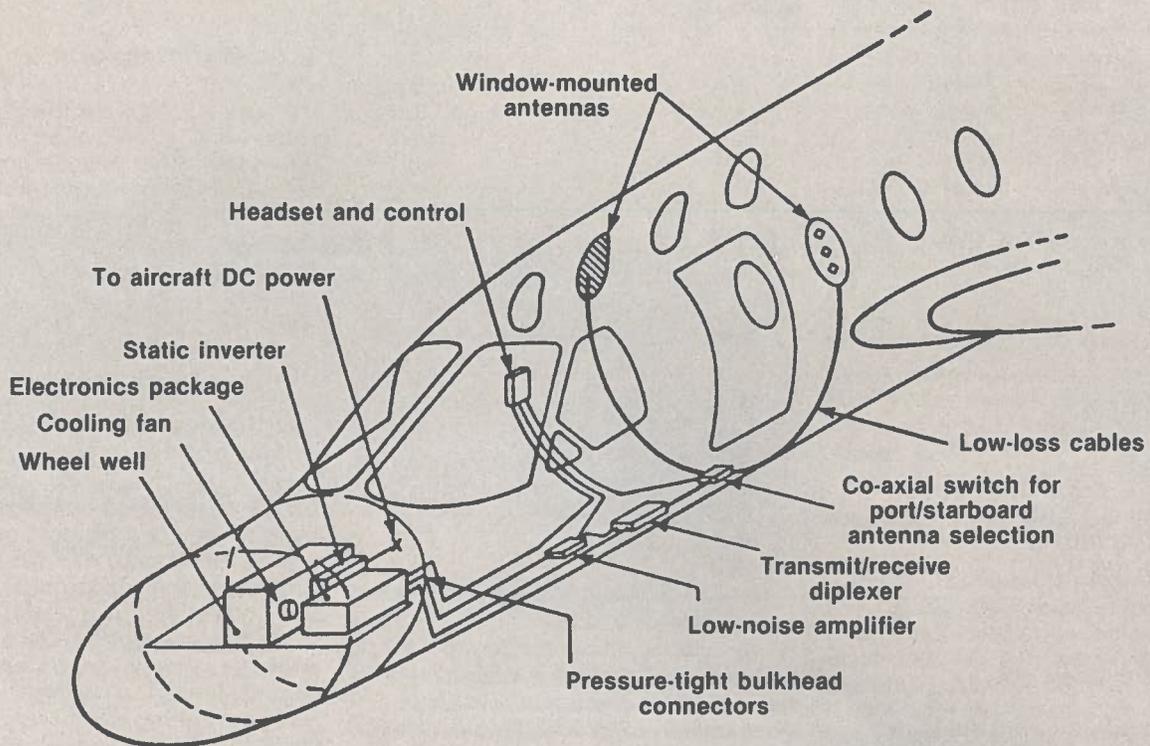


Figure 2 General view of installation



c) it was also robust to backhaul interconnection distortions. For example, calls were made with interconnections at Medcom, to the long-distance PSTN, other dispatch control centres, cellular radio and to the VHF radio system used in land ambulances.

One flight of particular interest was made to determine the western limits of coverage. The pilot chose a flight plan to Regina, Saskatchewan, located west of the 0° elevation look angle contour of MARECS-B. Using ACSSB, it was possible to acquire a usable communications link 2000 m above Regina.

Throughout the test phase, one limiting factor noted in the experimental configuration was the lack of omnidirectional antenna coverage. Although 220 degrees of azimuth were covered, it was necessary on occasion to alter the aircraft's direction to establish communications. This created some difficulty for the pilots, particularly in controlled airspace where course alterations required air traffic control clearance.

Future plans, however, include the development of a suitable externally mounted antenna.

Transition to operational service

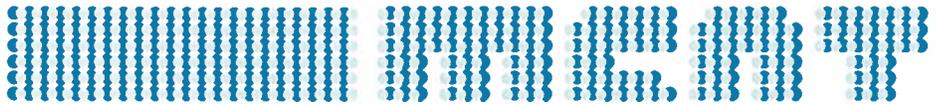
This program has been exceptionally successful, to the point where Teleglobe and Telesat have undertaken to immediately initiate a limited operational service using MARECS-B. To support this initiative, the terminal equipment was modified to provide the necessary signalling and billing information at the completion of the experiment. Also, additional brassboard radios are being developed at CRC for testing in air ambulance helicopters. Finally, development activity in industry is underway to address some of the outstanding key technology areas (for example, the antenna) and to assemble and test a prototype radio.

For further information on the Ontario Air Ambulance aeronautical mobile satellite communications experiment, please contact John Lodge at CRC, (613) 998-2284. □

All systems go for AMSC

The American Mobile Satellite Consortium (AMSC) is making headway toward becoming a fullfledged operating entity. The consortium consists of eight members including Hughes Communications Mobile Satellite Services Inc., Mobile Satellite Corp., Mobile Satellite Telephone Co., North American Mobile Satellite Co., Skylink Corp., Transit Communications Inc., MCCA Space Technologies Corp. and McCaw Space Technologies Inc. It has filed a joint application with the Federal Communications Commission (FCC) seeking licence approval to operate a mobile satellite system in the United States.

Telesat Mobile Incorporated and AMSC are collaborating to define common characteristics of a mobile satellite system for North America. A working group has been established to define standards of the mobile voice terminal. These standards will ensure system and terminal compatibility for users operating anywhere in North America. □



Note from Spar

Recently, Spar Aerospace Limited was awarded a Contribution Agreement from Canada's Department of Regional Industrial Expansion (DRIE) for \$7 million.

This funding will allow the continuation of the Space Segment System Design Optimization so that Spar will be in a good position to submit a winning proposal to Telesat Mobile Incorporated (TMI) and the American Mobile Satellite Consortium (AMSC) when they issue their request for proposal.

The current Spar system design is for an 11-spot coverage beam for all of North America; four beams for Canada, five for the United States, and two for Mexico as shown in the

illustration. Two identical satellites would be capable of providing mutual backup for each other.

The spacecraft platform would be in the same class as ANIK-E, but would have two 5-metre mesh deployable reflectors dominating the in-orbit configuration.

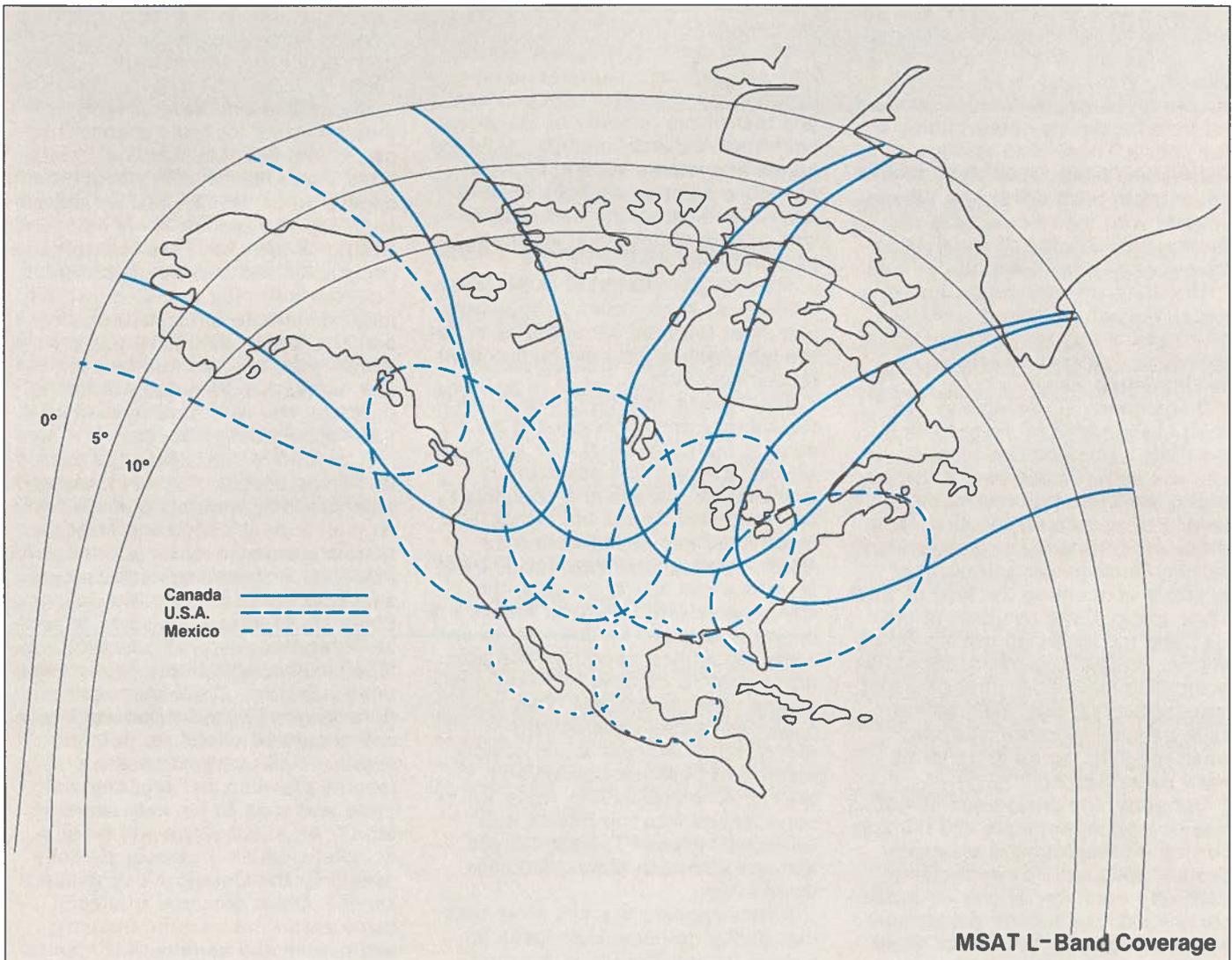
The development of the payload units is also part of the Contribution Agreement, and work will continue mainly on the L-Band high power transmit section including the antenna feed array; the critical unit being the L-Band HPA which now uses the GaAs FET power devices.

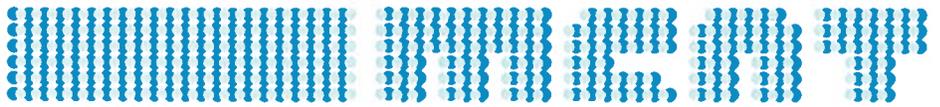
Recent development activity by the reflector suppliers will see passive intermodulation testing with MBB's 5-metre mesh reflector in Munich, and detailed space segment design later. □

Vehicle Navigation and Information Systems International Conference (VNIS '89)

A VNIS Conference, jointly sponsored by Institute of Electrical and Electronics Engineers (IEEE) Vehicular Technology Society, IEEE Toronto Section, Ministry of Transportation of Ontario and Transport Canada, will be held September 12 to 14, 1989 in Toronto, Ontario, Canada.

Papers are invited on vehicle navigation and information systems technology and applications. Presentations on user requirements, choice of technology, operations, economic assessment and performance evaluation are welcome. Of particular





interest are papers on research and development programs and pilot projects, as well as those dealing with critical issues affecting system implementation such as standards, cost, market size, privacy, safety, human factors, private and public sector roles, etc.

For more information you can call Hugh Reekie, Department of Communications, Ottawa, Ontario, at (613) 990-4099. □

TMI saves money for the trucking industry

Until now, truckers have been out of touch with their home base while on the road. With FleetStar, transport drivers will never be more than a button's press away from contact with their dispatchers.

Telesat Mobile Inc. (TMI) has developed FleetStar, a fleet management system for the trucking industry. Drivers will be able to send and receive messages in the cab, saving time previously spent finding a pay phone. These time savings alone could mean \$0.07 to \$0.12 per kilometre to each driver and vehicle. Contact with their home base will decrease the feeling of isolation for drivers who spend days on the road. Their safety will also be protected since they will be able to contact their base at any time in case of emergency, when a telephone may be kilometres away.

Dispatchers will be able to pinpoint the location of every truck in their fleet. This position location feature will allow dispatchers to better deploy vehicles and improve customer service by accurately locating each shipment in order to ensure its timely delivery. Information will also be available concerning the type of truck being tracked, the contents of the load and the expected availability of the rig. Drivers' paperwork should be reduced considerably through a text transfer service that will electronically transmit invoices and print when required, so no more forms need be written up.

Currently, the design and manufacture of mobile terminals and the supporting infrastructure is underway. System trials will be conducted in 1989 with commercial service available in 1990. The federal government has committed to buy 300 of these terminals for the Communications

Trials Program. In addition, the federal government has contracted for long-term, large-capacity usage of services under the MSAT Program.

For further information on FleetStar or other MSAT services, please contact G. Egan or H. MacIntosh at Telesat Mobile Inc., (613) 746-5920. □

A report on WARC-MOB-87

The WARC-MOB-87 accepted the essential principle of recognizing Land Mobile Satellite Service (LMSS) as the third main service to be accommodated within the 1530-1559 MHz and 1626.5-1660.5 MHz bands (as shown in the diagram). It did not, however, go as far as to accept the generic Mobile Satellite Service (MSS) allocations sought by Canada, the United States and Australia as reported in the MSAT News, Issue #6, September 1987.

This recognition, however, was a hard fought compromise solution between the Canadian-U.S. position and that of the majority of European countries. It clearly permits the emergence of systems serving all types of mobile satellite services such as MSAT, while ensuring that each service retains priority over a certain portion of the spectrum.

Thus, in the aftermath of WARC-MOB-87 all sides could claim victory and most returned home happy in the thought each could now pursue their respective plans.

For Canada and the United States this victory was accompanied by the somber realization that it is no longer a case of how much spectrum is available for Canada and how much for the United States but rather how much spectrum is available for a *North American system*. For no matter who owns which satellite, the coverage pattern for North America is primarily dictated by the need to conserve the limited spectrum available rather than to cater to the individual claims of either country. This principle has helped considerably in diminishing tensions at the government level between Canada and the United States and to move the negotiations into the private sector arena between Telesat Canada and the American Mobile Satellite Consortium.

It now appears that the most difficult part of the spectrum issue is behind us and Canada is proceeding with the necessary international

spectrum co-ordination under International Frequency Review Board (IFRB) rules. To date, the two meetings with INMARSAT have been very cordial and productive.

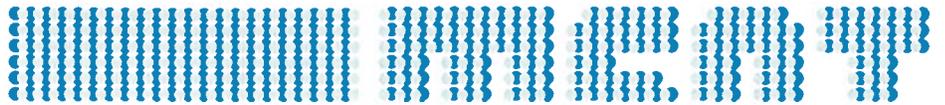
The only outstanding issue acting as a deterrent to the final spectrum sharing is the delay by the FCC in officially licencing the American consortium. Without such licence no agreements between the principals can be finalized. Come on FCC, lets get moving! □

A trials plan for Mobile Satellite services

There has been a considerable amount of backroom activity in the trials planning area since the last issue of MSAT News. The Communications Trials Plan, as outlined in the last issue, means that demonstrations of voice services to selected end-users may start as early as fall 1989.

Applicants who have already had their requests for trials accepted as part of the Post-Launch Communications Trials Plan (PLCP) will still be eligible when MSAT capacity is available. The Pre-Launch Trials Plan is an additional offer, and has restricted geographic and service capabilities. Some of the trials already accepted may be suitable for transfer to this earlier plan. An outline of this pre-launch plan is presented below, and details will be passed on to all organizations who have had their trials applications accepted.

A government contract has been let for the supply of voice transportable terminals that can operate over an interim space segment. Negotiations are proceeding for access to an INMARSAT space segment, using a spacecraft over the Atlantic Ocean. Plans are to offer a series of demonstrations to a range of potential MSAT users, both in the public and private sectors. These demonstrations may result in limited-use trials and should be useful for potential mobile voice users who have a lengthy planning and procurement cycle and wish to be early users of MSAT. An initial target will be public safety, which is already partially served by the Ontario Air Ambulance service. Other potential trial applicants are in the trucking industry, and marine and aeronautical applications. Depending on equipment and



WARC-MOB-87
New Table of Frequency Allocations for Mobile Satellite Services

DOWNLINK	MMSS & LMSS		MMSS & <i>lmss</i>		D & S	AMSS (APC)		LMSS
	1530	1533	1544	1545	1555	1559		
UPLINK	MMSS	MMSS & LMSS	MMSS & <i>lmss</i>		D & S	AMSS (APC)		LMSS
	1626.5	1631.5	1634.5	1645.5	1646.5	1656.5	1660.5	

- Legend**
- LMSS** = Land Mobile Satellite Service (Primary Allocation)
 - AMSS** = Aeronautical Mobile Satellite Service (Primary Allocation)
 - MMSS** = Maritime Mobile Satellite Service (Primary Allocation)
 - D&S** = Distress & Safety (Primary Allocation)
 - APC** = Aeronautical Public Correspondence (Pre-emptable by safety applications)
 - lmss*** = Secondary Allocation, Data Only

channel availability, it is hoped that limited-use trials may be set up in the fall of 1989 for selected parties. Between 10 and 20 voice transportable terminals will be available for limited voice demonstrations.

Telesat Canada, through its subsidiary Telesat Mobile Inc., has firm plans for a mobile data service in eastern Canada. The Department of Communications will make trials and demonstrations of that service available when firm schedules are established. The next issue of MSAT News will provide further details. Over 200 data terminals have been assigned for this activity.

In order to ensure that maximum benefit is derived from the limited pre-launch trials capability, the Department will consider entering into co-operative arrangements with providers of specialized mobile communications services who will be able to enhance the trial service offered through their existing infrastructure and expertise. □

News in Brief

MSAT government funding gets final Treasury Board approval

Treasury Board gave effective approval in September 1988 to the funding of the Department of Communications trials program and the Government/Telesat Service Lease Agreement for a combined total of \$126.5 million.

MSAT service lease agreement signed

In September the Department of Communications, on behalf of the federal government and Telesat Mobile Incorporated (TMI), signed a lease worth \$126.5 million for mobile satellite services to be taken up by government users over a period of 10 to 15 years.

MSAT business arrangements on the move

Significant progress has been made in Telesat's negotiations with the American Mobile Satellite Consortium towards concluding a mutual co-operation agreement.

Several major telecommunications organizations have shown strong interest in becoming partners in MSAT. Telesat expects that final agreements will be completed shortly.

International frequency co-ordination

The Department of Communications and Telesat have held a series of meetings with INMARSAT to co-ordinate frequency usage by the respective systems within the International Frequency Review Board's rights. Progress to date is very encouraging. □



Contract awards

- Glenayre Electronics Ltd. was awarded a contract of \$1.44 million to develop a mobile radio terminal for use in conjunction with mobile satellite systems.

Delivery date: August 31, 1990.

- Skywave Electronics Ltd. was awarded a contract of \$103,000 to develop a prototype terminal for voice/data for the MSAT Interim Land Mobile Satellite Service.

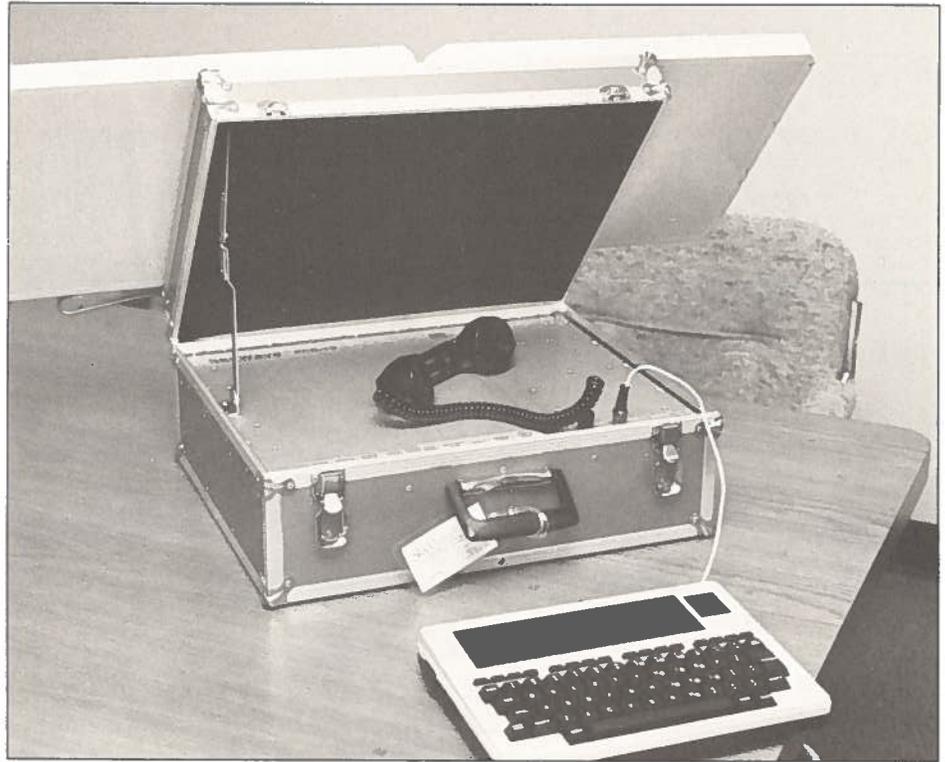
Delivery date: September 29, 1988.

- Nexus Engineering Corp. was awarded a contract of \$242,000 to develop high-power low-noise amplifiers for mobile terminals.

Delivery date: August 31, 1989.

- Spar Aerospace Limited was awarded a contract of \$6.95 million to continue developmental work on spacecraft systems.

Delivery date: July 31, 1989.



This prototype voice/data portable satellite terminal, currently undergoing customer evaluation, was developed by Skywave Electronics Ltd., Kanata, Ontario. Support for the project was provided by the Department of Communications and the Department of Regional and Industrial Expansion through its Defence Industry Productivity Program (DIPP).