RADARSAT Program

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ABSTRACT

Work on the RADARSAT system is progressing well to meet the currently scheduled launch date of early 1995. The spacecraft bus and the Synthetic Aperture Radar (SAR) payload are at various stages of development. Requirements for the ground segment have been mostly established. The design of the ground elements such as mission control facility and SAR data processor is underway. The SAR applications development work is continuing and the chosen distributor, RADARSAT International Inc. (RSI) is making preparations to market RADARSAT data internationally. A plan for the follow-on to RADARSAT I is being finalized to ensure continuity of SAR data under the Radarsat program.

INTRODUCTION

RADARSAT is a major Earth Observation (EO) program of the Canadian Space Agency (CSA). The program as presently approved includes construction, launch and operation of Canada's first remote sensing satellite - RADARSAT I, and establishment and operation of associated ground facilities. RADARSAT I will carry one instrument or sensor, a Synthetic Aperture Radar (SAR) operating at C-band (5.3 GH_z frequency) with horizontal transmit and horizontal receive (HH) polarizations. RADARSAT I is being designed to provide global SAR data operationally for five years after launch currently scheduled in early 1995.

RADARSAT I will be launched into a dawn-dusk, sun-synchronous polar orbit by NASA using a Delta II rocket from the Western Test Range. In return for this contribution of the launch and related services, the USA government will receive for its use a pro-rata share of the SAR on-time available during the RADARSAT I mission. CSA will also be splitting the available SAR on-time with the private sector. A Canadian company, Radarsat International Inc. (RSI) has been assigned the worldwide distribution rights for the RADARSAT I SAR data. These rights are in return for financial contributions to the program such as for the ground SAR processing facility in Canada. RSI will develop the commercial data sales worldwide and pay revenues to the Canadian government to offset the cost of the RADARSAT I mission.

One of the purposes of the RADARSAT program is to contribute to the creation of a viable international market for remote sensing data. This is to be accomplished by providing SAR data operationally through RSI to the worldwide remote sensing user community. Development of an international market by RSI, especially for operational applications, requires a continuing supply of SAR data. This need for SAR data continuity is now recognized and CSA accordingly is currently developing plans for follow-on RADARSAT missions. These plans should be finalized during 1993.

RADARSAT I MISSION

The RADARSAT mission is to supply and distribute global SAR data to the worldwide user community for such applications as ice mapping, ocean surveillance, agriculture and forestry monitoring, geological resource mapping and environmental studies. The development of applications and end users to utilize these applications and expand the economic benefits is an integral part of the mission. The Canada Centre for Remote Sensing (CCRS) has been managing a Radar Data Development Program (RDDP) for the last five years. This development work based on SAR data from the Canadian CV-580 aircraft and European ERS-1 satellite will be continuing so as to ensure users are capable and ready to utilize RADARSAT data.

To meet users needs the RADARSAT I SAR is to normally look right of the satellite track. This north looking configuration will provide essentially complete coverage of the Arctic but will leave a gap over the Antarctica. The spacecraft will be capable of undertaking manoeuvres so that the SAR can look to the left (south) for essentially a complete mapping of the Antarctic. This capability is being provided to meet the NASA requirement of mapping the Antarctic, once during a winter season and once during a summer season corresponding normally to the maximum and minimum formation of ice, respectively.

The RADARSAT I SAR is designed to provide options to users in selecting swath-width, spatial resolution, and angle of incidence. As illustrated in Figure 1, these options will be provided through various SAR modes of operation selectable by the ground control. Within the accessability ground swath of 500km it will be possible to select individual beams or SCANSAR with the associated swath width and resolutions as given in Figure 1. Experimental coverage will be possible outside this range. The 500km SCANSAR swath will provide daily coverage of the Arctic, almost complete coverage of Canada and the USA each 3 days period, and global coverage over approximately 5 days. A 24 day exact repeat orbit has been selected for the RADARSAT I mission.

In addition to the SCANSAR and multi-incidence beam observations, RADARSAT I is pioneering the dawn dusk orbit, i.e. the equator orbit crossing at approximately 6:00am or 6:00pm. This orbit offers advantages in solar power generation and associated design. It will avoid conflict in data reception on the ground with the other remote sensing satellites.

SAR data will normally be acquired when RADARSAT is within view of one of the ground data receiving stations (Canadian Prince Albert and Gatineau stations, the USA Fairbank station, and stations as licensed by RSI). Two on-board tape recorders are being provided, however, to acquire SAR data for any part of the globe and dump the recorded data when the satellite is within the Canadian station mask. RADARSAT I will be controlled and programmed by Mission Control System (MCS) in Canada. The MCS will accept user requests from order desks in Canada, USA, and other regions for filling either from the archived data or newly acquired data. The SAR data will be processed using the processing facility being set up in Canada by RSI. The USA Fairbanks station is expected to have its own processing facility. The stations licensed by RSI to receive RADARSAT data will likely have their own processing facilities as well. The quality of the SAR data delivered from this RADARSAT system will be monitored and controlled by the MCS. To facilitate maintenance of SAR data quality a ground calibration site consisting of transporters and passive targets is being established in Canada.

RADARSAT I SYSTEM DEVELOPMENT STATUS

The design and manufacture of flight hardware is well advanced at the prime contractor Spar Aerospace in Quebec and its major sub-contractors, COMDEV, CAL Corporation, MacDonald Dettwiler and Associates (MDA), SED Ltd., Fleet Aerospace and others across Canada. Ball Aerospace of Boulder, USA, the contractor for the spacecraft bus is in the final stages of assembling the flight hardware for the bus module. The other major sub-contractor is Dornier who is producing the High Powered Microwave Circuit which is similar in design to the one used on the ERS-1. The on-board tape recorders being procured from Odetics Inc. are presently under test.

Integration of the payload module (SAR sensor, tape recorders, and data handling system) is scheduled to begin mid 1993 at Spar. The final integration of the payload and bus modules plus the SAR antenna and the solar array will start early 1994 at CSA's David Florida Laboratory in Ottawa.

The existing Canadian receiving stations at Prince Albert and Gatineau, already operational for ERS-1, are being equipped to receive RADARSAT data. The existing Canadian facility for processing ERS-1 SAR data operationally is being upgraded for RADARSAT. The preliminary design review for this upgrade was held in 1992. The preliminary design reviews of mission control facility and telemetry, tracking and command stations of the MCS will be held soon. The requirement review for the mission planning and scheduling component of the MCS is planned for early 1993. The ERS-1 transponder design will be used for the development of the ground calibration transponder for RADARSAT. The concept for order desks has been finalized. The work on operations planning, training, and utilizing development has been started.

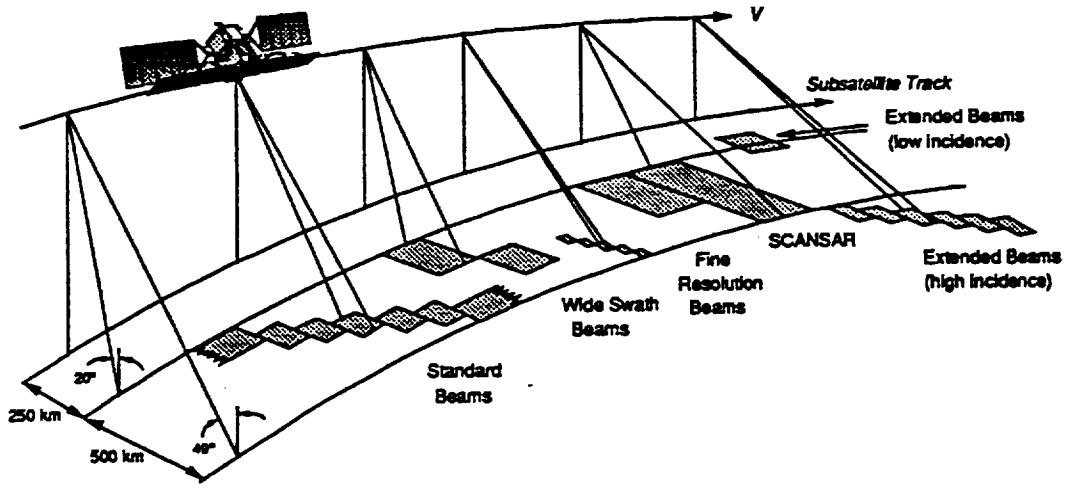
BEYOND RADARSAT I

RADARSAT I should supply SAR data till the year 2000. The development of applications and associated utilization technology and the development of market for future sales of RADARSAT data are underway. To strengthen this development and commitment of users to invest in SAR data utilization, the users need to be assured of the continuity of RADARSAT SAR data. Accordingly, it has been realized that continuation of the RADARSAT program beyond RADARSAT I is vital. The Canadian Space Agency is presently developing the Long Term Space Plan (LTSP) for Canada. A plan for the continuation of the RADARSAT program is being developed as part of the LTSP. This plan is proposing that a second RADARSAT satellite be built as early as possible after the launch of RADARSAT I. This will provide a backup should there be a premature failure of RADARSAT I. If RADARSAT I operates for five years as anticipated, then the backup satellite will be launched as RADARSAT II around the year 2000.

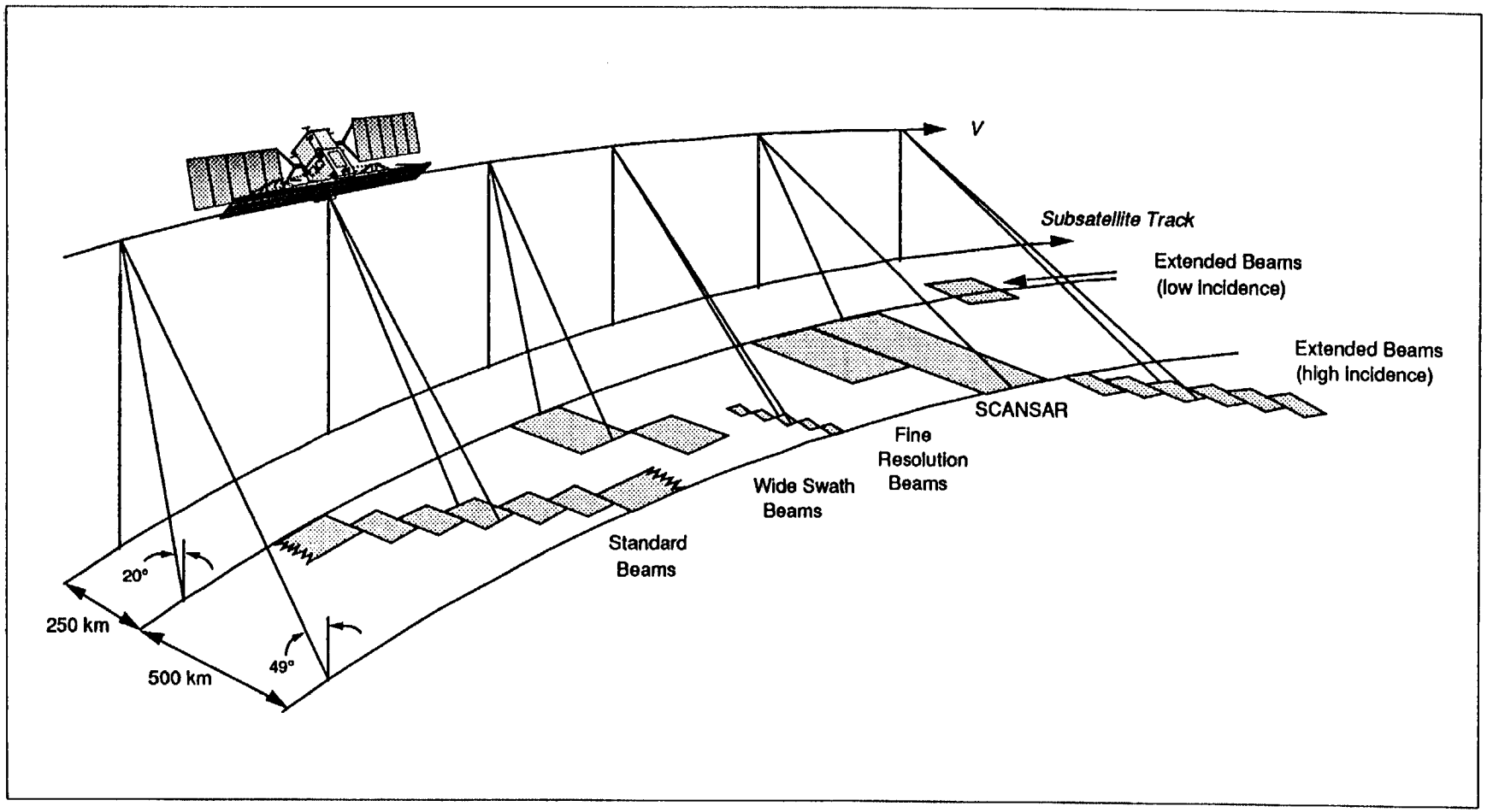
In parallel with RADARSAT II, it is proposed that work on enabling technologies for RADARSAT II begins soon. This would entail advanced system and technology development for the SAR and key ground segment elements such as the data processor. It is also planned to support development of new SAR applications and value-added products. RADARSAT III is proposed to be ready for launch around the year 2004 so as to ensure continuity of the supply of SAR data under the RADARSAT program. As these SAR missions are costly and serve global user communities, mutually beneficial cooperation with interested countries or organizations will be explored as part of this plan for RADARSAT II and III.

Figure 1. RADARSAT SAR Modes

Mode		Width (km)	Resolution R x A_z(m)	Looks	Incidence Angle (deg)
Standard		100	25 x 28	4	20 - 49
Wide Swath	(1)	165	48 - 30 x 28	4	20 - 31
	(2)	150	32 - 25 x 28	4	31 - 39
Fine Resolution		45	11 - 9 x 9	1	37 - 48
SCANSAR	(Narrow)	305	50 x 50	2 - 4	20 - 40
	(Wide)	510	100 x100	4 - 8	20 - 49
Extended	(High)	75	22 - 19 x 28	4	50 - 60
	(Low)	170	63-28 x 28	4	10 - 23



SAR Operating Modes



SAR Modes

Mode	*Width (km)*	*Resolution R x A_Z(m)*	*Looks*	*Incidence Angle (deg)*
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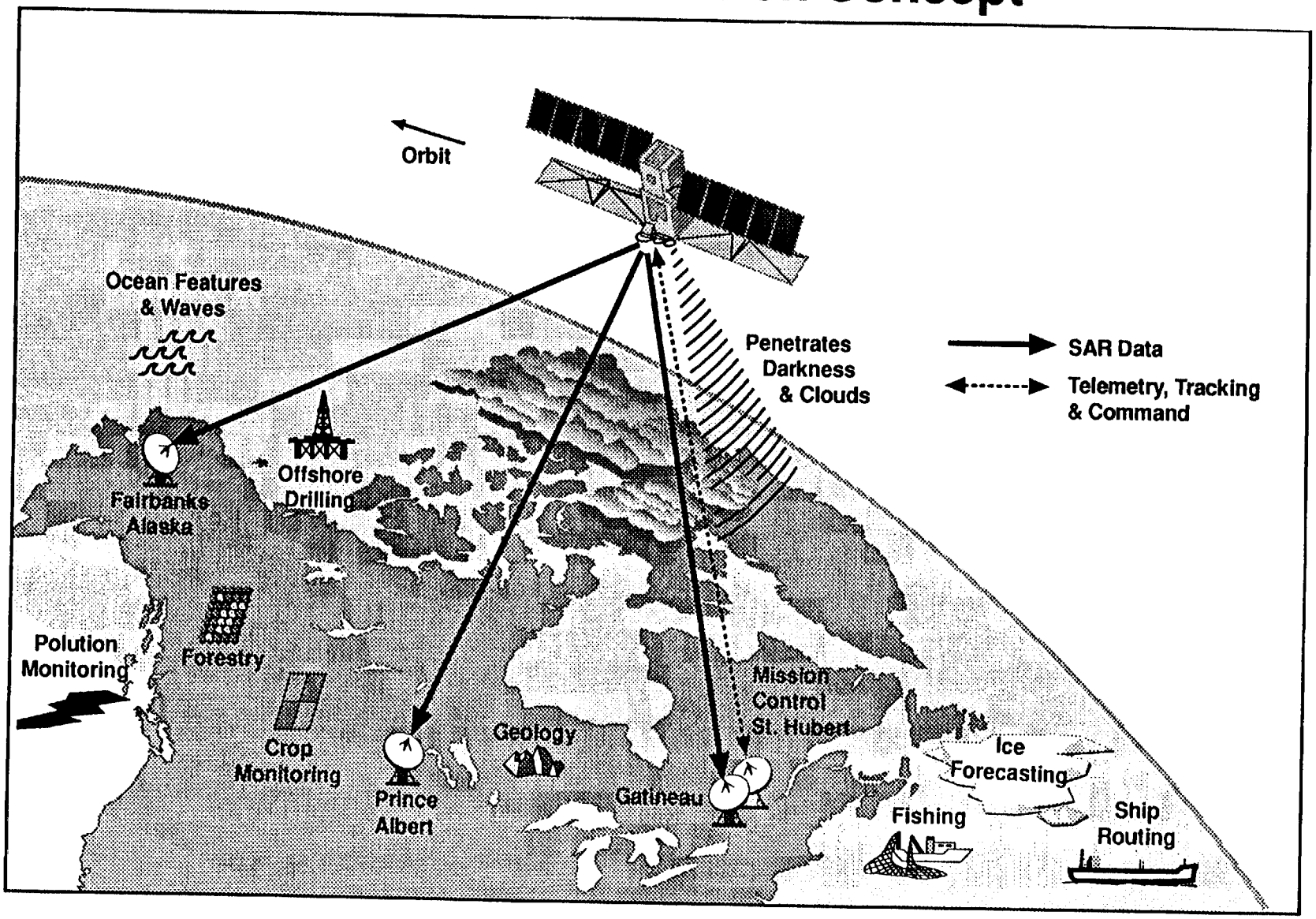
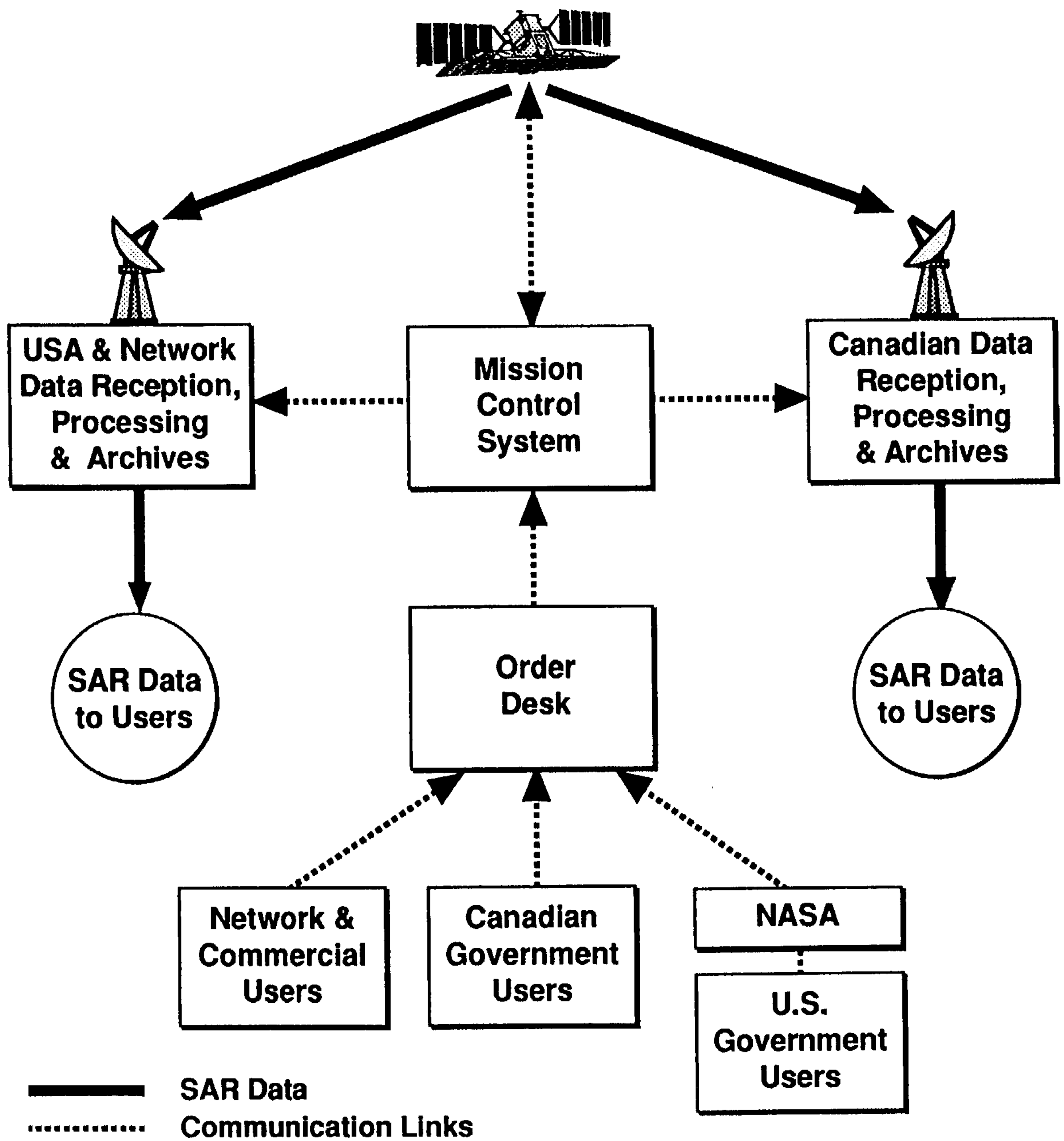
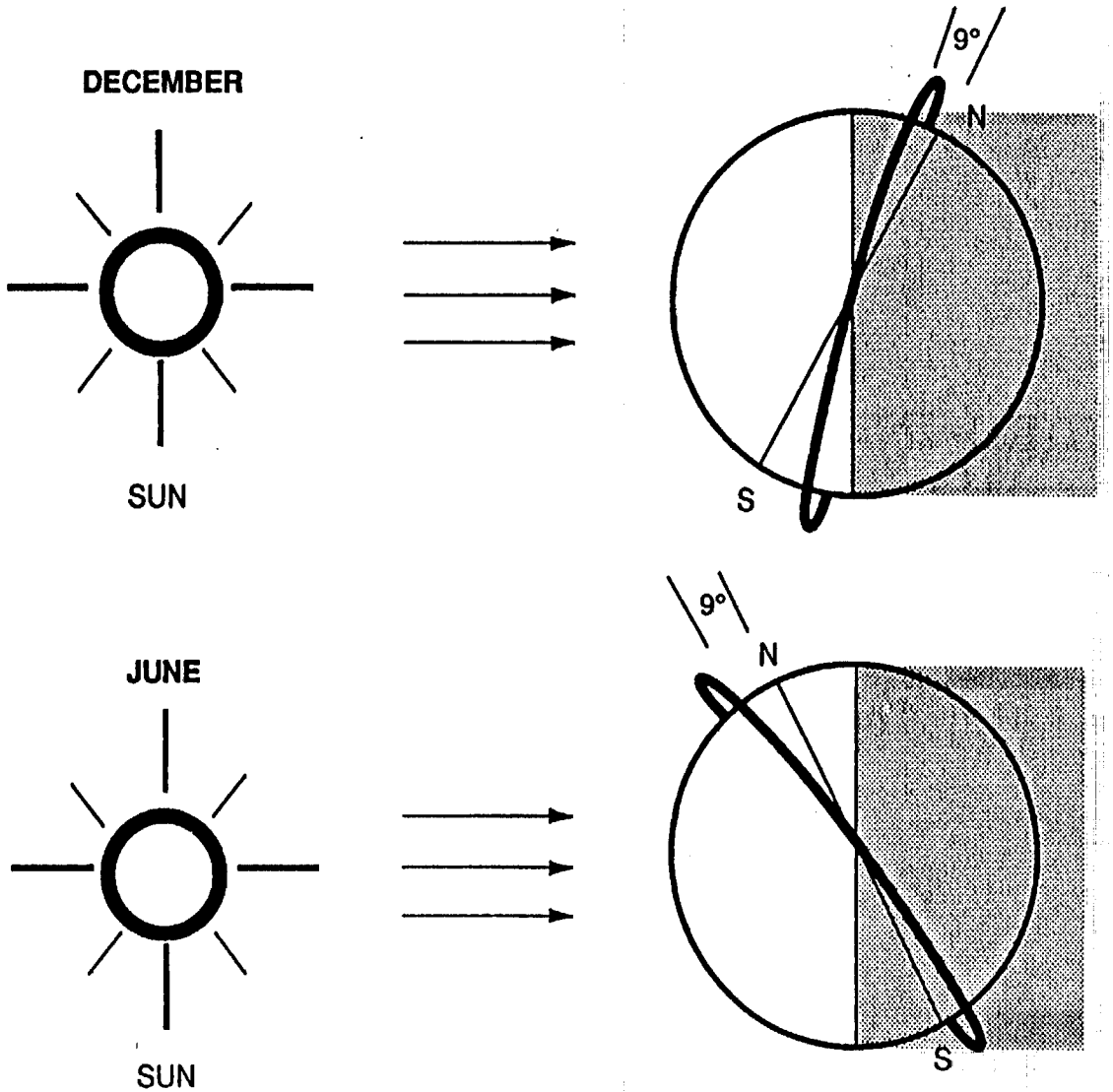
RADARSAT Mission Concept

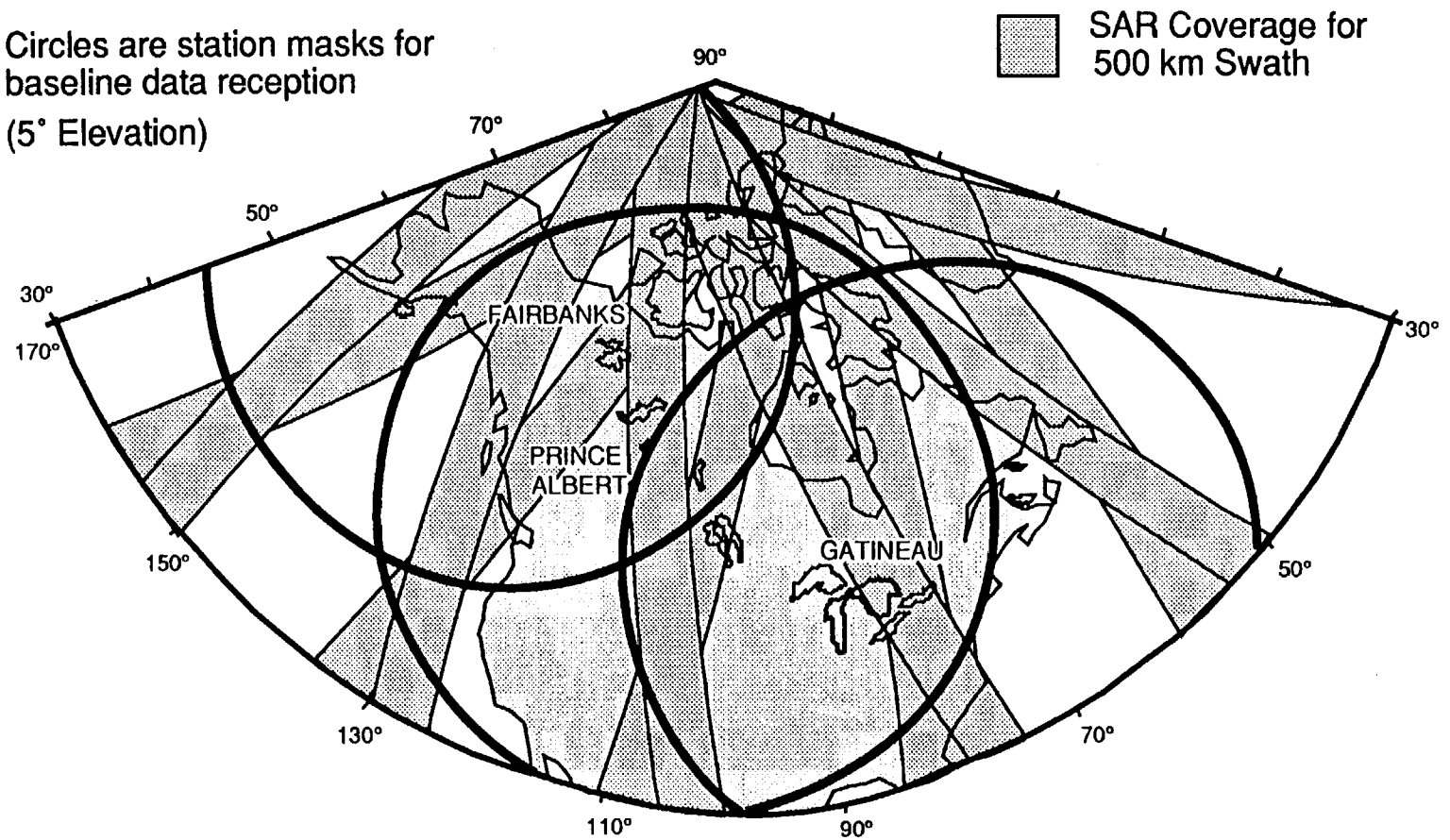



USA & Network
Data Reception,
Processing
& Archives
Mission
Control
System
Canadian Data
Reception,
Processing
& Archives
SAR Data
to Users
Order
Desk
SAR Data
to Users
Network &
Commercial
Users
Canadian
Government
Users
NASA
U.S.
Government
Users
SAR Data
Communication Links

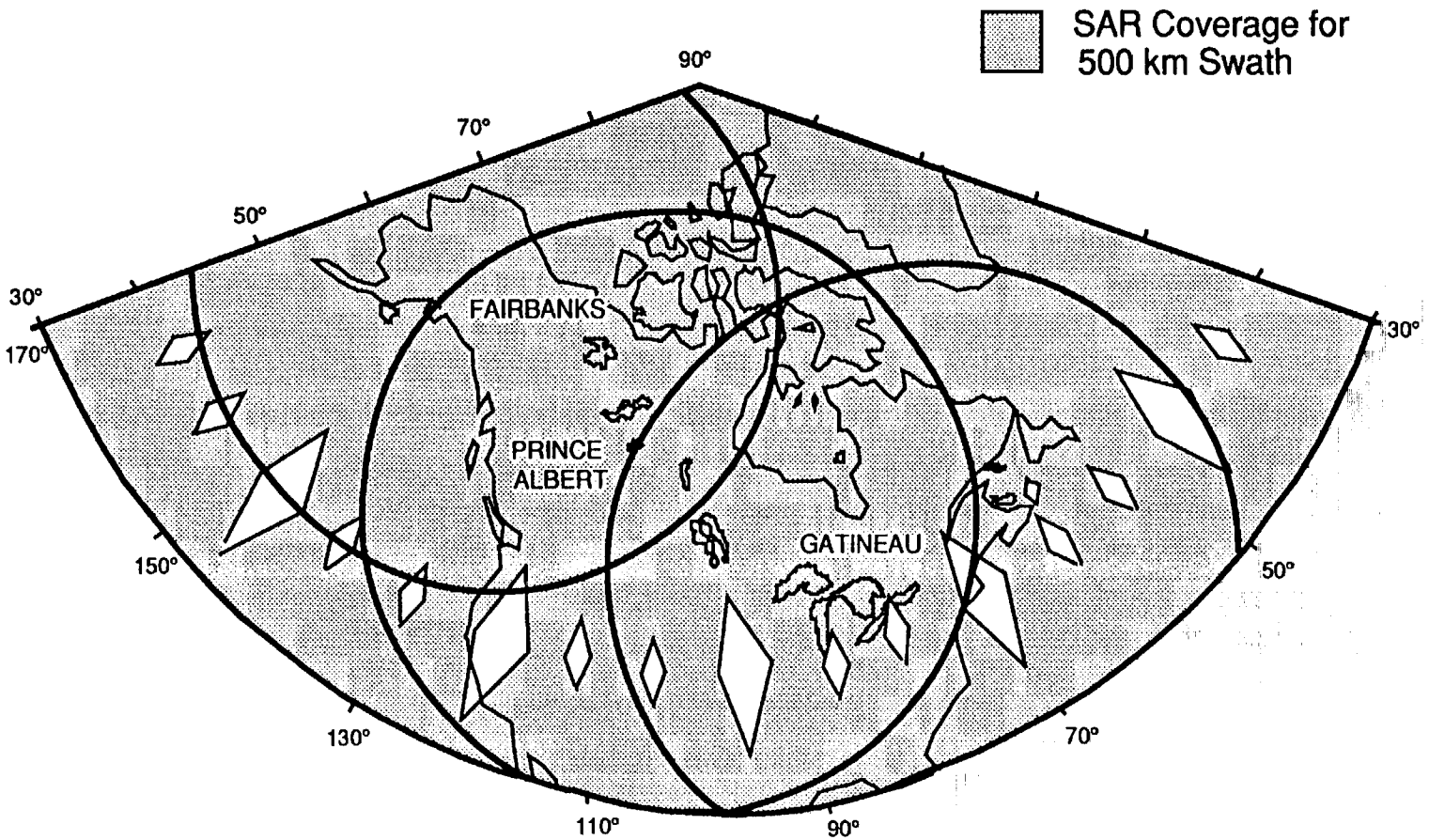
DAWN-DUSK ORBIT
SUN SYNCHRONOUS



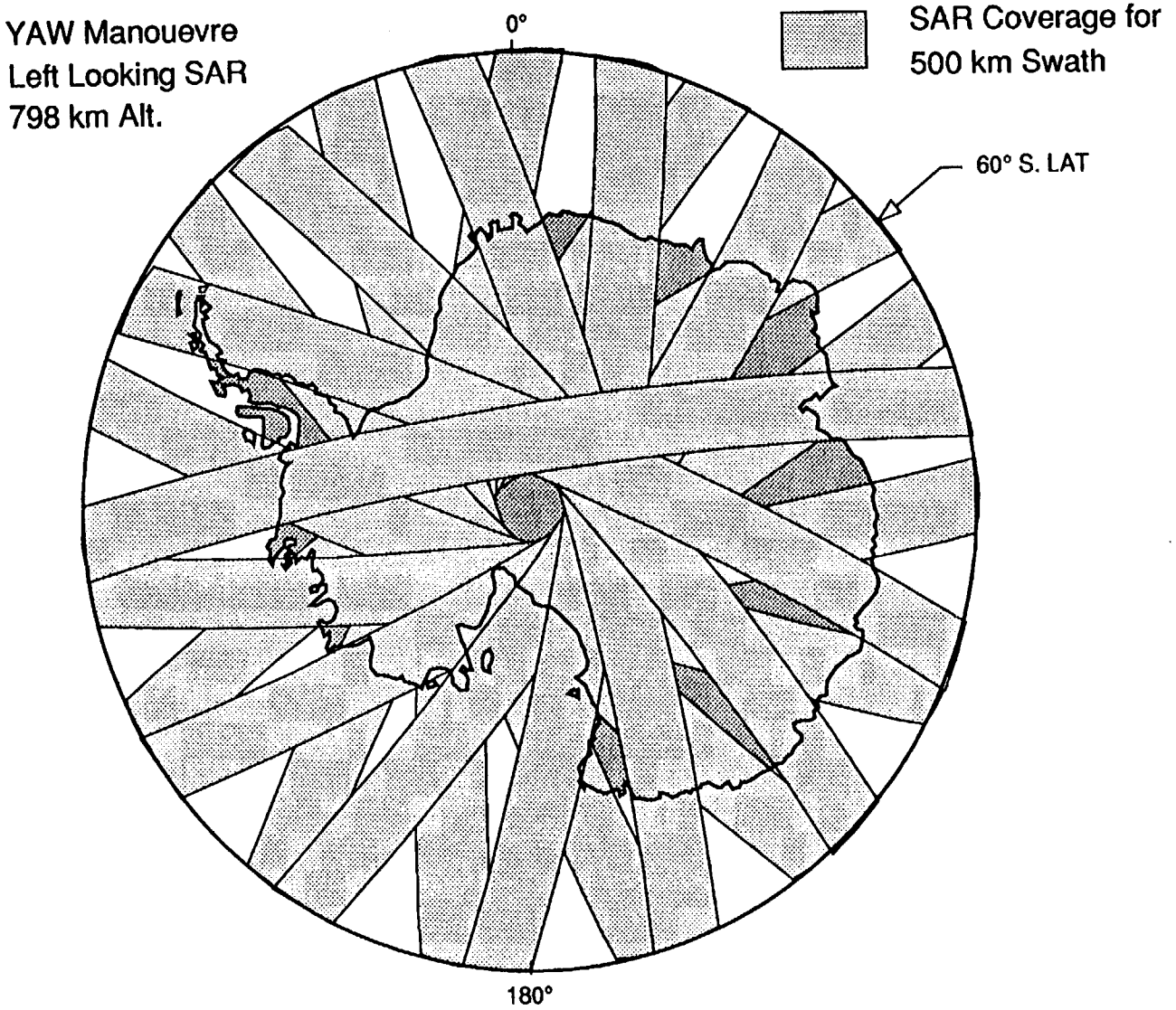
RADARSAT 1 Day Coverage



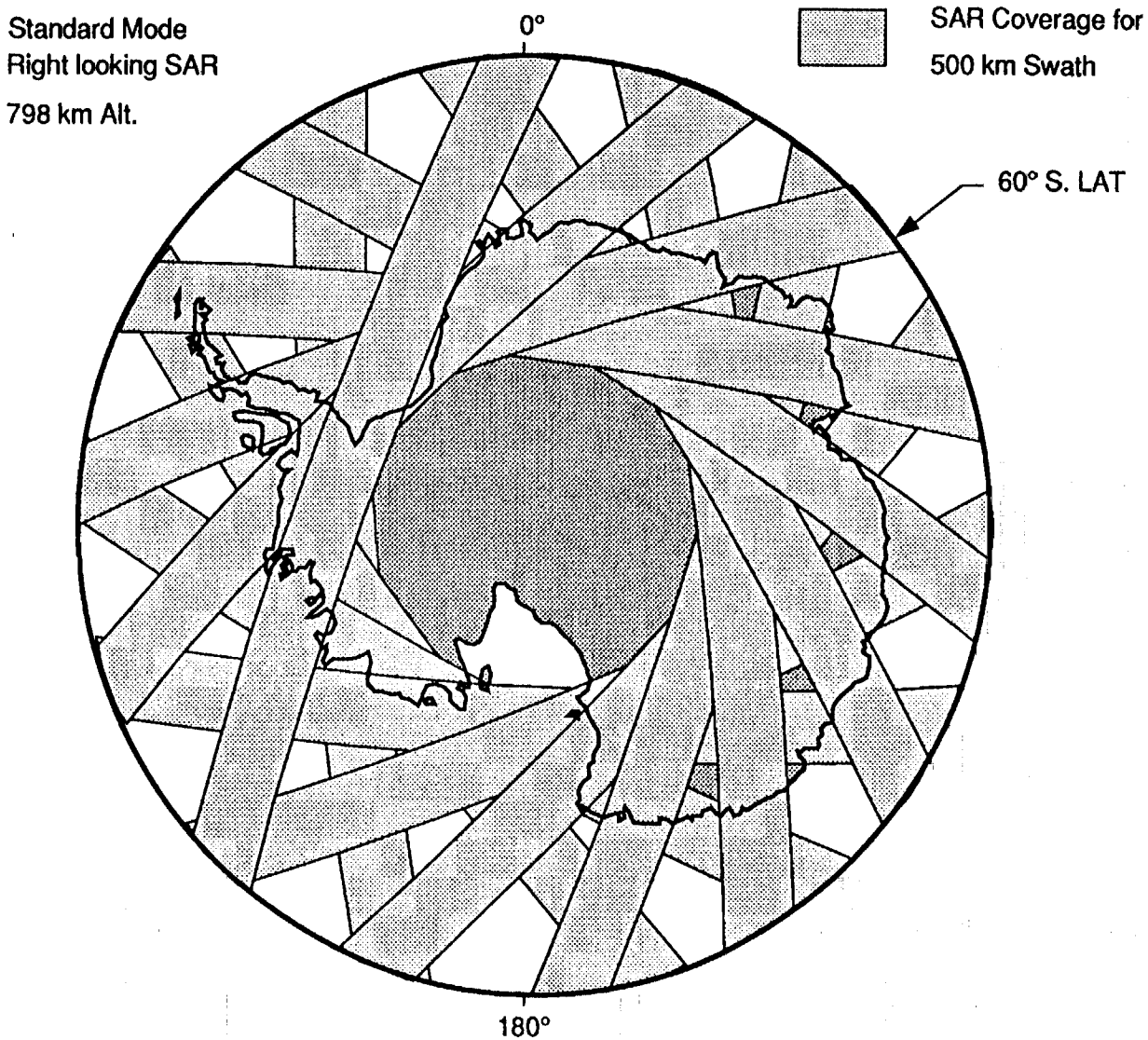
RADARSAT 3 Day Coverage



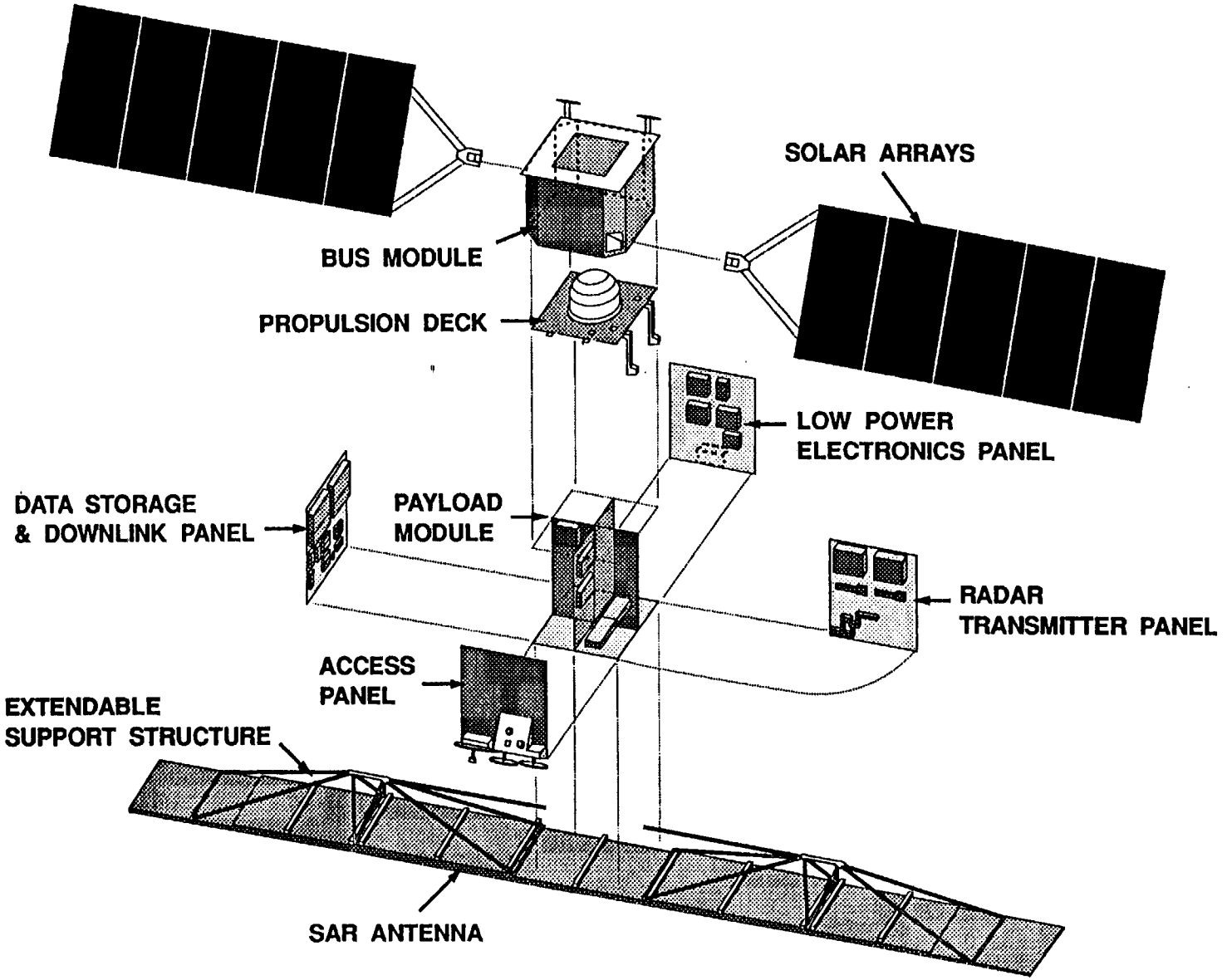
RADARSAT 1 Day Antarctica Coverage



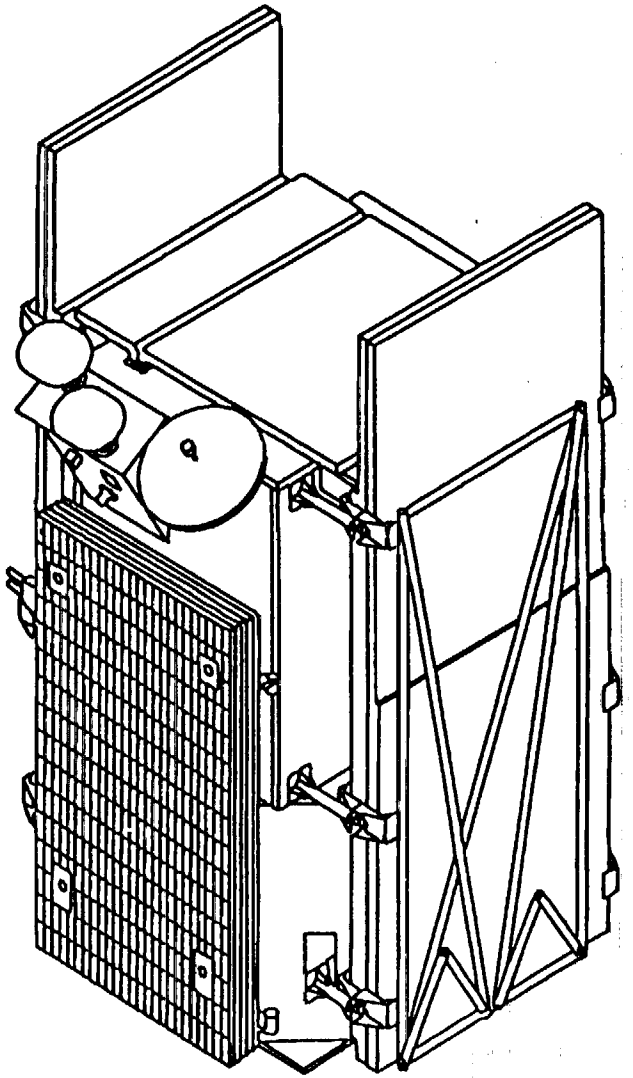
RADARSAT 1 Day Antarctica Coverage



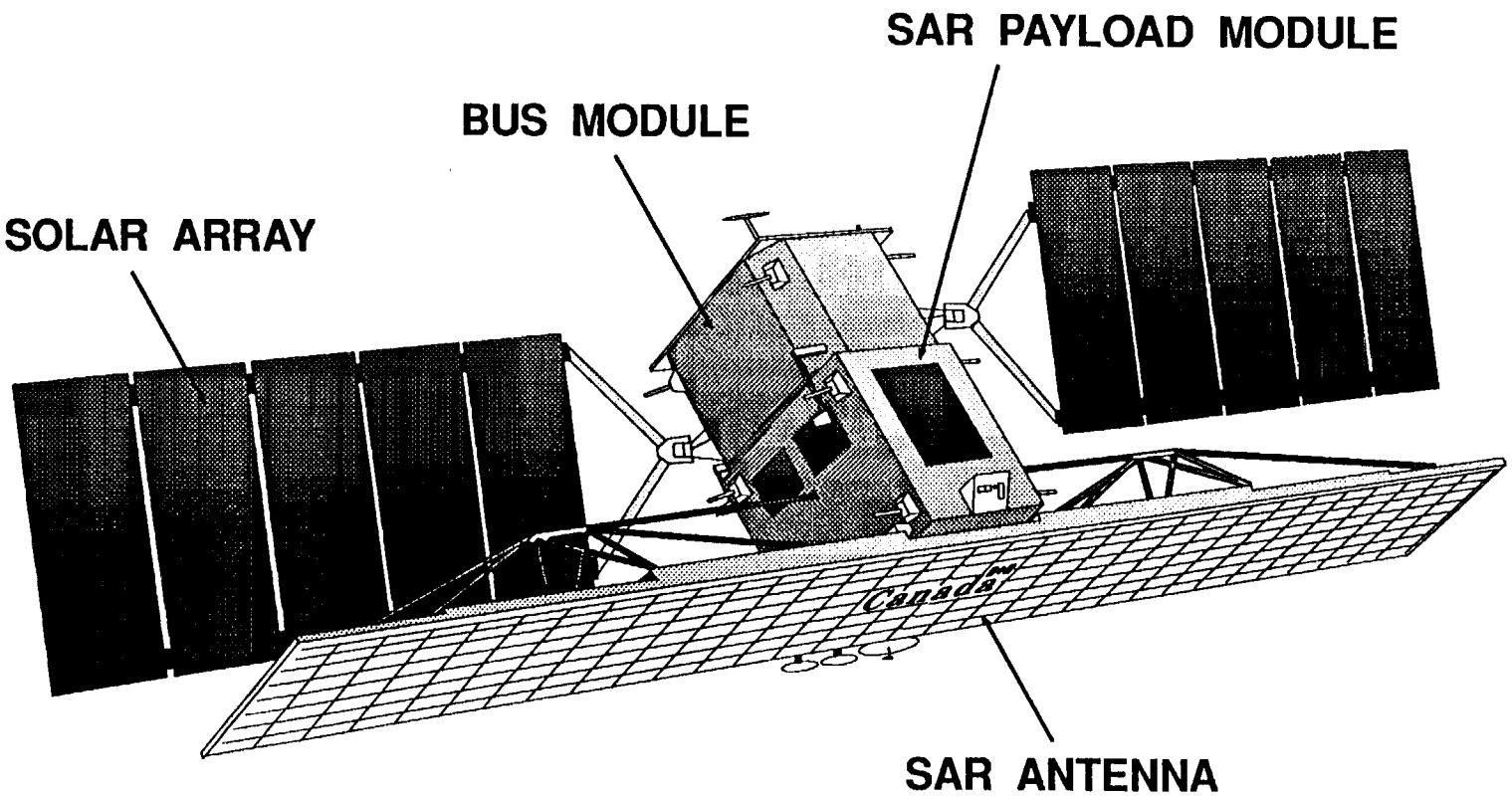
RADARSAT - General Layout

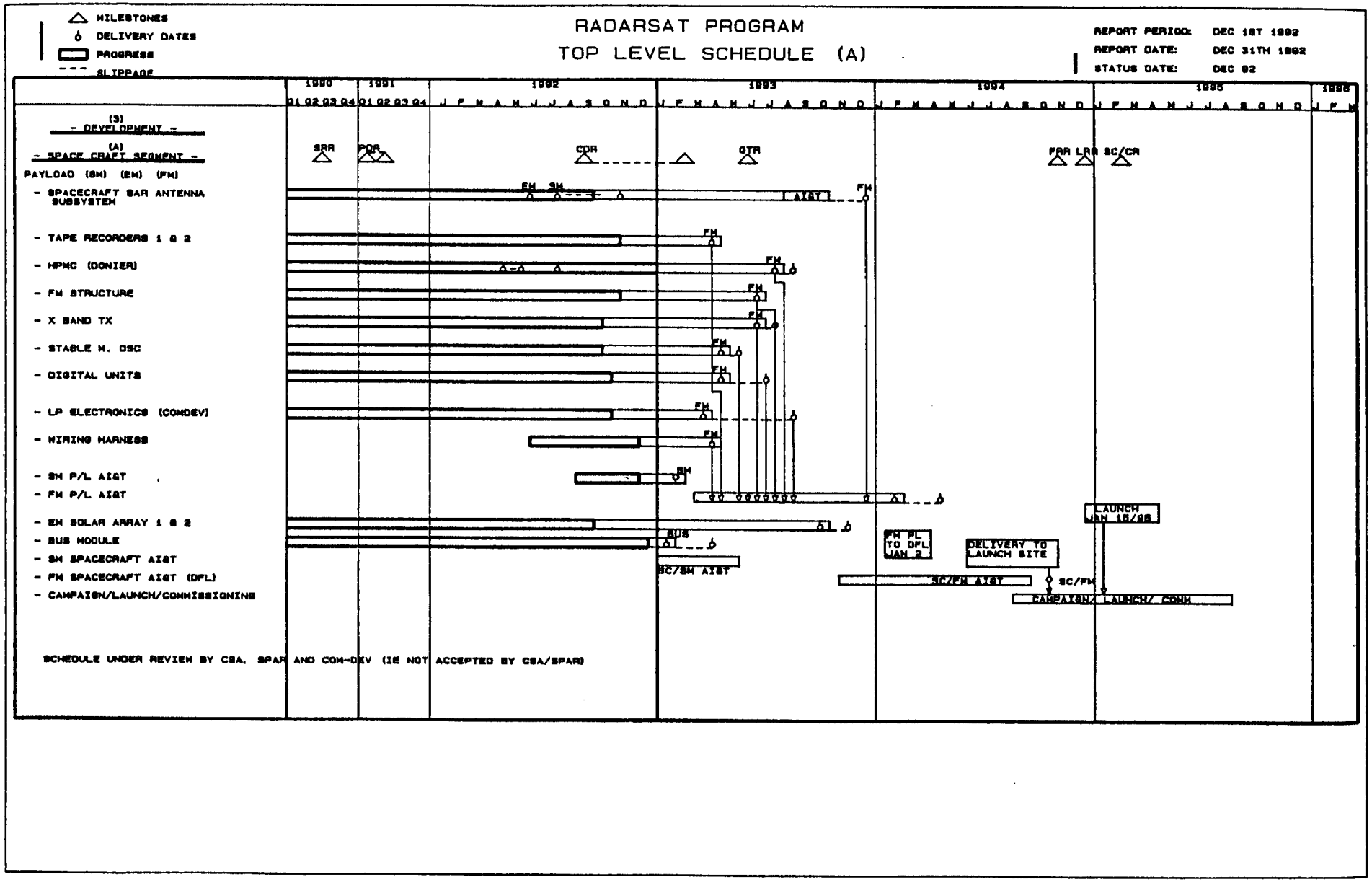


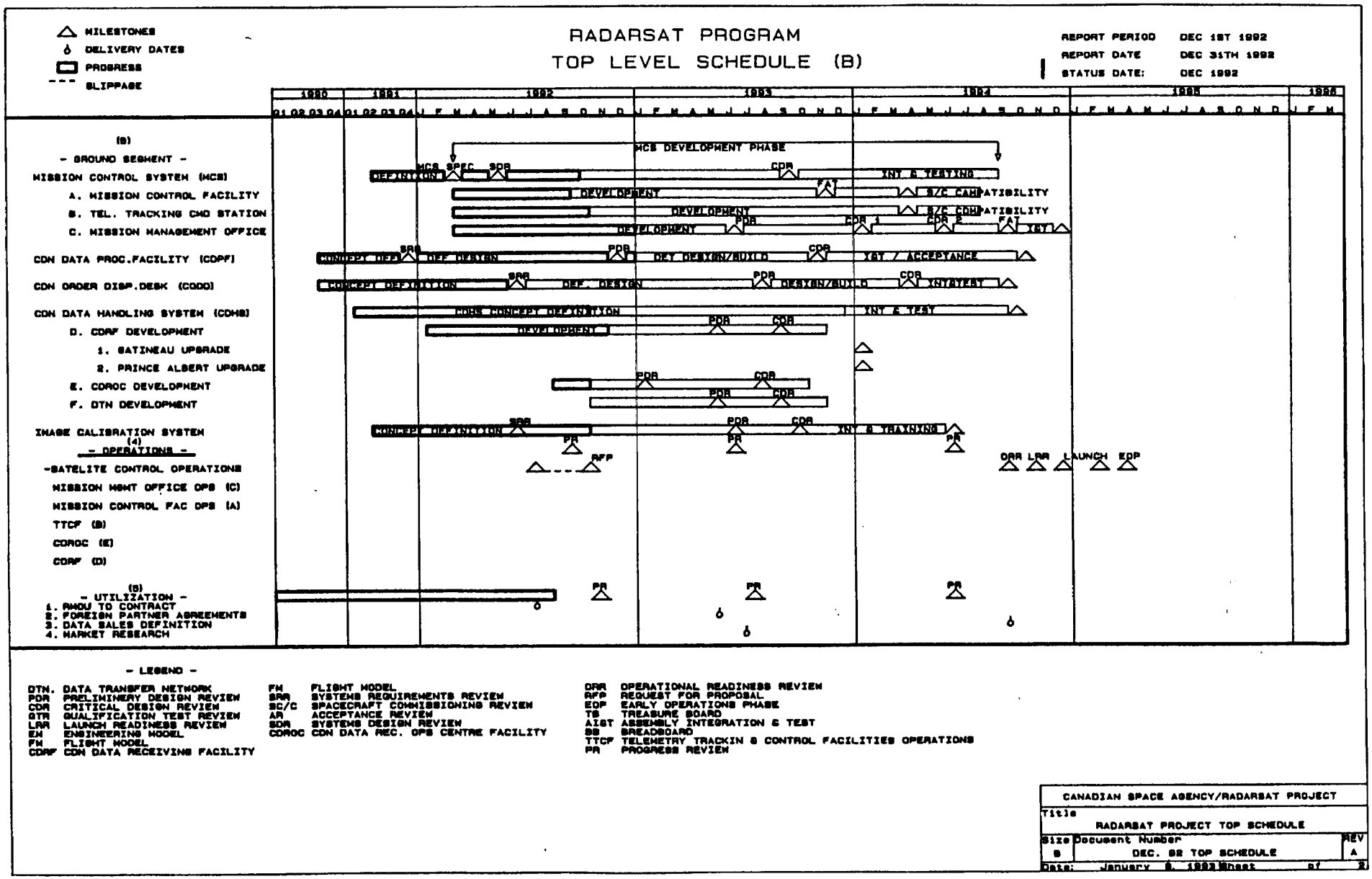
LAUNCH CONFIGURATION



SPACECRAFT CONFIGURATION




MILESTONES
DELIVERY DATES
PROGRESS
SLIPPAGE
RADARSAT PROGRAM
TOP LEVEL SCHEDULE (A)
REPORT PERIOD: DEC 1ST 1992
REPORT DATE: DEC 31TH 1992
STATUS DATE: DEC 92
1990
1991
1992
1993
1994
1995
1996
(3) - DEVELOPMENT -
(A) - SPACE CRAFT SEGMENT -
PAYLOAD (SM) (EM) (FM)
- SPACECRAFT SAR ANTENNA SUBSYSTEM
- TAPE RECORDERS 1 & 2
- HPMC (DONIER)
- FM STRUCTURE
- X BAND TX
- STABLE M. OSC
- DIGITAL UNITS
- LP ELECTRONICS (COMDEV)
- WIRING HARNESS
- SM P/L AIGT
- FM P/L AIGT
- EM SOLAR ARRAY 1 & 2
- BUS MODULE
- SM SPACECRAFT AIGT
- FM SPACECRAFT AIGT (DFL)
- CAMPAIGN/LAUNCH/COMMISSIONING
SRR
PDR
CDR
QTR
FAR
LAR
SC/CR
AIGT
FM PL TO DFL JAN 2
DELIVERY TO LAUNCH SITE
LAUNCH JAN 15/96
SC/FM AIGT
CAMPAIGN/ LAUNCH/ COMM
SCHEDULE UNDER REVIEW BY CSA, SPAR AND COM-DEV (IE NOT ACCEPTED BY CSA/SPAR)



- LEGEND -

DTN. DATA TRANSFER NETWORK
PDR PRELIMINERY DESIGN REVIEW
CDR CRITICAL DESIGN REVIEW
QTR QUALIFICATION TEST REVIEW
LRR LAUNCH READINESS REVIEW
EM ENGINEERING MODEL
FM FLIGHT MODEL
CDRF CDN DATA RECEIVING FACILITY

FM FLIGHT MODEL
SRR SYSTEMS REQUIREMENTS REVIEW
SC/C SPACECRAFT COMMISSIONING REVIEW
AR ACCEPTANCE REVIEW
SDR SYSTEMS DESIGN REVIEW
CDROC CDN DATA REC. OPS CENTRE FACILITY

ORR OPERATIONAL READINESS REVIEW
RFP REQUEST FOR PROPOSAL
EOP EARLY OPERATIONS PHASE
TB TREASURE BOARD
AIST ASSEMBLY INTEGRATION & TEST
BB BREADBOARD
TTCF TELEMETRY TRACKIN & CONTROL FACILITIES OPERATIONS
PR PROGRESS REVIEW

CANADIAN SPACE AGENCY/RADARSAT PROJECT

Title
RADARSAT PROJECT TOP SCHEDULE

Size	Document Number	REV
B	DEC. 92 TOP SCHEDULE	A

Date: January 6, 1993 Sheet of