

**COMMUNICATIONS TECHNOLOGIES
RESEARCH BRANCH**

**OVERVIEW & PRESENTATIONS
FOR THE
NABST EVALUATION OF FEDERAL LABORATORIES
BY THE LORTIE COMMITTEE**

*Communications Technologies Research Branch
Department of Communications*

November 1989

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OVERVIEW

COMMUNICATIONS TECHNOLOGY RESEARCH
BRANCH

DEPARTMENT OF COMMUNICATIONS

R W Breithaupt

October 25, 1989

From: Dr Breithaupt's Office 5-1-93

OUTLINE

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DEPARTMENT
BRANCH
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TRADITIONAL
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8. INTELLECTUAL PROPERTY AND TECH TRANSFER
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MISSION

COMMUNICATIONS TECHNOLOGIES RESEARCH BRANCH

TO PERFORM THE GENERIC R&D REQUIRED TO MEET CANADA'S LONG TERM NEEDS IN RADIO COMMUNICATIONS SYSTEMS AND SERVICES, AND TO PROMOTE THE APPLICATION AND INTRODUCTION OF THESE TECHNOLOGIES. TO COMPLEMENT R&D PERFORMED IN UNIVERSITIES AND INDUSTRY AND TO WORK CLOSELY WITH THE PRIVATE SECTOR TO ENSURE THE EFFECTIVE TRANSFER OF THESE TECHNOLOGIES. TO SUPPORT THE DEPARTMENT OF COMMUNICATIONS IN CARRYING OUT ITS MANDATED RESPONSIBILITIES IN ESTABLISHING TELECOMMUNICATIONS POLICY AND IN RADIO SPECTRUM MANAGEMENT.

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AREAS OF R&D

TRADITIONAL

DEFENCE RESEARCH LABORATORIES 1950 - 69

RADIO PHYSICS LAB

IONOSPHERIC RESEARCH
PROPAGATION RESEARCH
EM SCATTERING, RADAR
OPTICS

NATIONAL SPACE & TELECOMMUNICATIONS LAB

RADIO COMMUNICATIONS SYSTEMS
SPACE PROGRAMS (ALOUETTE, ISIS)
SPACE ELECTRONICS
SPACE MECHANICS

DEPARTMENT OF COMMUNICATIONS LABORATORIES 1969 - 87

RADAR AND COMMUNICATIONS RESEARCH

PROPAGATION RESEARCH
RADAR RESEARCH
RADIO COMMUNICATIONS RESEARCH
OPTICS

SPACE TECHNOLOGY AND SPACE PROGRAMS BRANCHES

SPACE ELECTRONICS
SPACE MECHANICS
SPACE PROGRAMS
(ISIS, HERMES, ANIK B, OLYMPUS, MSAT)
SATELLITE COMMUNICATIONS TRIALS
DAVID FLORIDA LAB(INT & TEST)

NATURE OF WORK

BASIC ORIENTED RESEARCH

VIRTUALLY ALL PHASED OUT SINCE THE CREATION OF DOC IN 1969. THERE IS NO R&D UNDERTAKEN WITHOUT EXPECTED APPLICATION TO TELECOMMUNICATIONS SYSTEMS, PRODUCTS OR SERVICES

MISSION ORIENTED RESEARCH

ALL RESEARCH UNDERTAKEN MUST RELATE TO THE DOC MISSION FOR WHICH THE MINISTER IS ACCOUNTABLE TO PARLIAMENT. SOME TELECOMMUNICATIONS RESEARCH IS UNDERTAKEN AT THE REQUEST OF OTHER DEPARTMENTS AND RELATES DIRECTLY TO THEIR MISSIONS. R&D SUPPORTED BY DOC EITHER INTERNALLY OR EXTRAMURALLY TENDS TO BE LONGER TERM AND HIGHER RISK THAN THAT SPONSORED IN THE PRIVATE SECTOR

APPLICATIONS AND DEVELOPMENT

A MODEST AMOUNT OF APPLICATIONS AND DEVELOPMENT IS UNDERTAKEN, USUALLY IN CLOSE COOPERATION WITH THE PRIVATE SECTOR, IN ORDER TO DEMONSTRATE AND VALIDATE NEW TECHNOLOGY, AND IN ORDER TO STIMULATE THE USE AND EXPLOITATION OF THE NEW INTELLECTUAL PROPERTY. TECHNOLOGY TRANSFER OFTEN REQUIRES THIS VALIDATION.

CLIENTS

GENERAL PUBLIC (STATUTORY)

IMPROVED SYSTEMS AND SERVICES TO MEET FUTURE NEEDS

DOC POLICY DEVELOPMENT (STATUTORY)

SPECTRUM MANAGEMENT

TELECOM POLICY

STANDARDS BODIES - DOMESTIC/INTERNATIONAL

FEDERAL AND PROVINCIAL DEPARTMENTS

RECOVERABLE PROGRAMS (E.G. DND, DOT, CSA)

JOINT TECHNOLOGY & SERVICE DEVELOPMENT

RADIO, SATCOM SERVICE USER GROUPS

VARIOUS ADVANCED SATCOM AND RADIO TRIALS

MANUFACTURERS

TECH TRANSFER AND COOPERATIVE R&D WITH COMPANIES

R & D AND APPLICATIONS CENTRES

CCMC, NWCRF, TELEMATICS AND HEALTH, TRIO ETC

UNIVERSITIES

INTELLECTUAL PROPERTY AND TECHNOLOGY TRANSFER

THE BASIC R&D PRODUCT IS INTELLECTUAL PROPERTY. HOW IS IT EXPLOITED TO THE BEST ECONOMIC AND SOCIAL BENEFIT OF CANADIANS? THE ANSWER DEPENDS ON WHETHER IT IS DONE FOR CIVIL OR MILITARY CLIENTS.

MILITARY

RESULTS ARE NOT ALWAYS PUBLISHED IN THE OPEN LITERATURE AND ARE THEN AVAILABLE ON A NEED TO KNOW BASIS ONLY. DOCUMENTED IN INTERNAL REPORTS.

TECHNOLOGY IS TRANSFERRED TO COMPANIES THROUGH DEFENCE PROCUREMENT CONTRACTS

CIVIL USE IS OFTEN MADE OF THE GENERIC TECHNOLOGIES DEVELOPED

VARIOUS FORA EXIST FOR INTERNATIONAL EXCHANGE, EG TTCP, AGARD, BILATERAL AGREEMENTS

INTELLECTUAL PROPERTY AND TECHNOLOGY TRANSFER (CONT)

CIVIL

RESULTS ARE DOCUMENTED IN VARIOUS FORMS, EG:

PUBLICATIONS IN THE OPEN LITERATURE

INTERNAL REPORTS WHICH MAY HAVE RESTRICTED DIST

WORKING PAPERS TO INTERNATIONAL BODIES (EG ITU/CCIR)

WORKING PAPERS TO POLICY BODIES (EG FCC, DOC)

LICENCE AND PATENT APPLICATIONS OR AGREEMENTS

NEWSLETTERS, BROCHURES, GAZETTE NOTICES

RFP TO INDUSTRY FOR FURTHER WORK

TECHNOLOGY TRANSFER MECHANISMS

USE OF ANY OF THE ABOVE DOCUMENTATION

COOPERATIVE AGREEMENTS - BILATERAL OR MULTILATERAL

STAFF EXCHANGE OR LOAN

PRECOMPETITIVE OR COMPETITIVE R&D CONSORTIA

INDUSTRY CONTRACTS FOR FURTHER DEVELOPMENT

INTERNATIONAL COLLABORATION (EG ITU/CCIR)

MAJOR ISSUES

FOR FEDERAL R&D

- * NO S&T FRAMEWORK TO ESTABLISH RELATIVITY BETWEEN AREAS
- * AGREED STRATEGIC PRIORITIES ARE NOT RECOGNISED
- * EROSION RATHER THAN GROWTH IN KEY AREAS
- * PURE AND APPLIED SCIENCES NOT POPULAR WITH STUDENTS
- * PRIVATIZATION IS POPULAR BUT POORLY UNDERSTOOD
- * POOR UNDERSTANDING OF THE OPTIMUM RELATION BETWEEN INDUSTRY, GOVERNMENT AND ACADEMIA R&D
- * NEW CULTURE NEEDED TO DEVELOP CONSORTIA APPROACHES
- * GREATER STABILITY IN INSTITUTIONS, GOALS AND RESOURCES NEEDED FOR OPTIMUM R&D PAYOFF

MAJOR ISSUES (CONT)

FOR THIS BRANCH

- * EXPLOSIVE GROWTH IN PERSONAL COMMUNICATIONS NOT REFLECTED IN R&D RESOURCES FOR RADIO COMS. MANY OPPORTUNITIES EXIST WHICH CANNOT BE PURSUED.
- * LARGELY A ZERO SUM R&D RESOURCE ENVIRONMENT FOR THE DEPARTMENT UNLESS MAJOR NEW INITIATIVES ARE PROMOTED SUCCESSFULLY
- * NEW MECHANISMS NEEDED TO SUPPORT COOPERATIVE R&D WITH THE PRIVATE SECTOR (EG SHARED FINANCING)
- * VARIOUS ADMINISTRATIVE PROCESSES IN DOC NEED REVIEW AND IMPROVEMENT
- * FURTHER EROSION OF BASE R&D RESOURCES MUST BE REVERSED THROUGH AN EFFECTIVE SELLING JOB
- * A MORE EFFECTIVE S&T POLICY FUNCTION IS NEEDED IN DOC
- * SUCCESS AT THE BRANCH LEVEL REQUIRES THAT MANY OF THE GENERAL S&T ISSUES FACING THE GOVERNMENT BE ADDRESSED

CURRENT PRIORITIES

EXISTING OPERATIONAL PLAN DELIVERY

- * PROGRAM DELIVERY TO CLIENTS, PARTICULARLY DND
CONCLUDE VARIOUS MOUS
- * DELIVER MSAT TRIALS PROGRAM, INDUSTRY BENEFITS
- * OLYMPUS PROPAGATION EXPERIMENTS
- * URBAN / INDOOR PROPAGATION
- * SHARP PROGRAM DEVELOPMENT
- * MOBILE SATCOM R&D SUPPORT
- * COMPLETE STAFFING
- * UPDATE PLANNING AND MGT PROCESSES

NEW INITIATIVES

- * SEARCH 20 R&D PROGRAM(NATIONAL INITIATIVE)
- * CONCLUDE VARIOUS NEW COOPERATIVE R&D AGREEMENTS
- * INITIATE MAJOR NEW SATCOM INITIATIVE (KA BAND)
- * APPROVAL AND RESOURCES FOR THE NEXT PHASE OF SHARP
- * ENHANCE CIVIL RADIO COMMS PROGRAM, INITIATE INDOOR
COMMS PROJECT

RELATION TO OTHER DOC ACTIVITIES

SPECTRUM MANAGEMENT AND REGIONAL OPS

- * REGIONAL PROGRAM DELIVERY
- * R&D ON EFFICIENT SPECTRUM UTILIZATION
- * NEW SERVICES, SYSTEMS (SHARP)
- * PROPAGATION AND INTERFERENCE INFO

CULTURAL AFFAIRS & BROADCASTING

- * VERY LITTLE INTERACTION

CORPORATE MANAGEMENT

- * STAFFING, PROCUREMENT, FINANCES, SERVICES

STRATEGIC PLANNING AND EXTERNAL

- * PROVINCIAL, INTERNATIONAL COOPERATION
- * INPUT TO OVERALL STRATEGIC PLANNING

SPECIAL PROJECTS (QUEBEC)

- * COOPERATION WITH CWARC
- * INDUSTRIAL, PROVINCIAL COOPERATION WITH QUEBEC

RELATION TO
OTHER DOC ACTIVITIES (CONT)

TELECOMMUNICATIONS AND RESEARCH

GOVERNMENT TELECOM AGENCY (DGGT)

- * NEW TECHNOLOGY, SYSTEMS, SERVICES
- * JOINT TRIALS

COMMUNICATIONS AND INDUSTRY DEVELOPMENT (DGIE)

- * R&D FOR APPLICATIONS AND SERVICE TRIALS
- * INDUSTRY DEVELOPMENT STRATEGY
- * CORPORATE TECH TRANSFER SERVICES

TELECOM POLICY (DGTP)

- * PLANNING DOMESTIC AND INTL SPECTRUM ALLOCNS
- * R&D ON SPECTRUM EFFICIENT METHODS
- * R&D AS COMPONENT OF TELECOM POLICY

TECHNOLOGY POLICY AND ASSESSMENT (DGTA)

- * INPUT TO DEPTL S&T PLANNING
- * R&D PUBLIC INFORMATION (PR)
- * NATIONAL R&D STRATEGY (EG SEARCH 20)

COMPONENTS AND DEVICES RESEARCH (DGCD)

- * CLOSE COOPERATION WITH DGRC AT DEVICE LEVEL

BROADCAST TECHNOLOGY RESEARCH (DGBT)

- * PROVIDES RADIO COMMS SUPPORT - MATRIXED
- * INTERACTION IN VOICE CODING / MODULATION AREA

RESOURCE SUMMARY FY 89-90
(Excluding Salaries, Overhead)

	FUNDS(\$K)		
	PY	DOC	OTHER
DGRC OFFICE	4	80	
SATCOM R&D	42	725	1854
MGT	4	95	
MILITARY SATCOM	6.4	45	752(DND)
ADVANCED SATCOM	11	305	612(NSS)
COMM SAT SYSTEMS	6.2	50	50(EMR)
MOBILE SATCOM	14.4	230	440(DOT)
MSAT	16	2985	7100
MGT	2	500	
PROGRAM OFFICE	8	925	
PROJECT OFFICE	6	1570	7100(DIST)
RADIO COM R&D	41	314	2412
MGT	3	29	
DND PROG MGT	2	60	
MILITARY RADIO COMS	30	30	2412(DND)
COMMS PROCESSING	2	45	
SHARP	4	105	
PROPAGATION R&D	24	467	401.4
MGT	2	15	
MOBILE/INDOOR PROP	5	144	
MICROWAVE PROP	6	119	176.9(D,SM)
ELF-UHF PROP	11	189	224.5(DND)
TOTAL	127	4571	11767.4

MISSION

DEPARTMENT OF COMMUNICATIONS

(From FY 88-89 Main Estimates)

OBJECTIVE

TO IMPROVE AND EXTEND COMMUNICATIONS SERVICES AVAILABLE TO CANADIANS AND TO INCREASE THE AVAILABILITY OF AND ACCESS TO CANADIAN CULTURAL PRODUCTS AND ACTIVITIES.

ACTIVITIES

TELECOMMUNICATIONS

PLANNING AND CONDUCTING OF EXPLORATORY R&D; FORMULATING POLICIES FOR REGULATION OF TELECOM SERVICES AND FACILITIES; PROMOTING THE DEVELOPMENT AND EXPLOITATION OF ADVANCED TECHNOLOGIES IN THE FIELD OF TELECOMMUNICATIONS AND INFORMATICS BY CANADIAN INDUSTRY, FOR BOTH DOMESTIC AND WORLD MARKETS.

GOVERNMENT TELECOM AGENCY

SPECTRUM MANAGEMENT AND REGIONAL OPERATIONS

CULTURAL AFFAIRS AND BROADCASTING

CORPORATE POLICY AND MANAGEMENT

RADIO COMMUNICATIONS TECHNOLOGIES

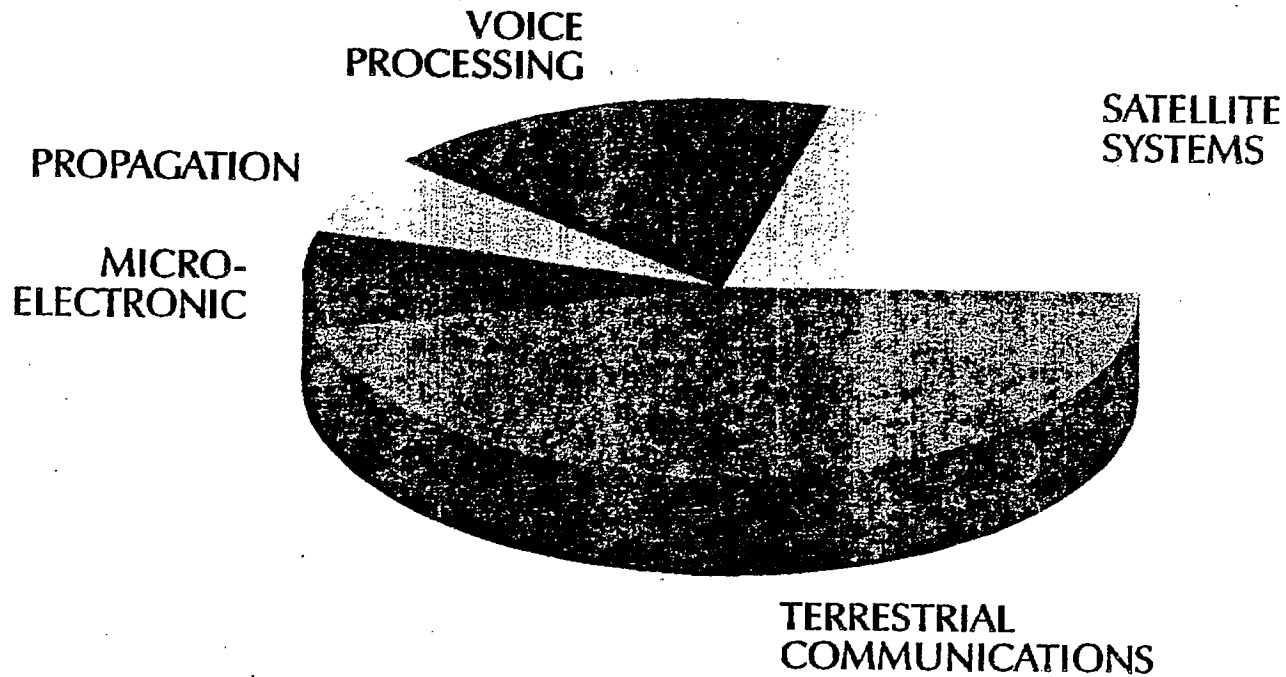
Structure of the presentation:

1. The Defence Recoverable Program
2. The Division Research Program

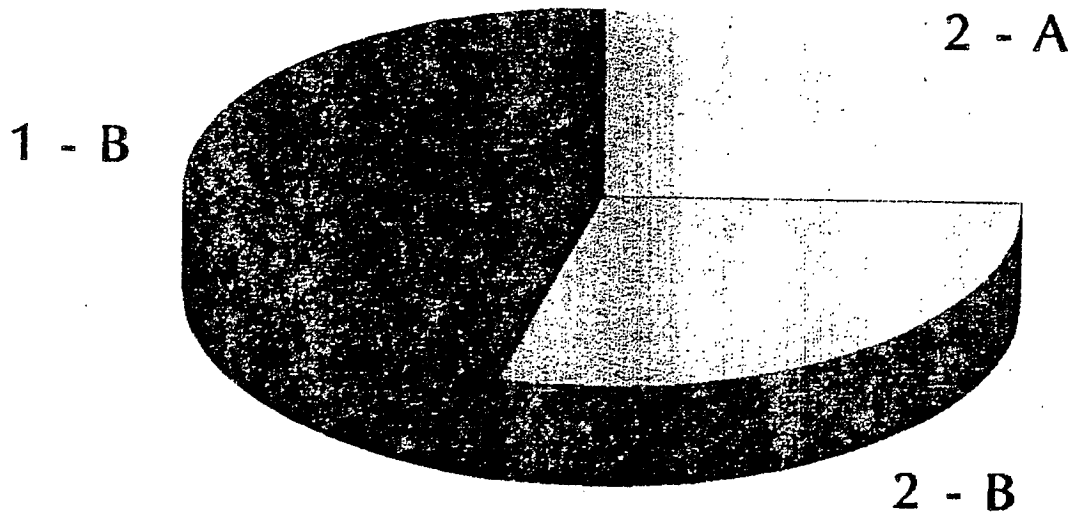
RECOVERABLE PROGRAM

PERSON YEARS	51
SALARY & OVERHEAD	\$4.7 M
GOODS & SERVICES	\$0.8 M
CAPITAL	\$4.4 M

PY Distribution Recoverable Program

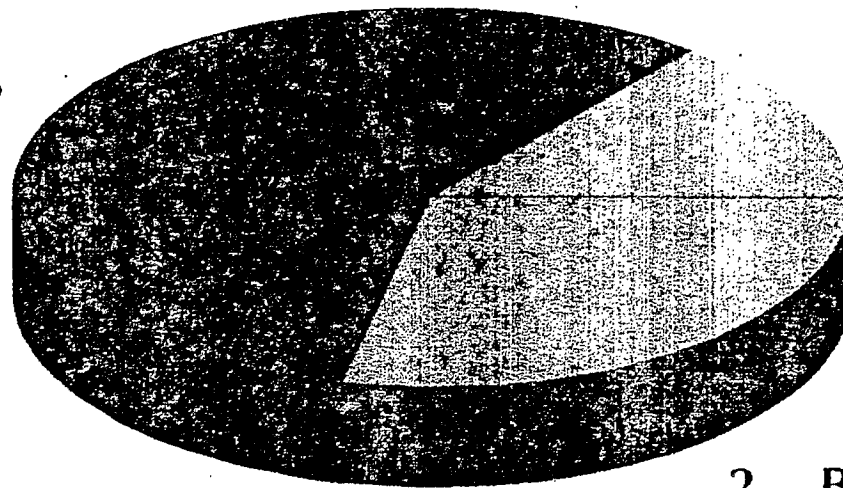


Capital Dollar Disbribution Recoverable Program



PY Distribution Recoverable Program

1 - B



2 - A

2 - B

RECOVERABLE PROGRAM

TERRESTRIAL COMMUNICATIONS
(23 PY)

ECCM TECHNIQUES

MULTI-MEDIA NETWORKS

SELF-ADAPTING HF NETWORKS

ARCTIC SYSTEMS

RECOVERABLE PROGRAM

VOICE PROCESSING (8 PY)

CODEBOOK EXCITED LPC

DYNAMIC FREQUENCY
BAND EXTRACTION

VOICE & DATA

INTERNATIONAL COMMITTEES

<u>TOTAL</u>	<u>(30)</u>
NATO	(9)
TTCP	(11)
CCITT	(4)

Radio Communications Technologies

Management and Admin



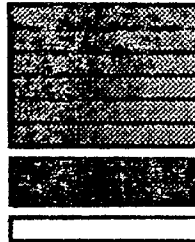
Defence Recoverable Program



SHARP



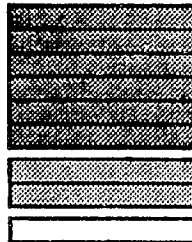
Tactical Comms Technology



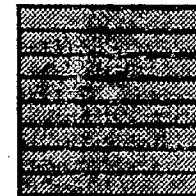
Analysis/Modelling



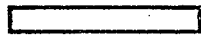
Comms Processing



Radio Networks



Modulation Techniques



DOC Projects



Secoded to DSAT



DND Projects

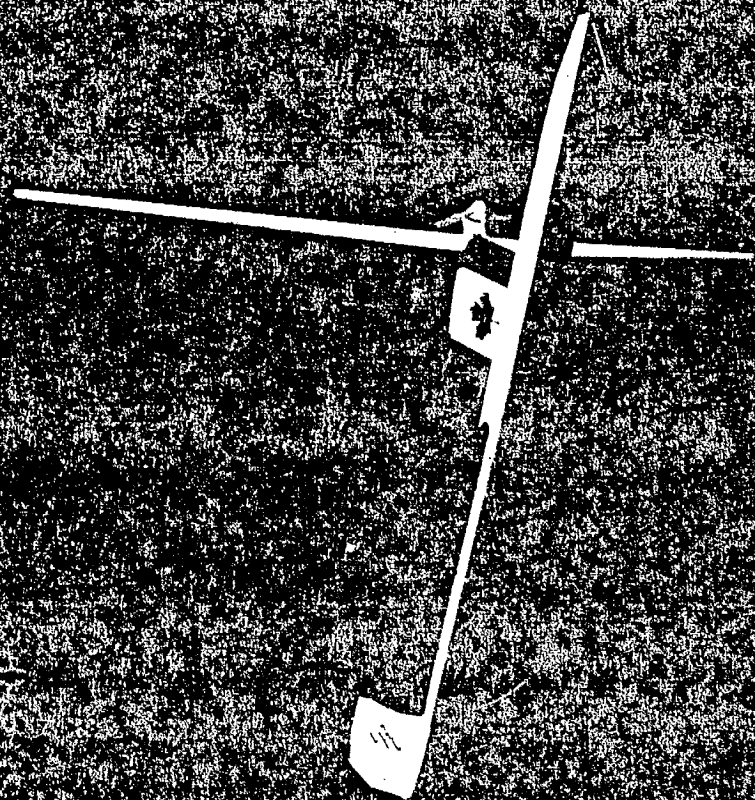


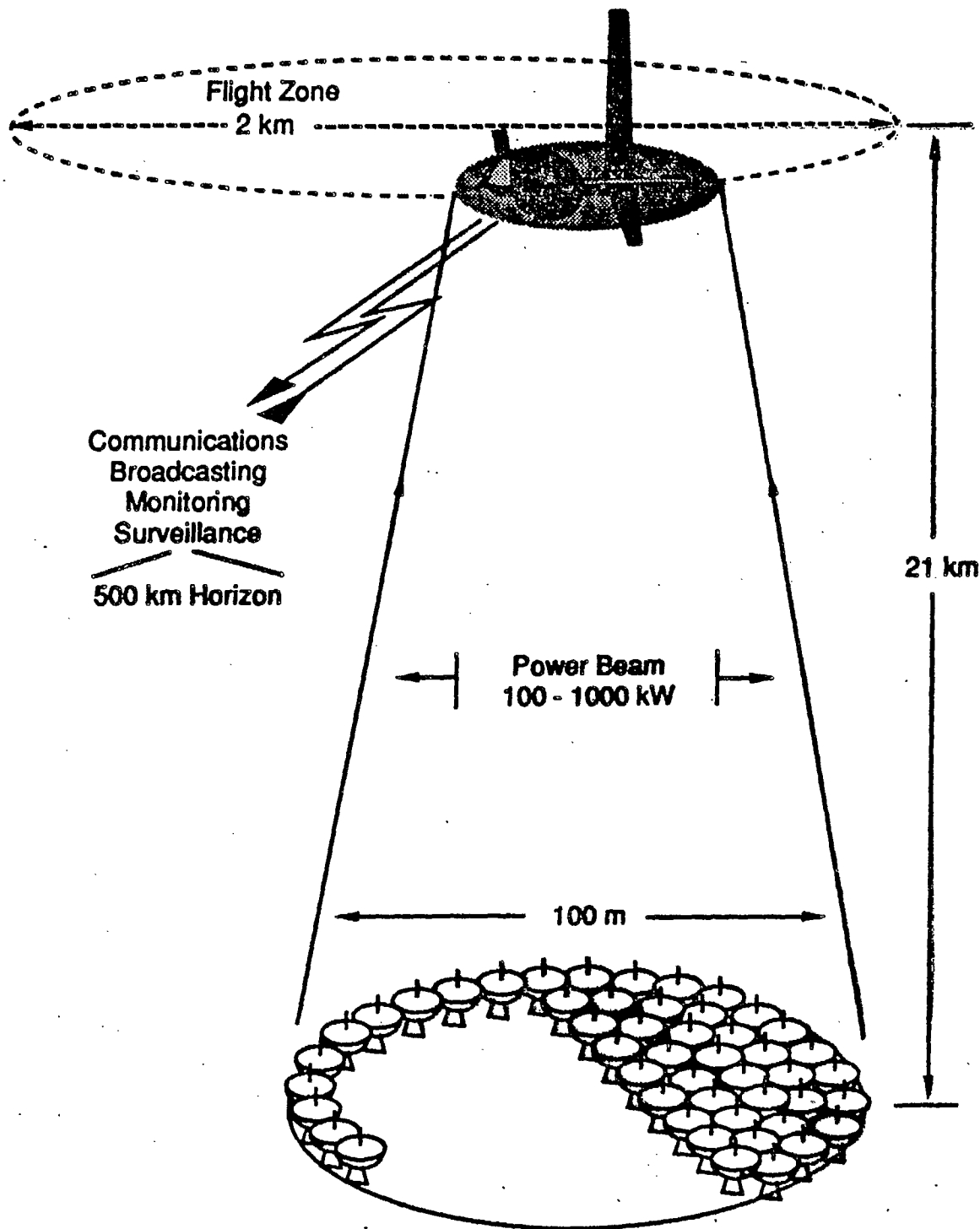
Secoded to DREO

41 PY (11 DOC, 30 DND)

\$291K DOC funds

\$2632K DND funds





SHARP System

Platform Characteristics

Altitude	21 km
Flight circle	2 km
Wingspan	40 m
Weight	1000 kg
Power (motor)	30 kW
Maximum speed	220 km/h
Payload weight	150 kg
Payload power	20 kW
Diameter of area coverage	1000 km
Flight endurance	6 mths

SHARP

C.R.C./D.O.C.

COMMUNICATIONS POTENTIAL OF SHARP

THE FOLLOWING SERVICES COULD BE OFFERED ON AN INTEGRATED BASIS:

- FM TV BROADCAST (12 GHz)
- RADIO TELEPHONE RURAL AREAS (800 MHz)
- CELLULAR RADIO (VERY LARGE CELLS)
- FM RADIO AND TV REGIONAL BROADCASTING (UHF)
- 1-WAY AND 2-WAY VIDEO (18-22 GHz)
- HIGH DEFINITION TELEVISION (18-22 GHz)

SHARP

C.R.C./D.O.C.

OTHER APPLICATIONS OF SHARP

- ENVIRONMENTAL MONITORING
 - CARBON DIOXIDE
 - OZONE

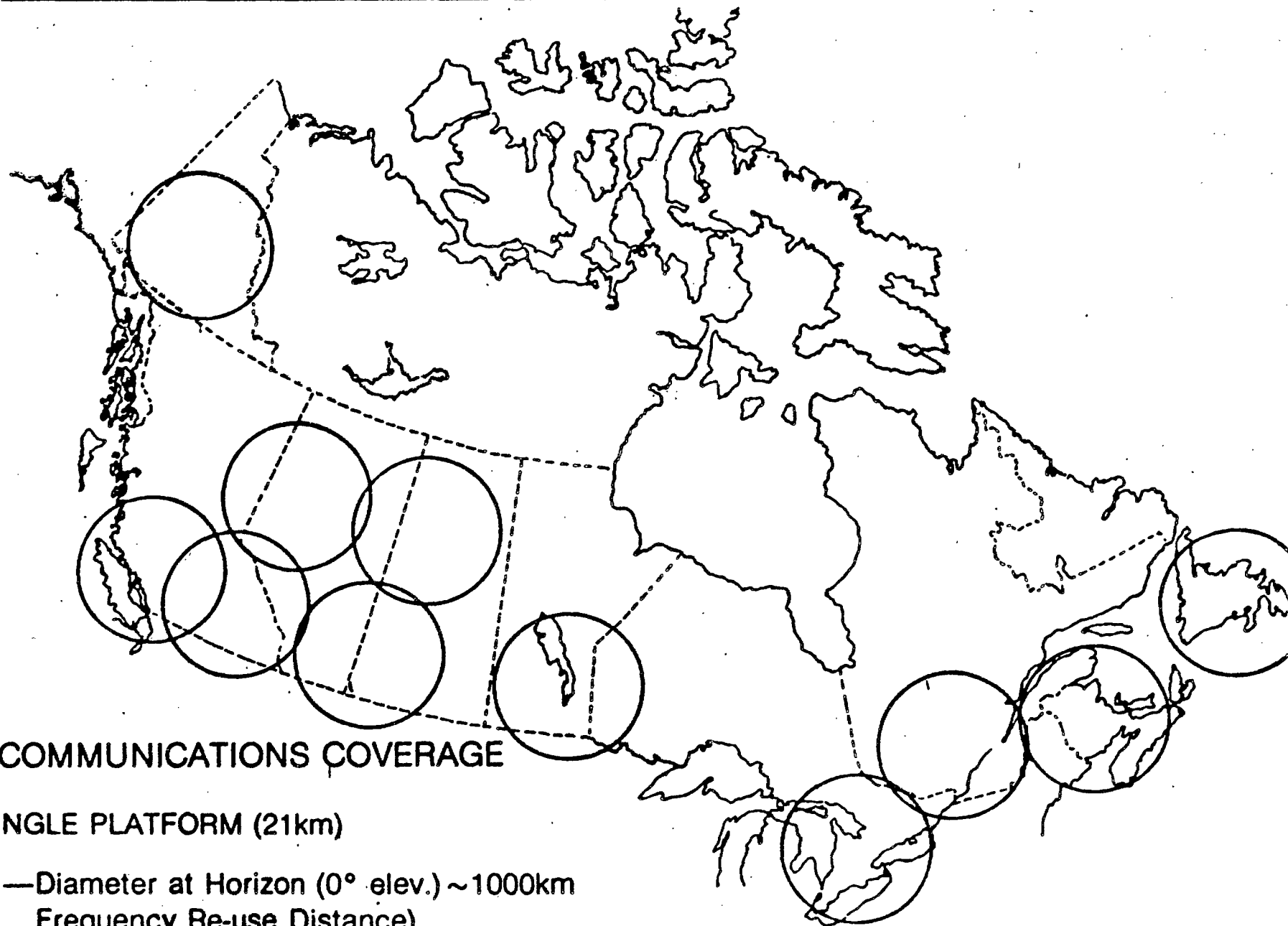
- RADAR SURVEILLANCE
 - COASTAL FISHING ZONE ENFORCEMENT
 - MILITARY EARLY-WARNING DETECTION SYSTEMS

- REMOTE SENSING
 - FOREST FIRE DETECTION
 - ICE DETECTION
 - CROP STUDIES

- RADIO NAVIGATION
 - AIRCRAFT
 - SHIPS

SHARP

C.R.C./D.O.C.



COMMUNICATIONS COVERAGE

A- SINGLE PLATFORM (21km)

- Diameter at Horizon (0° elev.) ~1000km
Frequency Re-use Distance)
- Service Diameter (3° elev.) ~600km

SHARP

COMMUNICATIONS RESEARCH CENTRE

ACTIVITIES AND MILESTONES

<u>ACTIVITIES</u>	<u>PERFORMER</u>	<u>START</u>	<u>FINISH</u>
SHARP PROGRAM	CRC	1981	ON-GOING
PRELIMINARY CONCEPT STUDY	CRC	1981	1982
	SED SYSTEMS		
	UTIAS		
RECTENNA DEVELOPMENT	CRC	1981	ON-GOING
MICROWAVE POWER MODULE	MILLER COMMS.	1982	1983
AERONAUTICAL RESEARCH	UTIAS	1982	ON-GOING
MAJOR FEASIBILITY STUDY	CRC	1984	1985
- AERONAUTICAL	J. F. MARTIN		
- COMMERCIAL VIABILITY	GOSS, GILROY & ASSOC.		
MICROWAVE POWER SYSTEM STUDY	CAL	1984	1985
AERONAUTICAL DESIGN	J. F. MARTIN	1984	ON-GOING
DEVELOP & BUILD SHARP-5	UTIAS	1985	FLEW 1987
DEVELOP MICROWAVE POWERING SYSTEM (DEMONSTRATOR)	CRC	1984	ON-GOING

SHARP

COMMUNICATIONS RESEARCH CENTRE

WORLD'S FIRST MICROWAVE BEAM POWERED FLIGHT

AIRPLANE	SHARP-5 (1/8 full scale) 4.5 m WINGSPAN 4.5 kg 150 W TO MOTOR
RECTENNA ARRAY	1 m² DUAL-POLARIZED
MICROWAVE POWER	10 kW
DATE	17 SEPT. 1987
DURATION	20 MIN.

SHARP

C.R.C./D.O.C.

RECTENNA RESEARCH

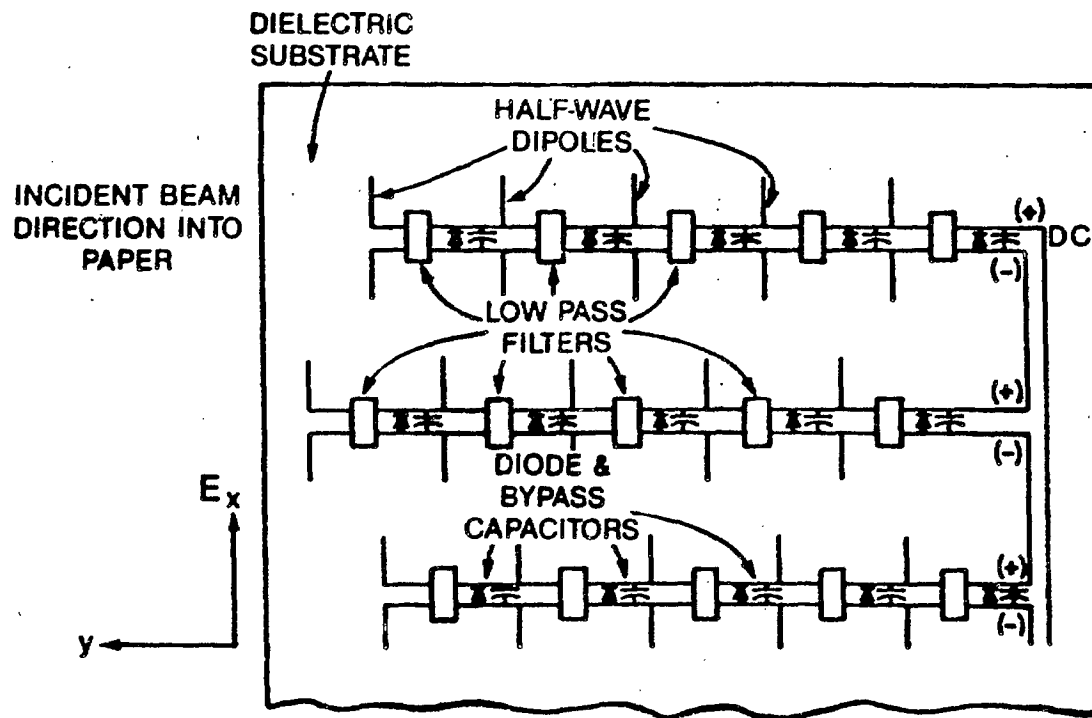
- **FIRST RECTIFYING ANTENNAS (RECTENNAS)
DEVELOPED IN EARLY 1960'S**

- **LINEAR-POLARIZED THIN FILM PRINTED CIRCUIT
VERSION FIRST DEVELOPED IN 1981**

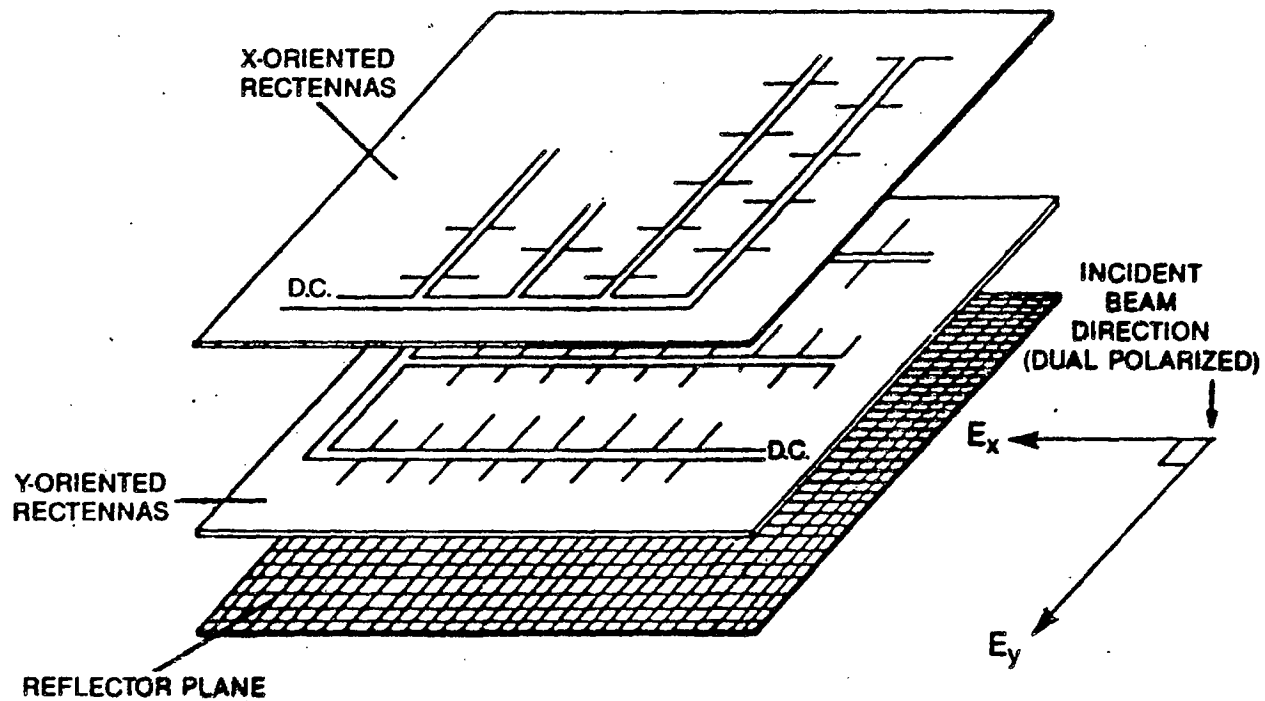
- **RESEARCH AT CRC SINCE 1982 INCLUDES**
 - **DUAL-POLARIZED ARRAYS**
 - **NOISE FREE DESIGNS**
 - **HARMONICS REDUCTION**
 - **2.45 AND 5.8 GHz VERSIONS**

SHARP

C.R.C./D.O.C.



RECTENNA ARRAY



DUAL POLARIZED RECTENNA ARRAY

SHARP

COMMUNICATIONS RESEARCH CENTRE

THE NEXT PHASE

- **SYSTEM**

- 1/2 SCALE (20M WINGSPAN) AIRCRAFT
MICROWAVE AND SOLAR POWERED
- MICROWAVE TRANSMITTER FOR FLIGHT AT 3 KM
- SOLAR POWERED FLIGHT TO 15 KM

- **GOALS**

- PROVE THE CONCEPT
- DEVELOP TECHNOLOGY
- DEVELOP REGULATORY REGIME (MOT, DOC)
- APPLICATIONS TRIALS (100-200 KM RADIUS)
- ESTABLISH FLIGHT ENDURANCE RECORD

- **TIME FRAME**

- SOLAR POWERED COMMS TRIALS : 1991
- MICROWAVE-POWERED TRIALS: 1992-93

- **COST \$ 17M**

SHARP

C.R.C/D.O.C.

RESEARCH ISSUES

1. **LAUNCH AND RETRIEVAL** - solar powering, jet stream
2. **RFI/EMC** - harmonic suppression, interference between payload and power system
3. **ENVIRONMENT** at 20 KM - wind, turbulence
4. **MATERIALS** - UV radiation and ozone
5. **AUTOMATED FLIGHT** - flight patterns, MOT regulations
6. **RECTENNA** - high capacity diodes, efficiency, heat dissipation
7. **SAFETY ISSUES** - radiation hazards, aircraft avionics
8. **POWER SYSTEM** - low cost microwave energy electronic steering of array



**Multi-media
Networks**

In the military environment, there is a need for distinct communications media such as HF, VHF, SATCOM. Multi-media networks refers to the combined use of multiple communications media in a manner which will be transparent to the user.

**Multi-media
Networks**

**Self-adapting
HF Networks**

- To investigate the application of new technologies to provide faster and more reliable HF communications under difficult propagation conditions.

**Data
Networks**

- To find solutions to network management problems, particularly in the multi-media environment.

**Network
Applications of
Expert Systems**

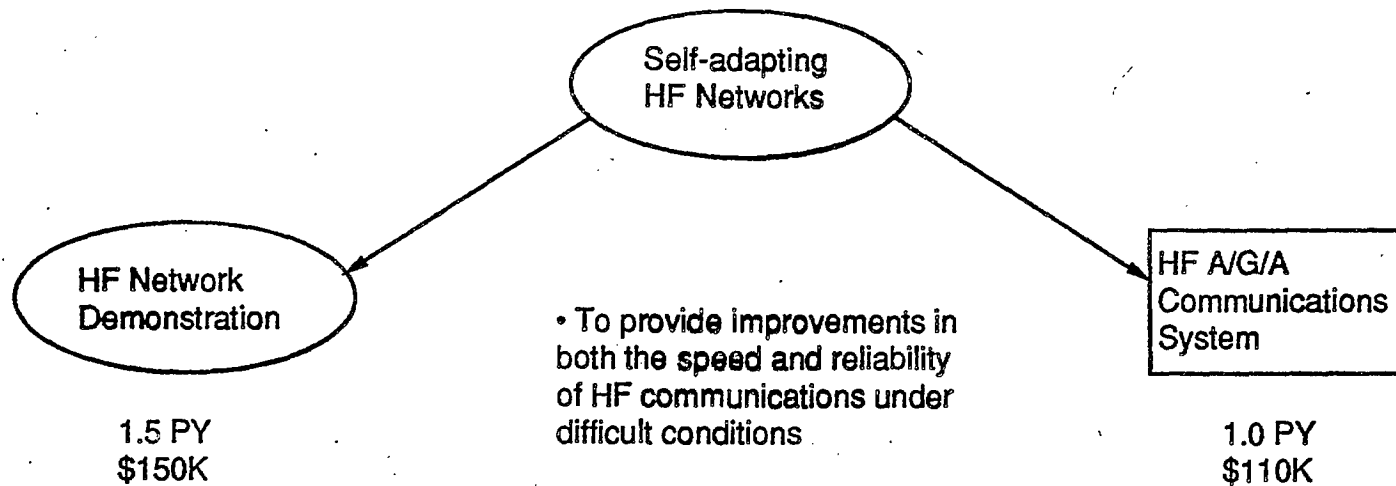
- To develop expertise in the appropriate use of knowledge engineering techniques.

**Transportable
LANs**

- To investigate the potential of high speed, limited distance local area networks in the tactical environment.

OSI

- To examine various aspects of OSI standards and models in light of military requirements



- To demonstrate the operation of reliable HF communications networks

- New, adaptive packet radio techniques have been developed for HF radios

- A network connecting Carp, Shilo, Churchill and Penhold is to be installed in the fall of 1989. DCEM has made extensive purchases of radios in support of this demonstration

- Supported by DCEM on behalf of PM NAADM

- To provide A/G/A communications between the ROCC and AWACS aircraft on patrol in the Arctic

- Trials will be started this summer from Inuvik, Yellowknife and Cambridge Bay to Resolute Bay

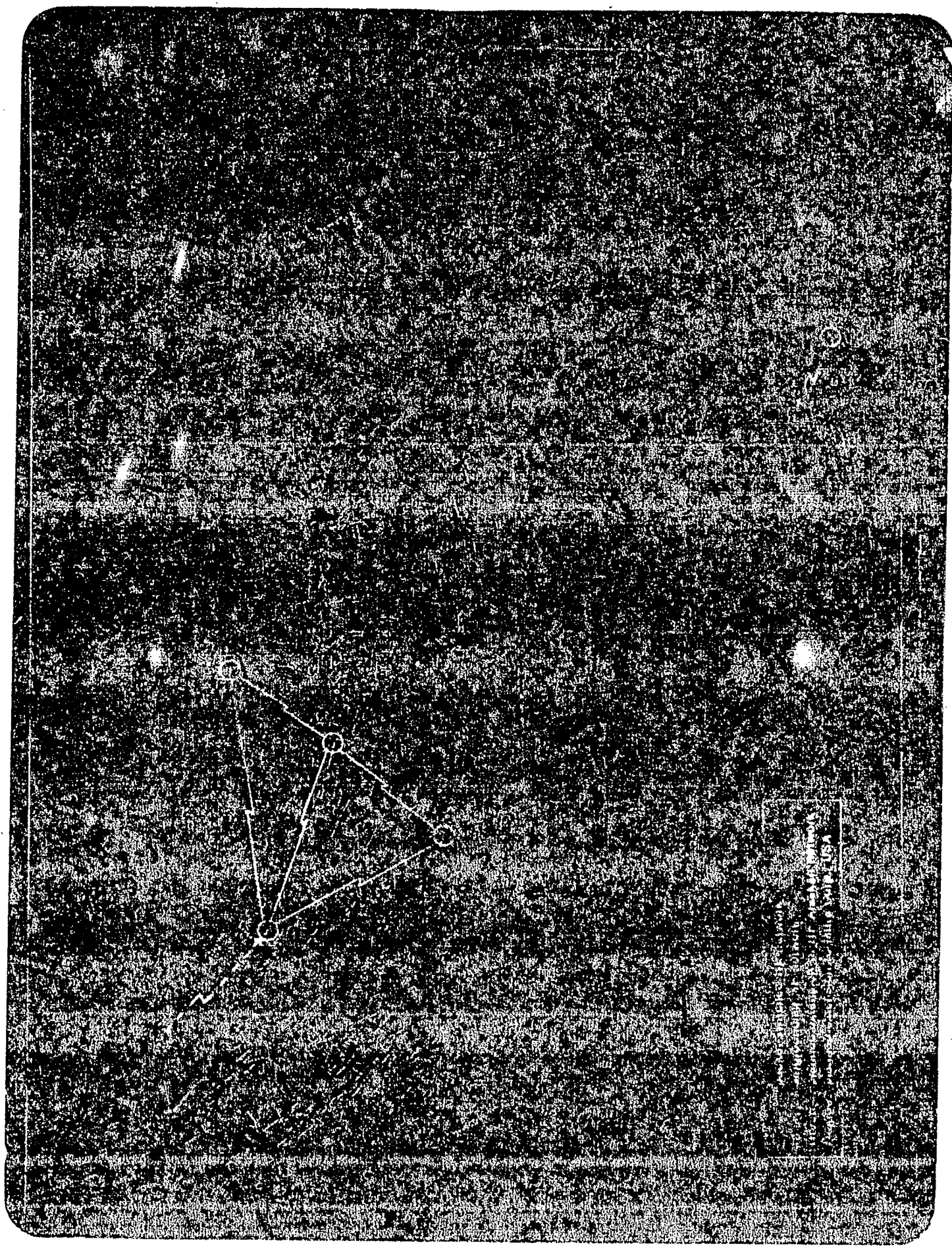
- The US (ESD, RADC) has been invited to participate in this work



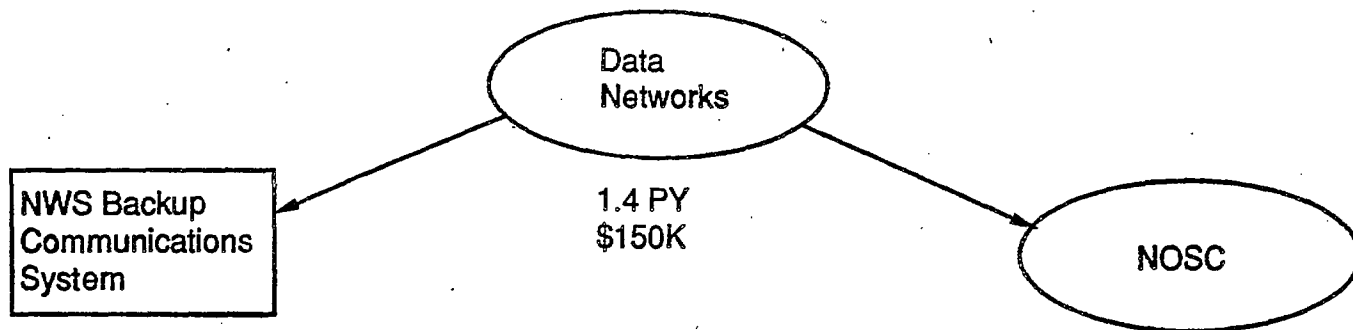
Tech Base Research



Development Tasking



WORLD BOOK ENCYCLOPEDIA
A Division of World Book Company
Chicago, Illinois



Data
Networks

1.4 PY
\$150K

NWS Backup
Communications
System

0.1 PY
\$150K CRAD
\$150K NAADM

NOSC

- To increase the functionality of military networks

- To extend the techniques of multi-media communications to strategic networks

- To design and develop an austere back-up communications system for the North Warning System

- To provide a proof-of-concept demonstration in the Mackenzie Delta region

- Contracted to Diversitel Communications Inc., with installation scheduled for this fall

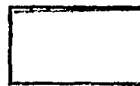
- Multinational meetings are being held toward the definition of joint developments in multi-media technologies

- Canada will probably contribute part of the adaptive HF technology, and will receive value in kind

- It is hoped to establish a Canadian testbed as part of this work

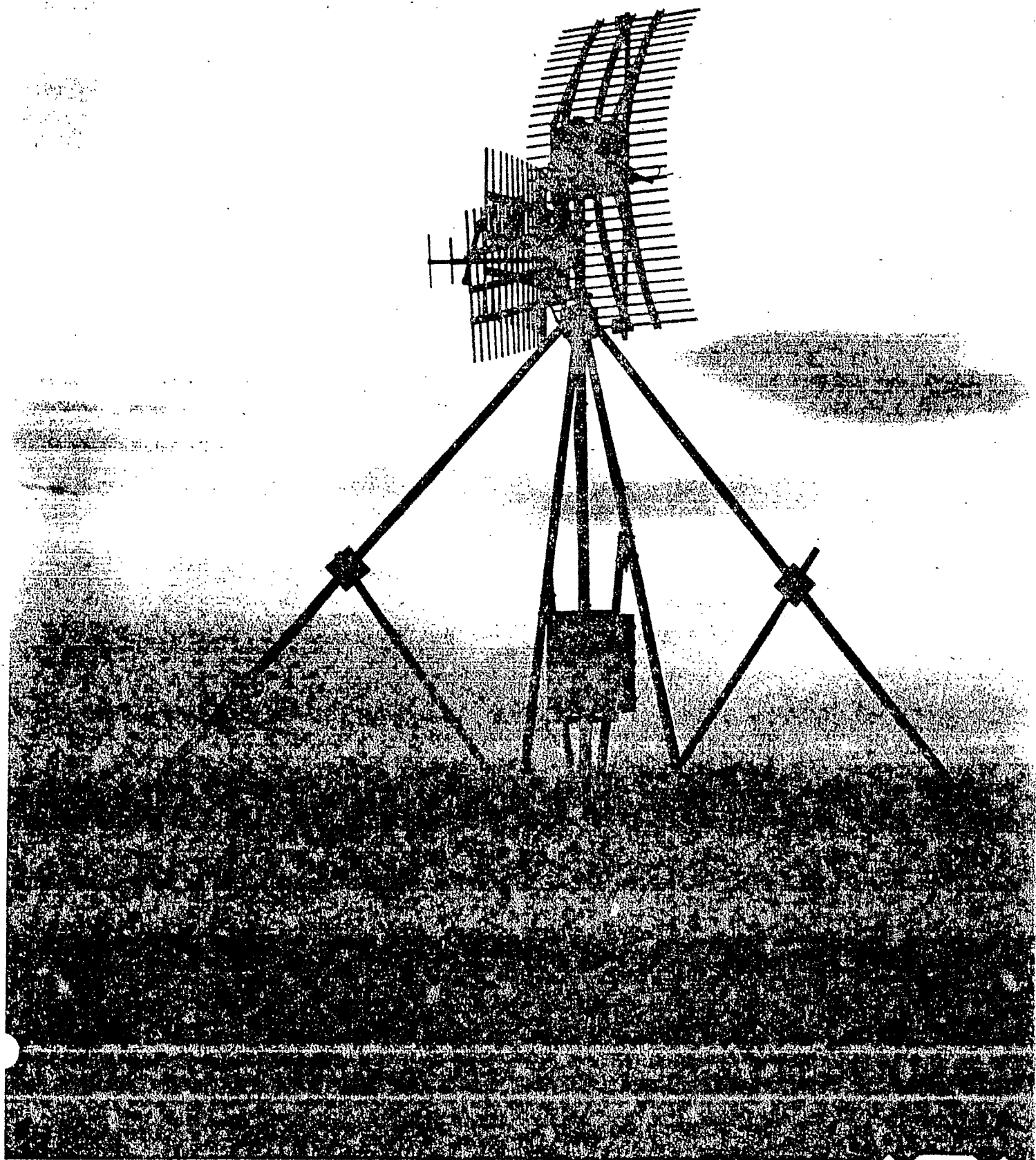


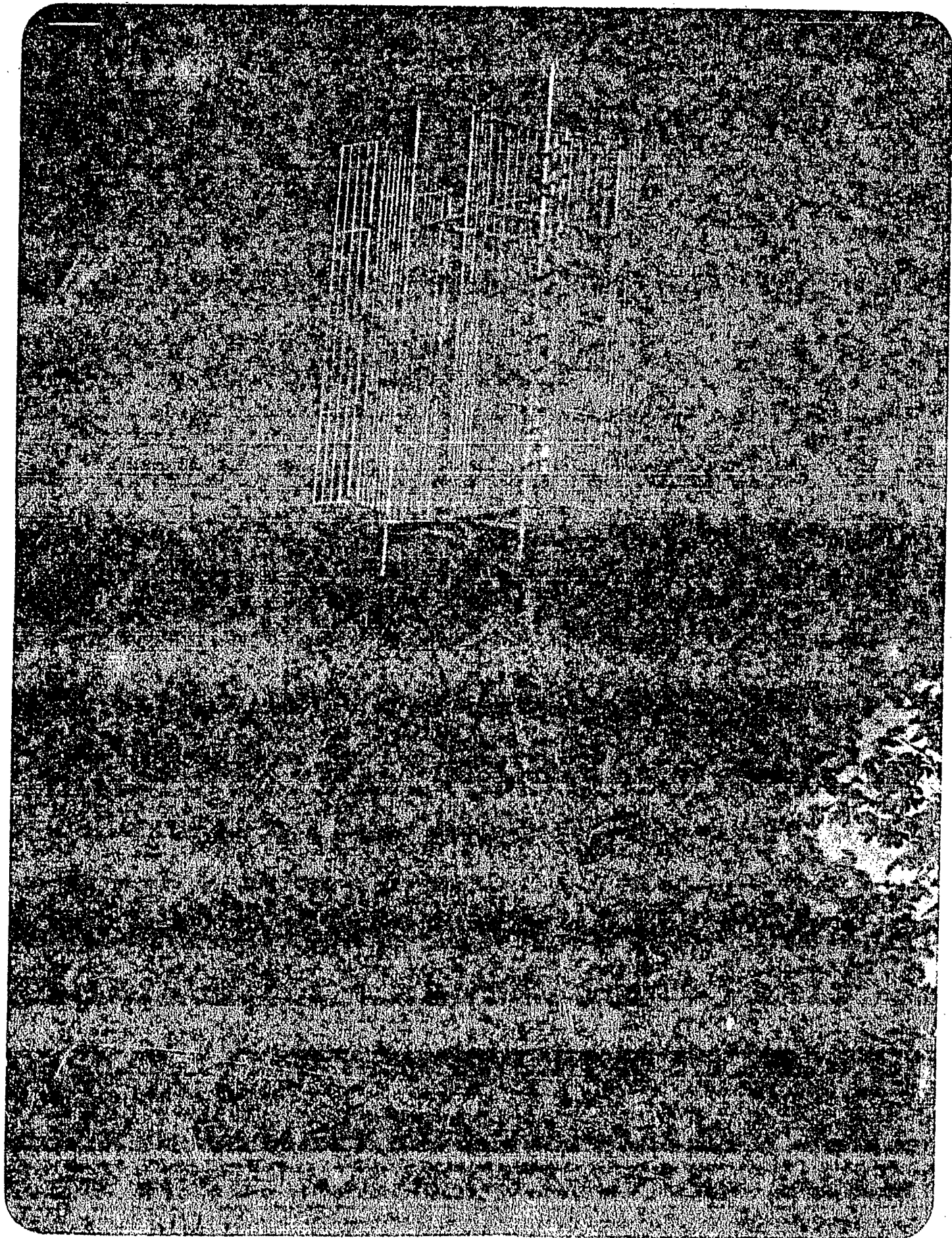
Tech Base Research

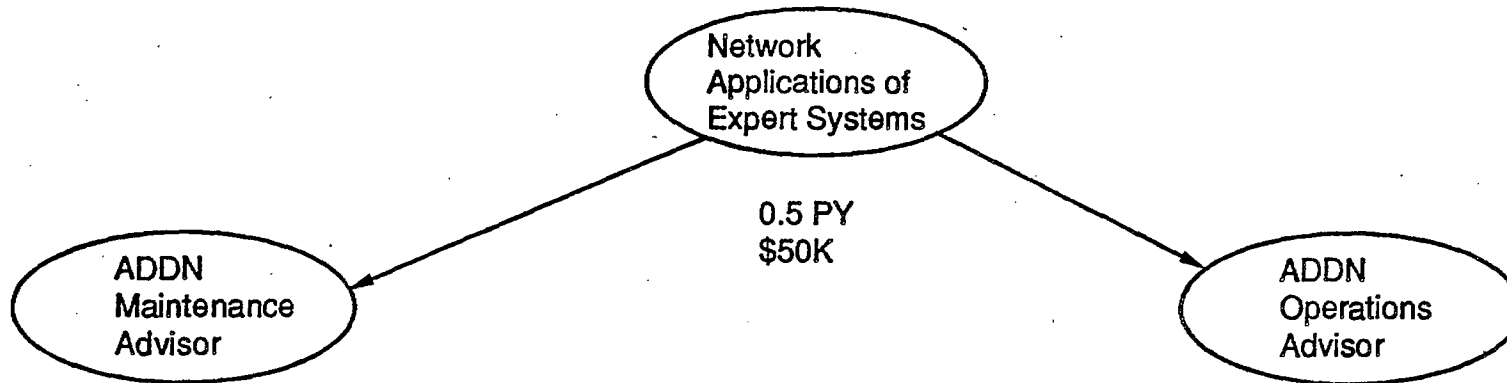


Development Tasking

[Redacted]







- This was the initial work in the area. It has provided an "advisor" for the concentrator on the ADDN

- Eight systems are currently in the field. This part of the work is completed except for improvements as requested by the users

- To develop a strong technology base in the selection of appropriate expert system applications, and the use of tools and techniques

- To provide solutions to network problems through the use of knowledge engineering

- This is follow-on work from the maintenance advisor. It is intended to assist operators with network analysis and recovery.

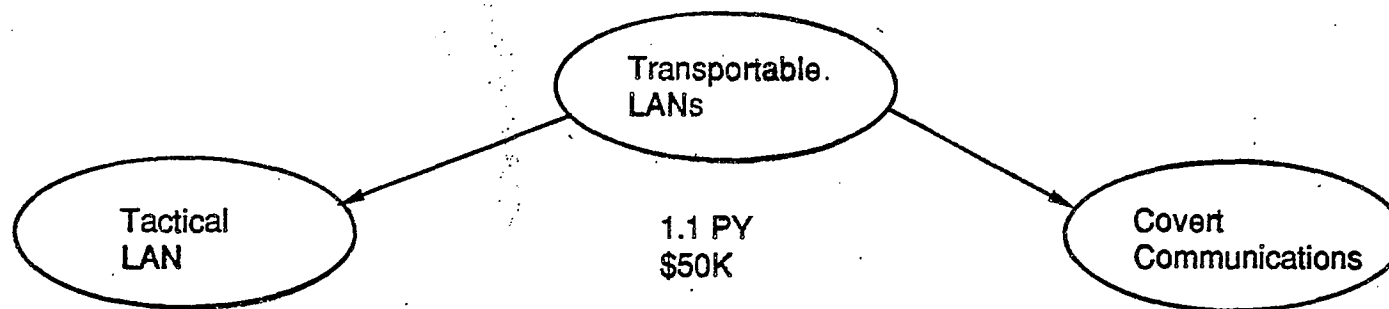
- The current phase of the work involves the evaluation of more powerful tools and graphic displays than were used for the maintenance advisor.



Tech Base Research



Development Tasking



- Investigation of megabit per second, wireless voice and data networks

- Study feasibility of SHF/EHF, optical techniques

- Study protocols

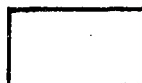
- Work is just beginning

- To develop techniques to improve the speed of deployment, flexibility of operation, and reliability of networks in a limited-distance tactical situation

- The research program has not yet been defined



Tech Base Research



Development Tasking



**ECCM
Techniques**

Modern warfare places a strong emphasis on reliable, consistent communications. Command and control systems are increasingly demanding of data gathered elsewhere for their functioning. In some circumstances it is imperative that the communications be covert so as not to alert an enemy. Thus, electronic warfare has become an important part of military strategy to detect, evaluate and disrupt an opposing force's communications.

This program is intended to develop a strong base in ECCM techniques to meet a wide variety of DND tactical and strategic communications requirements.



ECCM
Techniques

Signal Design
Strategies


This work consists of the design and testing of various specialized modulation and coding techniques.

Adaptive
Antenna
Techniques

Previous work involved the design, construction and testing of null-steering techniques for ship-borne HF arrays. The current work extends the to VHF radios using more modern equipment and processors.

ECCM
Simulation

The division has constructed several computer simulations for various purposes, such as spread spectrum simulation. A current project, in support of a NATO working group, involves the study of HF waveforms which are ECM resistant.



Spectrum Efficient
Voice coding
Techniques

Voice communications are the mainstay of command and control in the military environment. Increasing spectrum congestion demands techniques to minimize the RF channel bandwidth occupied by transmissions. Voice transmissions must be encryptable, must provide speaker recognition, and must be resistant to interference.

Spectrum Efficient
Voice coding
Techniques

CELP
Vocoder

Codebook Excited LPC. The current algorithm provides high quality voice at a data rate of 4800 bps. It is implemented on a single TMS320C25 running at a clock speed of 48 MHz.

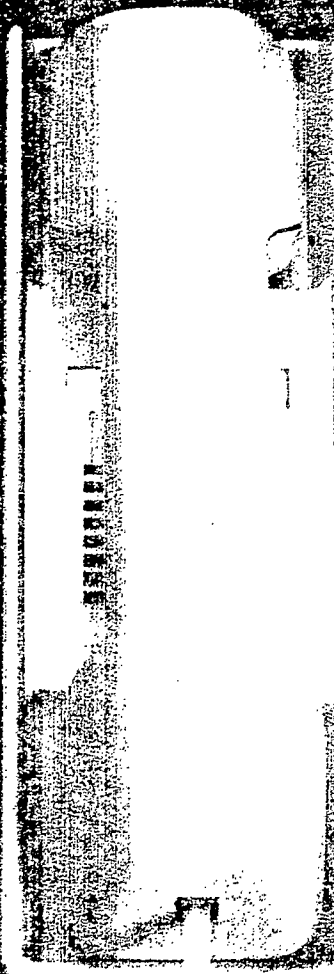
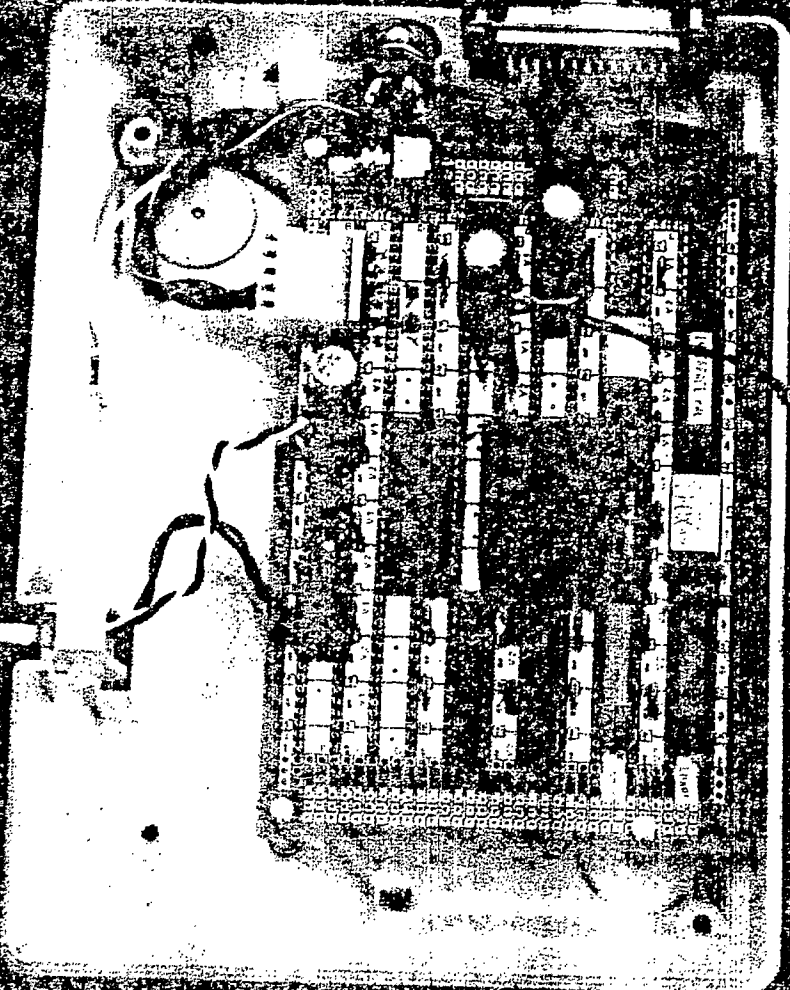
Narrowband
Speech QAM

This is a dynamic windows extraction technique in which narrow frequency bands of the voice spectrum are extracted as spectral lines, normalized, and stacked at "zero" frequency. These spectral lines are then transmitted as QAM along with various other information in digital form. The current implementation provides high quality speech in a 2.5 kHz channel.

Robust Voice and
Data
Transmission

This study of multiplexing voice and data is just beginning. A traffic emulator will be constructed which will produce a composite signal from a number of phantom radios to accurately reflect the real composite signal on a combat network. This signal will send and receive signals from up to five real radios to study their performance under different protocols and coding schemes.

HAMMOND
PART 412 011



CELP 4800
Communications
Canada

1	ABC	DEF
2		3
GHI	JKL	MNO
4	5	6
PQR	TUV	WXY
7	8	9
*	0	#

RADIO PROGAGATION DIRECTORATE

Director: Dr. J.S. Belrose

OUTLINE

ORGANIZATION AND GENERAL OBJECTIVES

ELF-UHF ANTENNAS AND PROPAGATION GROUP

Objective, Resources, Clients

Major Achievements

Five-year Science Plan

LAND MOBILE/INDOOR RADIO PROPAGATION GROUP

Objective, Resources, Clients

Major Achievements

Five-year Science Plan

MICROWAVE PROPAGATION GROUP

Objective, Resources, Clients

Major Achievements

Five-year Science Plan

INTERNATIONAL ACTIVITIES

TECHNOLOGY TRANSFER MECHANISMS

CURRENT ISSUES

RESEARCH AREAS REQUIRING INCREASED EMPHASIS

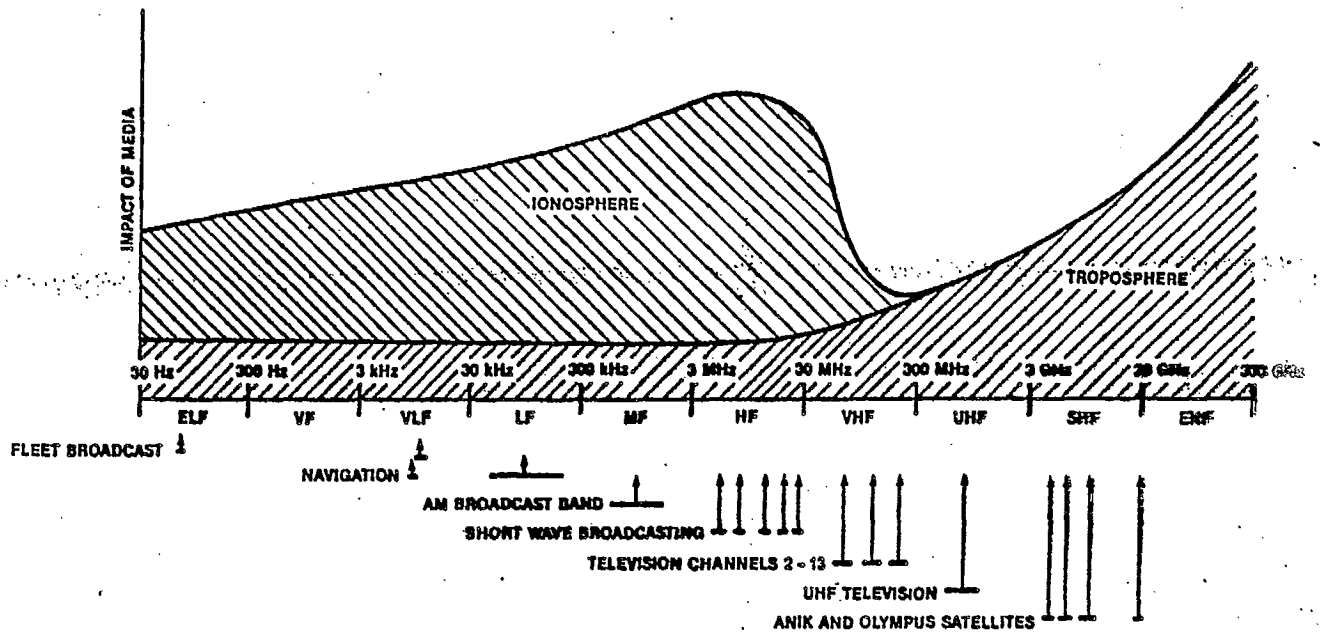
RADIO PROPAGATION

ORGANIZATION:

- **ELF-UHF ANTENNAS AND PROPAGATION GROUP**
D.B. Ross, Manager (MF-UHF)
W. Lauber, Manager (ELF-LF)
- **LAND MOBILE/INDOOR RADIO PROPAGATION GROUP**
R.J.C. Bultitude, Manager
- **MICROWAVE PROPAGATION GROUP**
R.L. Olsen, Manager

GENERAL OBJECTIVES:

- **MEASURE PROPAGATION, INTERFERENCE, AND NOISE DATA FOR FREQUENCY RANGES AND REGIONS OF THE COUNTRY WHERE FEW DATA EXIST** (e.g., EHF RANGE, ARCTIC)
- **CONDUCT FUNDAMENTAL RESEARCH ON THE LESS WELL UNDERSTOOD PROPAGATION PHENOMENA AND MEDIA** (e.g., MULTIPATH PROPAGATION, MAGNETOSPHERE)
- **DEVELOP AND IMPROVE PROPAGATION PREDICTION TECHNIQUES FROM EXPERIMENTAL DATA AND THEORY**
- **PROVIDE INFORMATION AND ADVICE TO CLIENTS**
- **PROVIDE EXPERTISE TO INTERNATIONAL SCIENTIFIC AND TECHNICAL ORGANIZATIONS** (e.g., ITU/CCIR) **AND CARRY OUT OTHER INTERNATIONAL COMMITMENTS**



ELF-UHF ANTENNAS AND PROPAGATION GROUP

OBJECTIVE: Propagation research (and limited associated antenna research) covering the range of frequencies from the ELF to UHF bands

RESOURCES (1989/90):

PY	11
G&S	\$78,000
Capital	\$105,000
DND Funding	\$224,500

CLIENTS: Spectrum Management, Policy, and International Branches of the Department of Communications

Department of National Defence and other government departments

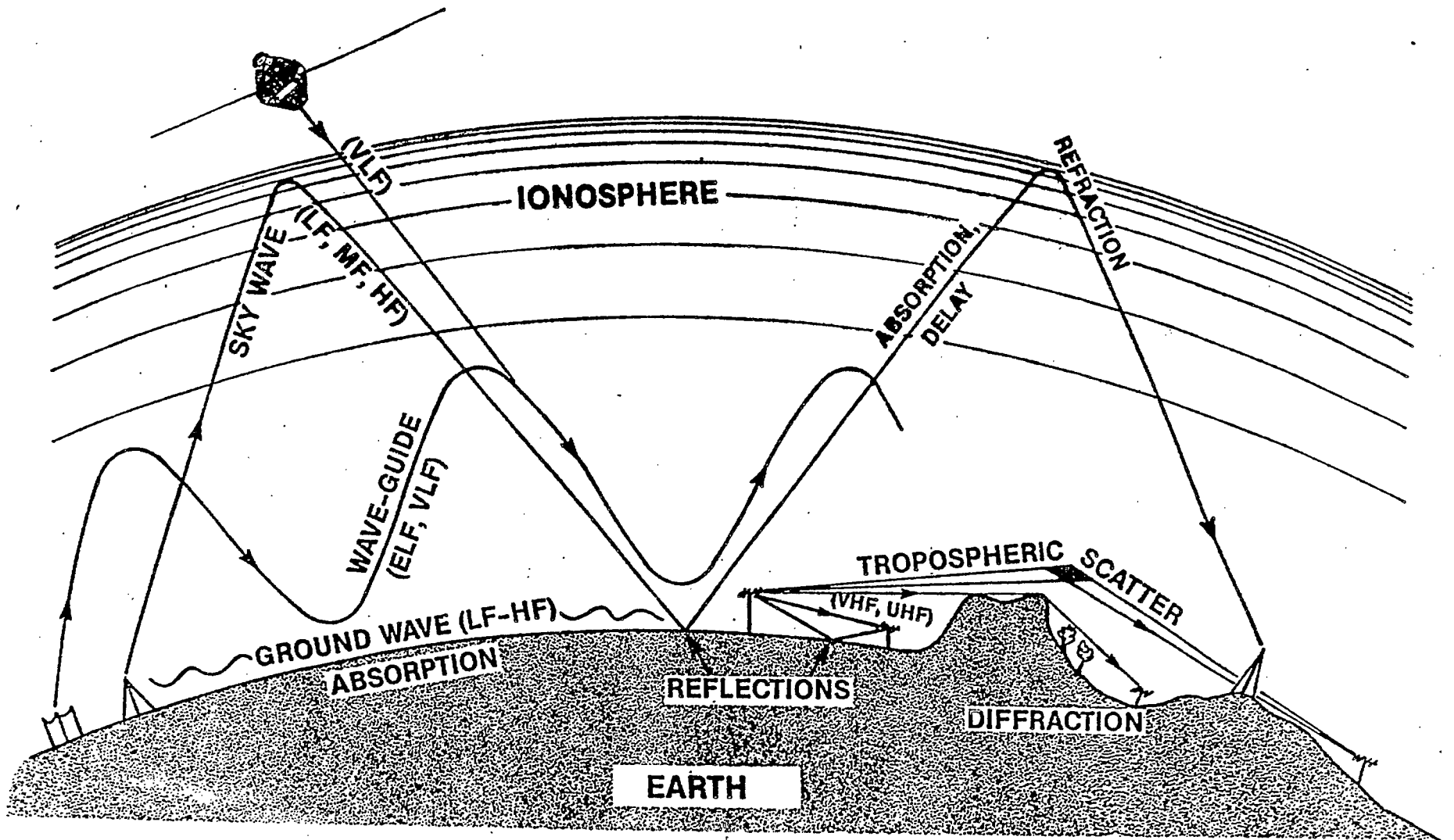
Royal Canadian Mounted Police

National Research Council of Canada

Private Industry

ELF — UHF ANTENNAS AND PROPAGATION GROUP

Main Propagation Mechanisms at ELF-UHF



MAJOR ACHIEVEMENTS

IONOSPHERIC/MAGNETOSPHERIC PHYSICS:

- 1965 Discovery of the region of low electron density in the high-latitude ionosphere known as the F-region trough
- 1970 Observation and explanation of electrostatic resonant spikes using ALOUETTE/ISIS topside sounders
- 1978-80 Feasibility of Waves in Space Plasmas (WISP) bistatic propagation experiment established from ISIS rendezvous experiments
- 1980 Explanation of long-delay ionospheric echoes by three mechanisms giving different delay ranges
- 1983 New data on antenna nonlinearities in magneto-plasmas from observation of solar accelerated plasmas on the ISIS topside sounders
- 1977-86 Explanation of the origin of irregularities in ionospheric electron density and of their interaction with EM waves
- 1989 First demonstration of plasma sheath waves in the OEDIPUS 1-km sounding rocket tether exp.
- 1980-89 Development of WISP - HF Experiment to be performed on demonstration flight of NASA Orbital Maneuvering Vehicle from US space shuttle in 1993

HF PROPAGATION AND NOISE

- 1954 Development of Canadian HF prediction method for northern hemisphere
- 1960's Development of one of the earliest computer programs for HF prediction
- mid-60's Unique service providing maps showing coverage of various frequencies from given transmitter made available to users
- 1973 Canadian HF prediction program and mapping service licensed to private industry.
- 1973-79 Development and use of the first "site survey procedure" to characterize the man-made noise degradation for HF receiving sites
- 1979-82 First extensive use of amplitude probability distribution and other statistical models to characterize HF power line noise

VHF/UHF PROPAGATION AND NOISE

- 1975-84 Development of VHF/UHF prediction program and terrain data base, and dissemination to private industry and government agencies
- 1977-84 First extensive measurement program of 100-950 MHz man-made noise in Canada for business, residential, and rural areas
- 1983-87 Extensive VHF/UHF measurements of multipath fading on LOS overwater links in the arctic
- 1984-89 Development of improved VHF/UHF program based on rigorous diffraction theory; implementation on dial-up IBM PC

CCIR

- 1975 IWP 6/3: addition of F1 layer prediction to Report 340 - "CCIR Atlas of Ionospheric Characteristics"
- 1982 IWP 6/11: provision of chairman who wrote Report 886 - "Special properties of the high-latitude ionosphere affecting radiocommunications"
- 1982-84 IWP 6/12: development of framework for assessing HF broadcasting requirements forming basis for planning method approved by the 1984 HF Broadcasting Conference.
- 1986 IWP 5/1: incorporation of improved conductivity map for Canada in Report 717 - "World atlas of ground conductivities"

TRAIL RADIO

- 1977 Demonstration of VHF trail radio system in Koartak, Québec.
- 1978-79 Demonstration of prototype radiotelephone interconnect (RTI) system employing hardware elements developed in-house and in Canadian industry
- 1985-89 HF trail radiotelephone system installed on the Labrador coast for use by six communities.

FIVE-YEAR SCIENCE PLAN

ACTIVITIES IN NEXT FIVE YEARS DRIVEN BY FOUR MAIN TRENDS:

- 1. INCREASED INTEREST BY DND IN VLF/LF TERRESTRIAL COMMUNICATIONS IN THE ARCTIC.**
- 2. INCREASED INTEREST BY DND AND OTHER ORGANIZATIONS IN HF AND UHF TERRESTRIAL COMMUNICATIONS SYSTEMS FOR "BACKUP" PURPOSES.**
- 3. RAPIDLY INCREASING USE OF FIXED POINT-TO-POINT AND LAND-MOBILE COMMUNICATIONS SYSTEMS IN THE VHF/UHF BANDS.**
- 4. CONTINUING INTEREST BY NRC IN DOC SUPPORT FOR SPACE SCIENCE PROGRAMS ON THE IONOSPHERE AND MAGNETOSPHERE.**

TECHNOLOGY TREND AND CORRESPONDING ACTIVITIES

**TREND 1 : INCREASED INTEREST BY DND IN VLF/LF
TERRESTRIAL COMMUNICATIONS IN THE ARCTIC**

**TREND 2 : INCREASED INTEREST BY DND AND OTHER
ORGANIZATIONS IN TERRESTRIAL
COMMUNICATIONS SYSTEMS FOR "BACKUP"
PURPOSES.**

ACTIVITIES:

- **DEVELOPMENT AND IMPROVEMENT OF COMPUTER
MODELS FOR PROPAGATION PREDICTION - VLF
THROUGH HF**
 - Develop programs for LF and MF bands based on CCIR
models (contract with Petrie Telecommunications)
 - Adapt existing US programs for the VLF band
and validate from measurements

- **MODELLING OF ANTENNA CHARACTERISTICS USING
NUMERICAL AND EXPERIMENTAL TECHNIQUES**
 - Scale model measurements and numerical modelling of
VLF antennas for DND
 - HF antenna measurements

TECHNOLOGY TREND AND CORRESPONDING ACTIVITIES

TREND 3 : RAPIDLY INCREASING USE OF FIXED POINT-TO- POINT AND LAND-MOBILE COMMUNICATIONS SYSTEMS IN THE VHF/UHF BANDS

ACTIVITIES:

- **IMPROVEMENT OF THE CAPABILITY TO PREDICT
PROPAGATION LOSS AND THE PERFORMANCE OF RADIO
COMMUNICATIONS SYSTEMS IN THE VHF AND UHF
BANDS.**
 - Complete the model for diffraction attenuation over
irregular terrain
 - Determine the location variability of received signal
strength in various environments

- **INTERFERENCE MEASUREMENTS AT UHF IN MANITOBA**

TREND 4 : CONTINUING INTEREST BY NRC IN DOC SUPPORT FOR SPACE SCIENCE PROGRAMS ON THE IONOSPHERE AND MAGNETOSPHERE

ACTIVITIES:

- **PARTICIPATION IN OEDIPUS TETHER EXPERIMENTS,
PROJECT "ACTIVE", ETC.**
 - Cooperation with Norway, US, USSR, etc.

- **PREPARATION FOR WISP-HF EXPERIMENT IN 1993**
 - Chair international experimenters group
 - Monitor development contract with CAL

LAND MOBILE / INDOOR RADIO PROPAGATION GROUP

OBJECTIVE: Propagation research in the VHF - EHF bands on channel modeling and prediction of digital system performance for application to terrestrial land mobile communications systems and indoor LANS

RESOURCES (1989/90):

Person Years	5
Goods and Services	\$87,000
Capital	\$53,000

CLIENTS: Spectrum Management, Policy, CWARC, and International Branches of the Department of Communications

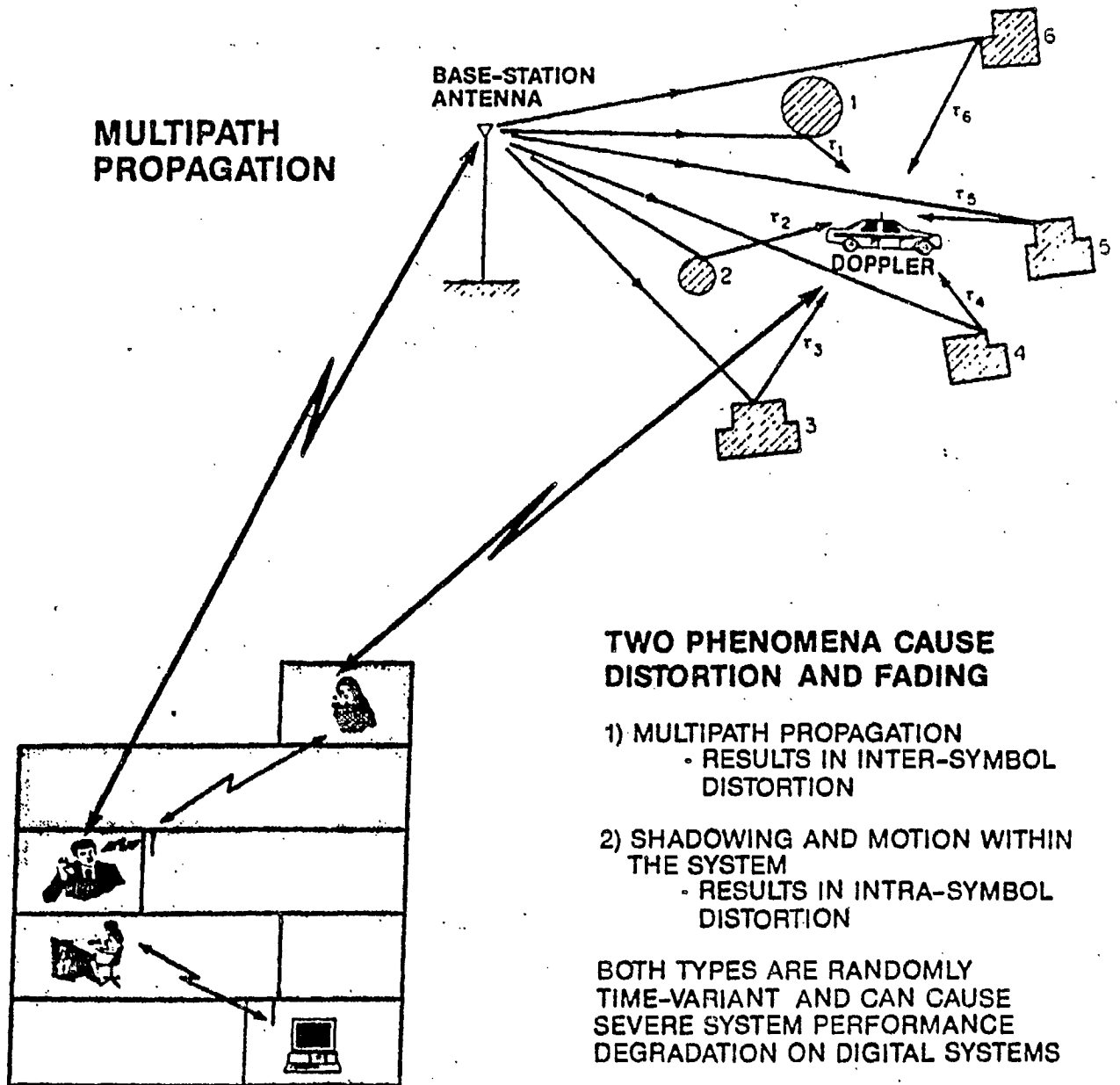
Other Government Agencies

Cellular Network Carriers

Industry (e.g., NovAtel, Bell-Northern Research)

LAND MOBILE / INDOOR PROPAGATION GROUP

Fading, Distortion, and Interference Mechanisms



ALL USERS CAN CAUSE, OR BE SUBJECT TO MUTUAL INTERFERENCE

MAJOR ACHIEVEMENTS

- 1982 Development of wideband mobile channel sounding equipment still unique in Canada
- 1983-1987 Development of analytical techniques which avoid invalid assumptions of the GWSSUS model, enabling prediction of digital system performance
- 1982 Development of variable rate DPSK modem for use in obtaining performance measurements for comparison with performance predictions
- 1986 First report of Rician statistics on non-line-of-sight fixed indoor channels
- 1986 Confirmation of waveguide-type propagation in building corridors
- 1989 First wideband measurements reported on microcellular urban mobile channels, and demonstration of significant propagation advantages over conventional cellular channels

FIVE-YEAR SCIENCE PLAN

ACTIVITIES FOR THE NEXT FIVE YEARS ARE DRIVEN BY THREE MAIN TECHNOLOGY TRENDS:

TREND 1: THE PROPOSED UNIVERSAL USE OF DIGITAL MODULATION IN MOBILE AND PORTABLE SYSTEMS

TREND 2: THE OPENING OF HIGHER FREQUENCY BANDS FOR MOBILE, PORTABLE, AND INDOOR COMMUNICATIONS

TREND 3: THE INTRODUCTION OF INDOOR WIRELESS LOCAL AREA NETWORKS

ACTIVITIES

A. CHANNEL MEASUREMENTS AND MODELLING

- **LAND MOBILE RADIO CHANNEL EXPERIMENTS**
 - urban experiments on conventional and microcellular channels
 - experiments in mountainous terrain (possible cooperation with NovAtel)
- **INDOOR RADIO CHANNEL EXPERIMENTS**
 - measurements in the 900 MHz, 1.7 GHz and 60 GHz bands
 - partnerships with NovAtel, Carleton University (potential with BC Tel., University of BC)

B. PATH LOSS/INTERFERENCE MEASUREMENTS AND MODELLING

- loss due to obstructions within buildings, between floors; indoors-to-outdoors
- effects of narrowband and broadband interference
- noise measurements / effects studies
- partnerships with NovAtel

C. DIGITAL SYSTEM PERFORMANCE PREDICTIONS

- predict DPSK system performance based on channel and interference models
- verify with simultaneous DPSK system performance and channel measurements
- partnership with Carleton University

MICROWAVE PROPAGATION GROUP

OBJECTIVE: Propagation research in the SHF and EHF bands for application to terrestrial and earth-space links and various associated interference geometries

RESOURCES (1989/90):

Person Years	6
Goods and Services	\$45,000
Capital	\$108,000
DND Funding	\$156,000

CLIENTS: Spectrum Management, Policy, and International Branches of the Department of Communications

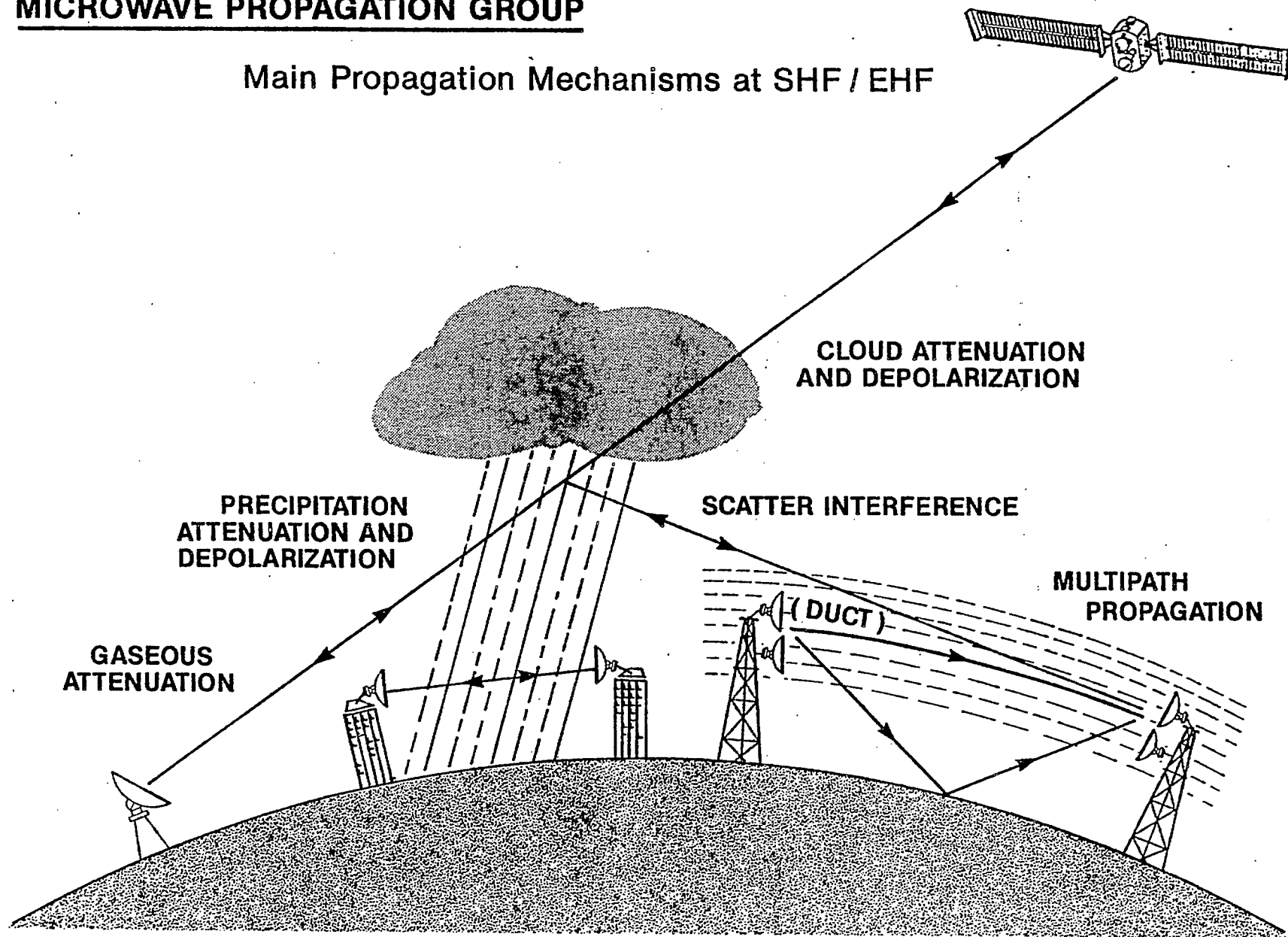
Department of National Defence and other Government Departments

Telecommunications Carriers

Private Industry (e.g., Bell-Northern Research, Lapp-Handcock, etc.)

MICROWAVE PROPAGATION GROUP

Main Propagation Mechanisms at SHF / EHF



MAJOR ACHIEVEMENTS IN MEASUREMENTS

- | | |
|------------|--|
| 1966-1968 | Earliest slant-path measurements of rain attenuation (aircraft beacons, IDCSP satellites) |
| 1969-1973 | Earliest simultaneous use of satellite beacons, radiometers, and radar for rain attenuation measurements on earth-space paths |
| 1972-1975 | First observations of forward scattering by ice clouds (with AFCRL) |
| 1973-1979 | Earliest and among the most extensive multiple location radiometric measurements of slant path rain attenuation |
| 1975-1979 | Most extensive set of measurements of rain rate statistics over a large region |
| 1979-1980 | First simultaneous use of satellite beacon and polarimetric radar for slant path attenuation and depolarization measurements (with NRC) |
| 1979-1981 | Measurements of new melting layer attenuation effects on inclined terrestrial LOS link (via contract with UBC, co-op. with BC Tel) |
| 1968-1985 | Most extensive low-angle clear-air fading measurements on earth-space paths |
| 1980-pres. | Most extensive multipath angle-of-arrival/ amplitude measurements on terrestrial LOS links (via contracts to UWO, co-op. with MTT, NB Tel, Bell-Canada, BNR) |

MAJOR CONTRIBUTIONS TO DEVELOPMENT OF CCIR STUDY GROUP 5 PROPAGATION MODELS

RADIO CLIMATOLOGY/METEOROLOGY:

Rain rate distribution/zone model
Model for worst-month statistics

TERRESTRIAL PATHS:

Model for rain attenuation
Model for rain depolarization
Model for multipath depolarization

SATELLITE PATHS

Model for rain attenuation
Scaling model for low-angle fading
Model for rain depolarization
Model for rain/ice depolarization scaling
Model for propagation delay variation

INTERFERENCE PATHS

Model for upper atmosphere rain/ice reflectivity profile
Model for differential rain attenuation

TABLE 1. COMPARISON IN TERMS OF TYPE AND LEVEL OF CONTRIBUTION

(1) Radio Climatology/Meteorology (Section 5C of "Green Book")

	LEVEL 1	LEVEL 2	LEVEL 3
Rain Rate Statistics			
Rain zone climate model	Canada,US		
Contour map model	France		Italy
Distribution model	Canada,US		
Integration time model	Canada		
Fundamental research	Canada,US	France,UK,Ital.	Japan,USSR
Measurements	Canada	Italy,UK,US	France,Japan Australia,Brazil India,USSR Greece,Norway
Microstructure of precipitation			
Dropsize distribution 'model'	US		Italy
Terminal velocity 'model'	Canada		
Shape and orientation 'model'	US		
Refractive index 'model'	UK		US
Fundamental research	US	Canada,UK	Neth.,Switz.
Measurements	US	Canada,UK	Switz.
Sand and dust storm attenuation			
Fundamental research	UK,US	Sudan,Iraq	
Measurements	Sudan,Iraq		
Radio refractivity statistics			
Radio refractivity profile models	US		
Climate models	US		
Fundamental research	US,UK	Canada,Japan France	Brazil,USSR
Measurements	US	Canada,Japan France,UK	Brazil,USSR
Attenuation by atmospheric gases			
Specific atten. oxygen model	US		
Specific atten. water vap. model	US		
Eff. path length model (slant paths)	US		
Fundamental research/meas.	US	UK	Belgium,France
Emission			
Atmos. gases/hydrometeor models	US		
Extraterrestrial sources model	US		
Land and water surface models	US	UK	
Fundamental research/meas.	US	UK	
Worst Month Statistics			
Model	Neth.	Canada,US Japan,Switz.	UK
Presentation of model	Canada,Neth.	US	
Fundamental research/meas.	US,Switz.	Neth.,UK Canada,Japan	

TABLE 2. OVERALL COMPARISON IN TERMS OF MODELING, FUNDAMENTAL RESEARCH, AND MEASUREMENTS (RADIO CLIMATOLOGY/METEOROLOGY, TERRESTRIAL PATHS, SATELLITE PATHS, AND INTERFERENCE PATHS COMBINED)*

Country	Modeling		Fund. Research		Measurements	
	Points	Rank	Points	Rank	Points	Rank
Canada	(50)61	(3)2	(26)52	(5)3	(18)35	(6)4
France	52	3	33	5	28	5
FRG	3	8	13	7	16	8
Italy	14	6	23	6	27	6
Japan	18	5	49	4	47	3
Netherlands	9	7	7	8	18	7
United Kingdom	27	4	63	2	52	2
United States	90	1	99	1	93	1

TABLE 3. OVERALL COMPARISON IN TERMS OF RADIO CLIMATOLOGY/METEOROLOGY, TERRESTRIAL PATHS, SATELLITE PATHS, AND INTERFERENCE PATHS (MODELING, FUNDAMENTAL RESEARCH, AND MEASUREMENTS COMBINED)*

Country	Radio Clim./Met.		Terrestrial Paths		Satellite Paths		Interfer. Paths	
	Points	Rank	Points	Rank	Points	Rank	Points	Rank
Canada	(24)35	(3)2	(33)52	(5)4	(30)49	(4)2	(8)12	(4)3
France	12	4	77	2	13	7	11	4
FRG	0		22	7	9	8	1	7
Italy	6	6	30	6	28	5	0	
Japan	12	4	59	3	38	4	5	5
Netherlands	11	5	1	8	18	6	4	6
United Kingdom	31	3	44	5	45	3	22	2
United States	79	1	97	1	72	1	29	1

* Numbers in parentheses for Canada are the values assuming maximum bias.

FIVE-YEAR SCIENCE PLAN

ACTIVITIES IN NEXT FIVE YEARS DRIVEN BY FOUR MAIN TECHNOLOGY TRENDS:

- 1. INCREASING USE OF HIGHER FREQUENCY BANDS (5
ACTIVITIES)**
- 2. INCREASING USE OF DIGITAL COMMUNICATIONS
TECHNOLOGY (2 ACTIVITIES)**
- 3. INCREASED FREQUENCY SHARING BETWEEN
SERVICES (2 ACTIVITIES)**
- 4. USE OF OLDER COMMUNICATIONS TRANSMISSION
TECHNIQUES FOR BACKUP COMMUNICATIONS
(1 ACTIVITY)**

TECHNOLOGY TREND AND CORRESPONDING ACTIVITIES

TREND 1: INCREASING USE OF HIGHER FREQUENCY BANDS

ACTIVITIES:

- **INVESTIGATION OF PROPAGATION EFFECTS ON SHORT TERRESTRIAL LINKS IN THE 18 AND 23 GHz BANDS**
- **OLYMPUS PROPAGATION EXPERIMENT**
 - 12, 20, and 30 GHz attenuation and depolarization measurements using the Olympus satellite
 - partnership with RMC
 - Cooperation between ESA member countries
- **DEVELOPMENT OF RAIN ATTENUATION PREDICTION TECHNIQUES FOR INTERCONTINENTAL SATELLITE LINKS**
 - Joint project with Lapp-Hancock Assoc. on Intelsat contract (12/14 GHz band)
- **COOPERATIVE EARTH-SPACE PROPAGATION EXPERIMENTS WITH BRAZIL AND THE ASEAN COUNTRIES (12/14 GHz BAND)**
- **DEVELOPMENT OF LOW-ANGLE FADING PREDICTION TECHNIQUES FOR CANADA**
 - DND sponsored research activity

TECHNOLOGY TREND AND CORRESPONDING ACTIVITIES

TREND 2: INCREASING USE OF DIGITAL COMMUNICATIONS TECHNOLOGY

- Conversion of long distance terrestrial microwave networks to digital radio (2-8 GHz bands)
- Increasing use of more complex digital modulation schemes to increase capacity
- Use of new protection schemes for digital radio

ACTIVITIES:

- **EXPERIMENTAL INVESTIGATION OF MULTIPATH
PROPAGATION EFFECTS ON DIGITAL RADIO**
 - Partnership with Bell-Northern Research, Bell-Canada, and University of Western Ontario (via contract)
- **DEVELOPMENT OF NARROW-BAND AND WIDE-BAND
MULTIPATH FADING PREDICTION TECHNIQUES**
 - Informal partnership with France and Norway
 - Other cooperation through Canadian leadership of CCIR working group on terrestrial propagation

TECHNOLOGY TRENDS AND CORRESPONDING ACTIVITIES

TREND 3: INCREASED FREQUENCY SHARING BETWEEN SERVICES

ACTIVITIES:

- **DEVELOPMENT OF PREDICTION TECHNIQUE FOR MELTING-LAYER SCATTER INTERFERENCE**
 - Contract to UBC for one part, potential partnership with RMC on another
- **INVESTIGATION OF PROPAGATION EFFECTS ON SHARING BETWEEN BROADCASTING SATELLITE AND TERRESTRIAL FIXED SERVICES IN THE 23 GHz BAND**

TREND 4: USE OF OLDER COMMUNICATIONS TRANSMISSION TECHNIQUES FOR BACKUP COMMUNICATIONS

ACTIVITY:

- **INVESTIGATION OF TROPOSCATTER FOR HIGH ARCTIC DND LINK**

INTERNATIONAL ACTIVITIES

- **MAJOR PARTICIPATION IN CCIR STUDY GROUP 5 (NON-IONIZED MEDIA)**
 - National Chairman (B. Segal)
 - Membership in Interim Working Parties 5/2, 3, 6
 - Chairman of IWP 5/2 Working Group on Terrestrial Propagation (R.L. Olsen)

- **MAJOR PARTICIPATION IN CCIR STUDY GROUP 6 (IONIZED MEDIA)**
 - National Chairman (D. Ross)
 - Chairman of Working Group 6P (D. Ross)
 - Membership in Interim Working Parties 6/1, 2, 4, 5
 - Chairman of IWP 6/5 on LF Propagation (J.S. Belrose)

- **PARTICIPATION IN SERVICE STUDY GROUPS 2,4,8,9 AT THE NATIONAL LEVEL AND OCCASIONALLY 4,9 AT THE INTERNATIONAL LEVEL**

- **MAJOR PARTICIPATION IN ITU ADMINISTRATIVE RADIO CONFERENCES**
 - 1974 HF Maritime Mobile WARC
 - 1979 General WARC
 - 1980 MF RARC for Region 2
 - 1983 Region 2 RARC-Satellite Broadcasting
 - 1984/87 HF Broadcast WARC

- **NATO/AGARD ELECTROMAGNETIC WAVE PROPAGATION PANEL MEMBERSHIP (J.S. Belrose)**

EXAMPLE IN THE USE OF INTERNATIONAL RESOURCES* FOR NATIONAL/INTERNATIONAL BENEFIT

DEVELOPMENT OF A TECHNIQUE FOR PREDICTING MULTIPATH FADING DISTRIBUTION ON TERRESTRIAL LINE- OF-SIGHT LINKS (UHF/SHF/EHF):

$$A = G + 33 \log d + 9 \log f + 11 \log(1+|e_p|) + 12 \log \phi - 10 \log P$$

$$G = -54 + 15 \log P_L$$

1. Establishment of basic empirical relation using extensive data base within a relatively small region (47 links in France/UK)
 - Prediction technique for France/UK
2. Establishment of the dependence of G on the refractivity gradient statistic P_L using Canadian data (29 links, 47 radiosonde stations)
 - Prediction technique for Canada
3. Fitting of 1966 US world contour map for P_L to British/Canadian/French data on G
 - CCIR prediction technique for the world
4. Extrapolation to UHF using multi-frequency data from Italy, US, etc. and new understanding of multipath propagation physics

* Canada, France, Norway, UK, etc.

SEMI-PERMANENT CCIR IWP 5/2 WORKING GROUP ON TERRESTRIAL MICROWAVE PROPAGATION

Chairman: R.L. Olsen (Canada)

1. **SINGLE-FREQUENCY MULTIPATH FADING**
Chairman: R.L. Olsen (Canada)/T. Tjelta (Norway)
2. **DIVERSITY IN CLEAR-AIR CONDITIONS**
Chairman: Y. Hosoya (Japan)
3. **PROPAGATION DISTORTION**
Chairman: L. Martin (France)
4. **RAIN ATTENUATION**
Chairman: M.S. Assis (Brazil)
5. **TROPOSCATTER TRANSMISSION LOSS**
Chairman: R. Larsen (UK) [M.G. Zhang (China)]

MAIN OBJECTIVE: Use of CCIR international data bases to test and develop propagation prediction techniques

WORKING PROCEDURES:

- **Correspondence/telephone/facsimile**
- **IWP 5/2 Meetings approx. every two years**
- **Main Meetings approx. every two years**

TECHNOLOGY TRANSFER MECHANISMS

- **Regular formal contacts with DOC Branches (e.g., ADMSR/ADMTR review committee on propagation research)**
- **Reports on projects jointly funded with other DOC branches, telecom carriers, and industry, sometimes involving universities**
- **Reports on projects wholly or partially funded by DND or other government agencies**
- **Formal assistance agreements with industry (e.g., Lapp-Handcock on INTELSAT contract)**
- **Expected future agreements with regional "applications centres"**
- **CCIR/ITU contributions**
- **Publications and conference/seminar presentations**
- **Contacts through contracts to universities and industry**
- **Informal contacts**

CURRENT ISSUES

- How to obtain funds from clients providing little or no direct support
- How to cope with the situation of an aging population of scientists but increased difficulty in recruiting young scientists
- How to remain effective in the face of decreased resources (particularly people) and increased accountability (including evaluation) requirements
- How to effectively employ new technology transfer mechanisms such as regional applications centres
- How much effort to devote to international cooperative activities (e.g., CCIR/ITU)

RESEARCH AREAS REQUIRING INCREASED EMPHASIS (RESOURCES)

- **TERRESTRIAL MOBILE PROPAGATION**
- **INDOOR RADIO PROPAGATION**
- **MOBILE SATELLITE PROPAGATION**
 - continue initial effort on land mobile satellite propagation within systems group (DSAT) in propagation group (DRC)
 - no current effort in maritime or aeronautical mobile satellite propagation
- **PROPAGATION EFFECTS ON FREQUENCY SHARING**
 - the future for the more mature research programmes such as the ELF - UHF Antennas and Propagation Group and the Microwave Propagation Group

DIRECTORATE OF SATELLITE
COMMUNICATIONS

FY 89/90 RESEARCH PROGRAM

R.W. Huck
Oct. 26, 1989

DSAT

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SATELLITE COMMUNICATIONS

DIRECTOR - R.W. HUCK

**RADARSAT TECHNICAL
PROJECT OFFICE**

Mgr.: S. Ahmed

Technical management of contracts concerning the spacecraft and mission control

**ADVANCED SATELLITE
COMMUNICATIONS**

Mgr.: E.J. Hayes

Earth Stn. Technology
Olympus Experiment
Advanced System Studies
EHF Personal Communications
NSS R&D
Radio Determination Satellite Systems

**MOBILE SATELLITE
COMMUNICATIONS**

Mgr.: J. Rigley

MSAT Support
Aeronautical Terms.
Narrowband Modems
Air Ambulance Trials
Gov't Executive a/C Flight Test Program

**MILITARY SATELLITE
COMMUNICATIONS**

Mgr.: J.S. Butterworth

EHF Satcom Project
Advanced Techniques
Internal Co-operation
University Contracts

**COMMUNICATIONS
SATELLITE SYSTEMS**

Mgr.: J.L. McNally

MSAT Project Office
S/C System Studies
Project Support
Consultation

DSAT

SUMMARY OF RESOURCES

PERSON YEARS

39 PY - DOC

4 CSA Recoverable

3 Seconded from DRL

46 Total for FY 89/90

FINANCES

DOC A Base \$725,000

DND Funds \$752,000 (Recoverable Program)

NSS Funds \$612,000

DOT Funds \$381,000 (341K to term. dev)

DSS UP Funds \$700,000 (Flow Through)

TOTAL \$3,170,000 For FY 89/90

**RADARSAT PROJECT TECHNICAL OFFICE
(RPTO)**

TECHNICAL PROJECT OFFICE TO SUPPORT EMR

OBJECTIVES

RADARSAT - Provide ice and ocean information for Canadian arctic and coastal regions.

- Land resource data over Canada.

- Global resource data.

RPTO - Payload, spacecraft and mission implementation.

- Agreements with international partners.

- Manage contracts for industrial development.

RESOURCES:

- Currently 5 PY + 4 Contract

- Future 18 PY + 12 Contract

- Finances: To be provided by CSA

CLIENTS: CSA, EMR

STATUS: - Radarsat Project now part of CSA

- Interim RPTO at CRC

- Program Approved June/89

- DSAT providing 4 PY via Matrixed Assignment

DSAT

ADVANCED SATELLITE COMMUNICATIONS

DESCRIPTION: Conduct R&D into system concepts and technologies applicable to future generations of communications satellites.

CLIENTS: DOC, NSS, DND, Telesat, Cdn Industry
CSA (in future)

RESOURCES: 11 PY's, \$170 K G&S, \$135 K CAP
\$612K NSS
\$160K DND

DSAT

Adsat (Cont'd)

ACTIVITIES:

Advanced Satcom Studies

- Concepts for future communications satellites.
- On-board processing.

Olympus Experiment Development

- Experiment definition & planning
- Industrial development of OBP by COM DEV

Earth Station Technology Development

- EHF Terminal
- Component Development, Antenna, Modem/Frequency Converter

NATIONAL SEARCH AND RESCUE SECRETARIAT

- PLB Development
- GPS Equipment Survey and Development
- LEO/GEO Satellite Study

EHF PERSONAL COMMUNICATIONS

- System Concept Study
- Payload Concept Study (under SPAR MOA)

RADIO DETERMINATION SATELLITE SYSTEMS

- Satellite based Position Location Studie:

DSAT

(ADSAT Cont.)

MILESTONES :

Olympus OBP Experiment

Detailed test plan complete	Oct/89
Group Demodulator Development Completed	Oct/90
CRC/Industry experiment initiated	Jan/91

Olympus EHF Terminal Development

Rain Fade Countermeasures Study Complete	Mar/90
Terminals assembled and Documented	Jan/91

NSS Tasking

PLB Procurement	Mar/90
LEO/GEO Application	Mar/90
GPS Application to SAR	Nov/91

EHF Personal Communications

Complete Service Scenario Study	Aug/89
Complete Contracted Payload Study	Mar/90

Radio Determination Satellite Systems

Complete Satellite Geolocation Study	Mar/90
--------------------------------------	--------

DSAT

ADSAT Cont.)

ACHIEVEMENTS TO DATE:

- Newly formed group 3 years ago
- SARSAT Previous Major Program
- 406 MHz beacon signal processor developer
- EHF Satcom Terminals
- SAW on-board processor development
- Personal Communications system concept study

OUTPUTS :

- System Studies
 - EHF Personal Satellite Communications
- R&D Publications
 - Journal Papers
 - Conference Papers
 - Technical Memos
 - Internal Reports
- Earth Terminal Development
 - EHF Satcom
 - GOES Terminal
 - SARSAT Implementation
- Participation in International Standards Bodies (i.e., CCIR)
- Consulting Support to Other Gov't Departments

MOBILE SATELLITE COMMUNICATIONS

DESCRIPTION: Development of New Technology and System Concepts for Terrestrial, Aeronautical and Marine Mobile Satellite Communications.

RESOURCES : 16 PY (including 3 seconded) (+4 MSAT Term PY's)

Base Funds:	\$100 K G&S	\$130 K CAP
DOT Aero:		\$40 K CAP
Military Radio:	\$18 K G&S	\$200 K CAP
MSAT:		As Req'd
OAAS:	\$125 K reserved by Ont. Gov't	
Executive Aircraft:		TBD (DND)
G.A. Satcom:	\$1.65M (DOT, DSS, DOC)	

CLIENTS: DOC, MSAT Program, Telesat, TMI, Teleglobe, DOT, (Future to include FAA via DOT) ICAO, INMARSAT, Ontario Government, CSA (in future), Cdn industry.

BND

DSAT

Mobsat (cont 'd)

ACTIVITIES:

MSAT R&D Support

- Nine tasks under MOU with TMI
- Develop radios which use power and spectrum efficiently, to permit economic viability of MSAT
- Provide technical consultation to MSAT; TMI, TELEGLOBE, and participate in Equipment Standardization.
- Provide expert support to development and implementation of trial programs.
- Transfer technology to Canadian Industry; e.g., modems

Aeronautical SATCOM Development

- Participate in international standards - ICAO, AEEC
- Develop proof-of-concept modem hardware.
- Transfer technology to industry.
- Develop mobile satcom for general aviation.
- Develop and flight test terminals for Gov't Aircraft

Ontario Air Ambulance Project

- Trials and demos for proof-of-concept for jet aircraft
- Assist in transfer to pre-operational status
- Proof-of-concept for helicopters.

(Mobsat cont.)

Military Radio Technology

- Develop signal processing strategy to provide a very narrowband encryptable voice and data radio.
- Develop 3-5 radios for demonstration.
- Participate in international standards.

Advanced Modem Development

- Generic R&D supporting other projects.
- Development programs include TCM, CPM, OSQPSK, etc.
- Base for collaboration with industry and universities (eg., Industry partnership arrangements and University students)

DSAT

(Mobsat cont.)

MILESTONES:

- | | |
|--|---------|
| - Transfer MSAT Modem Technology to Industry
(Glenayre, Skywave, CAL, etc.) | Ongoing |
| - MSAT Trials Support | Ongoing |
| - International Aeronautical Development | Mar/90 |
| - Air Ambulance Helicopter Trials | Aug/90 |
| - General Aviation sat. term. Development | Oct/90 |
| - Deliver for trials - 3-5 Military Radios | Mar/90 |
| - Advanced ACSSB Modem (for MSAT) | Aug/89 |
| - Advanced Modem Development | Ongoing |
| - Aeronautical Terminal (Executive Fleet) | Dec/91 |

DSAT

Mobsat (cont'd)

ACHIEVEMENTS TO DATE:

- MSAT System Design Support
- Propagation Environment Characterization
- Development of Fundamental Hardware for MSAT earth Terminals (e.g. Modems/Codecs, antennas, etc.)
- Completion of Satellite Link Simulators
- Development of Propagation Simulators
- Ontario Air Ambulance Satcom Terminals
- Several Trials/Demo Programs on INMARSAT satellites
- Licensing to Industry of several modem/codec schemes. (DMSK, ACSSB, ABPSK, R1/2 Viterbi Decoder, etc.)
- Development of a Smart Squelch (DOT, DND)
- Development of a new concept for very narrowband Military tactical radio. (NSQAM)
- Participated on ICAO and AEEC panels
- ACSSB std adopted by Australia as alternate to Digital Voice
- ABPSK adopted by International Civil Aviation Organization

Mobsat (cont 'd)

OUTPUTS:

- Mobile Satcom System Design Reports
- Contracted R&D
- Hardware proof-of-concept development
- Patents/Licensing through CP&DL
- Journal and Conference Papers/Tech memos
- Consulting Support to Operational organization like Telesat
TMI, Teleglobe, ICAO
- Participation in Stds bodies, CCIR, ICAO, NATO
- Leveraged industrial support for equipment development,
e.g. General Aviation terminal
- ACSSB stds adopted in Australia
- ABPSK std adopted by ICAO

Mobsat(cont'd)

TECNOLOGY TRANSFER MECHANISMS:

- MOU's with industry (e.g. TMI, Memotec,)
- Confidential Disclosure Agreements
(CAL, Skywave, Glenayre)
- Licenses (Skywave)
- Contracted R&D - several companies and universities
- Visiting Scientist/University students
- Consulting support
- Partnership (e.g., CAL)
- Training visiting professionals (CCMC, Brazil Eng.)
- Graduate student research projects
- Personnel Exchanges

IMPACTS:

- Principle source of national R&D on mobile satcom
- Modulation concepts developed at CRC proved MSAT economic viability
- Proposed modulation concept accepted as International standard for aeronautical Satcom
- Participate in international standards activities, e.g. CCIR, ICAO (FANS and SARPS), NATO
- International reputation well established.

MILITARY SATELLITE COMMUNICATIONS

DESCRIPTION: Provide R&D support for Military Satellite Communications through a cost recoverable agreement with DND. The activities include advanced communications schemes which provide robustness and survivability from hostile action.

RESOURCES: - 7 PY's (including 1 seconded to DND)
DOC A-Base Funds: \$20 K G&S \$ 25 K CAP
DND Funds : \$435 K CAP

CLIENTS : Department of National Defence
Defence Research Establishment of Ottawa

ACTIVITIES:

RESEARCH ACTIVITIES

- SPACECRAFT-BASED SIGNAL PROCESSING.
 - broadband frequency hopping synthesizer
 - diversity combining for frequency-hopped signal.

- UNIVERSITY RESEARCH CONTRACTS
 - Queen's, Toronto, Univ. of Victoria
 - topics include Coding, Synchronization methods and Null-steering antennas

- LASER COMMUNICATIONS
 - In-house lasercom research
 - MPB contract on Intersatellite lasercom (\$317K)

DSAT

(Milsat Cont.)

TASKING :

- EHF SATCOM PROJECT SUPPORT
 - Assist Contract Management
 - Develop EHF Payload Simulator
 - System Analysis
- SPACE QUALIFICATION SPECIFICATION
 - Development

MILESTONES:

RESEARCH ACTIVITIES

Frequency-Hopping Synthesizer
University Research Contracts
MPB Lasercom Contract

Sept/89
Mar/90
Multi-year

TASKING

EHF Contracting Support
Payload Simulator
Space Qualification Specs

Multi-year
Multi-year
Mar/90

Milsat (Cont'd)

ACHIEVEMENTS TO DATE:

- Used Anik A2 to make low-angle fading measurements at Eureka NWT.
- Conducted SARSAT system studies and demonstrated proof-of-concept using amateur radio satellite
- Developed a ground terminal to provide teleconferencing between Canada and France using the French Symphonie satellite
- Developed and installed a ship-borne UHF terminal for the Canadian navy. Field trials run on HMS Athabaskan between Halifax and Australia
- Military Satcom terminal development C-Band and Ku-Band
- EHF Satcom Terminal Development
- EHF Satcom Experiments with LES 8 & 9
- Support of SAW Group Demodulator for Milsatcom
- Development of Analysis concepts for Anti-Jamming for Spread Spectrum

Milsat (Cont'd)

OUTPUTS:

- Participation in TTCP (Can/US/UK/Aus)
- Participation in NATO/AGARD
- R&D Publications
 - Journal papers
 - Conference papers
 - Tech memos
- DND Reports
- Detailed Analyses on Milsatcom concepts
- Consulting advice to DND major EHF Satcom project
- Hardware development
- Optical communications

TECHNOLOGY TRANSFER MECHANISMS:

- Contracted R&D
- University students
- University Professor Sabbaticals

IMPACTS:

- Principle source of R&D for Milsatcom for DND
- Source of expert advice for major military EHF payload Development

DSAT

COMMUNICATIONS SATELLITE SYSTEMS

DESCRIPTION: Centre of Expertise for Major Project Support
in areas such as:

- Spacecraft Systems
- Mission Analysis
- Reliability Engineering
- Spacecraft Costing
- Satellite Ops.
- Project Management

CLIENTS : DOC, DOC MSAT Program, CSA, EMR, SPAR, CAL

RESOURCES:

- 10 PY'S
- BASE FUNDS: \$25 K G&S \$25K CAP

ACTIVITIES:

- Project Management to MSAT Program
- Consulting Support to Major Projects
 - Radarsat
 - Milsatcom
 - Space Station
- Conduct Studies and Sponsor R&D for Future Satellites
e.g. EHF Personal Communications

MILESTONES:

All activities are ongoing and are tied to Project Office milestones

eg.: Launch of MSAT	1993
Launch of RADARSAT	1994
Launch of Space Station	TBD

DSAT

COMSAT (CONT'D)

ACHIEVEMENTS TO DATE :

- Support to SPAR for Brazilsat Bid
- Participation in CCSDS
- Successful program start for MSAT with Immediate Commercialization (To be covered by DMSAT)
- Contribution to successful program start for Radarsat
- Developed promising antenna for MSAT

OUTPUTS :

- Contribution to Major DOC and CSA programs.
- Contribution to Satcom system/concept planning
- Coordinate standards, regulatory and policy consideration

TECHNOLOGY TRANSFER MECHANISMS :

- Contracted R&D
- Taps R&D from other DOC groups and facilitates transfer
- University students
- MOA, MOU (with SPAR)
- Confidential disclosure agreements and licenses
- Personnel exchanges

CURRENT ISSUES

GENERAL:

- Lack of Research funding to support contracting.
- Change of Relationship with Universities and Industry.
 - Cooperative R&D
 - Shared cost programs
 - Maintaining Technical leadership
- Regionalization of R&D
- Managing R&D and providing National Leadership from within a bureaucracy.
- Creating and extending a client base for cooperative R&D
- Creating a process to accept funding support

SPECIFIC:

- Addressing next generation Satcom development
- Participating in International Satcom programs, e.g. ESA/SAT-2, IOL/ISL
- Focusing R&D effort in niche areas where Cdn space industry can benefit - requires thorough knowledge of R&D requirements, Satcom trends, Cdn industry capabilities. Provides input to policy formulation.

CURRENT PRIORITIES

- MOU's with outside Agencies to conduct R&D
 - DND - (in place)
 - Canadian Space Agency - (in development)
 - National Search and Rescue Secretariat - (in place)
 - DOT - (in development)
 - Cantel/Teleglobe - (in development)
 - Telesat - (in development)
 - Telesat Mobile Inc. - (in development)
- Accessing regional funding to support regional R&D initiatives tied into National priorities.
- Positioning Canadian industry to support MSAT equipment requirements.
- Establish new Satcom programs involving personal communications and possibly IOL/ISL
- Assisting DND in implementation of EHF Milsatcom

MOBILE SATELLITE DIRECTORATE

Director: D.C. Buchanan

DMSAT

VIEWGRAPH OUTLINE

<u>#</u>	<u>TITLE/CONTENT</u>	
1.	FUNCTION OF DMSAT-MCP CONCEPT] INTRODUCTION
2.	WHAT MSAT IS	
3.	SYSTEM DESCRIPTION	
4.	PICTURE OF MSAT	
5.	ROLE OF DOC AND OBJECTIVES] MANAGEMENT
6.	WP BREAKDOWN	
7.	ORGANIZATION CHART	
8.	EXTERNAL LINKAGES	
9.	FINANCIAL RESOURCES	
10.	ENABLING RESEARCH AND TECHNOLOGY DEVELOPMENT] ACHIEVEMENTS & OUTPUTS
11.	TECH TRANSFER AND INDUSTRY DEVELOPMENT	
12.	SUPPORT TO THE COMMERCIAL OPERATOR AND SERVICE PROVIDERS	
	- MARKET DEVELOPMENT/TRIALS	
	- BULK LEASE	
	- SEALINK EXAMPLE	
13.	POLICY AND REGULATORY DEVELOPMENT	
14.	IMPACTS I.E. LEVERAGE OF ABOVE	
15.	CURRENT ISSUES] WRAPUP
16.	PRESENT AND FUTURE PRIORITIES	

MSAT PROGRAM

- THE MSAT PROJECT IS A DOC INITIATIVE TO FOSTER MOBILE SATELLITE COMMUNICATIONS FOR CANADA
- IT BEGAN AS A JOINT DOC/NASA PROGRAM AND HAS NOW EVOLVED TO THE POINT WHERE IT IS BEING IMPLEMENTED BY COMMERCIAL ENTITIES IN CANADA AND THE U.S.
- BECAUSE OF THE LARGE HISTORICAL AND PROJECTED GOVERNMENT EXPENDITURE (\$200 MILLION) IT IS DESIGNATED AS A MAJOR CROWN PROJECT
- THE PROJECT LEADER IS DGRC WHO SETS MAJOR POLICY AND OBJECTIVES AND IS FORMALLY RESPONSIBLE TO THE DEPUTY MINISTER
- THE DEPUTY PROJECT LEADER IS DMSAT WHO IMPLEMENTS THESE OBJECTIVES AND PROVIDES DAY-TO-DAY MANAGEMENT

THE MAJOR CROWN PROJECT ENVIRONMENT

- ° BASIC OBJECTIVE IS TO IDENTIFY, CONTAIN AND CONTROL ALL COSTS ASSOCIATED WITH THE PROGRAM AND TO DELIVER AGREED PROGRAM ELEMENTS ON SCHEDULE

- ° ACCOUNTABILITY IS AT THE DEPUTY MINISTER LEVEL VIS A VIS TREASURY BOARD

- ° PROJECT LEADER AND DEPUTY PROJECT LEADER TO HAVE SPECIFIED LEVELS AND CAPABILITIES

- ° OVERVIEW PROVIDED BY AN INTERDEPARTMENTAL PLANNING AND IMPLEMENTATION COMMITTEE CONSISTING OF SENIOR REPRESENTATIVES

- ° FORMAL REPORTING OF SCHEDULE, COST, AND PROGRESS TO TREASURY BOARD SEMI-ANNUALLY ON THE BASIS OF AN AGREED PROJECT PLAN

SYSTEM CONCEPT

PICTURE

MSAT SATELLITE

PICTURE

ROLE OF DOC AND OBJECTIVES

- TO BRING COMMERCIALY VIABLE MOBILE SATELLITE COMMUNICATIONS SERVICES AND SYSTEMS TO ALL OF CANADA AND TO REALIZE SOCIAL, ECONOMIC, AND INDUSTRIAL BENEFITS

- THIS IS IMPLEMENTED BY A COORDINATED THRUST IN FOUR MAIN AREAS:
 - ENABLING TECHNOLOGY DEVELOPMENT
 - TECHNOLOGY TRANSFER AND INDUSTRY DEVELOPMENT
 - DEVELOPMENT OF A FAVOURABLE POLICY AND REGULATORY ENVIRONMENT
 - SUPPORT TO THE COMMERCIAL OPERATOR BY MARKET DEVELOPMENT TRIALS AND THE PRE-PAYMENT FOR ANTICIPATED GOVERNMENT USE OF THE SYSTEM

- TO MANAGE MSAT PROGRAM WITHIN THE DISCIPLINE OF THE MAJOR CROWN PROJECT ENVIRONMENT A PROGRAM/PROJECT MANAGEMENT STRUCTURE WAS ADOPTED AND INDIVIDUAL WORK PACKAGES IDENTIFIED, REPORTED ON, AND CONTROLLED

MSAT PHASE C/D WORK
BREAKDOWN STRUCTURE

WM 1: MSAT MANAGEMENT

WM 2: MSAT PROGRAM DEVELOPMENT

- WM 2.1 PROGRAM MANAGEMENT**
- WM 2.2 COMMERCIAL IMPLEMENTATION
SUPPORT**
- WM 2.3 DEVELOPMENT OF MSAT
COMMUNICATION TRIALS**
- WM 2.4 POLICY DEVELOPMENT**
- WM 2.5 FREQUENCY COORDINATION**
- WM 2.6 MANAGEMENT OF COOPERATIVE
ARRANGEMENTS**
- WM 2.7 MSAT WORKING GROUPS AND
COMMITTEES**
- WM 2.8 PROGRAM SUBMISSIONS**
- WM 2.9 PUBLIC INFORMATION**

WM 3: MSAT TECHNOLOGY DEVELOPMENT

- WM 3.1 PROJECT MANAGEMENT**
- WM 3.2 SYSTEM ENGINEERING SUPPORT**
- WM 3.3 SPACE SEGMENT TECHNOLOGY
DEVELOPMENT**
- WM 3.4 EARTH SEGMENT TECHNOLOGY
DEVELOPMENT**
- WM 3.5 MSAT APPLIED RESEARCH**
- WM 3.6 PRE AND POST LAUNCH FIELD TRIALS**

ORGANIZATION CHART - ORGANIGRAMME

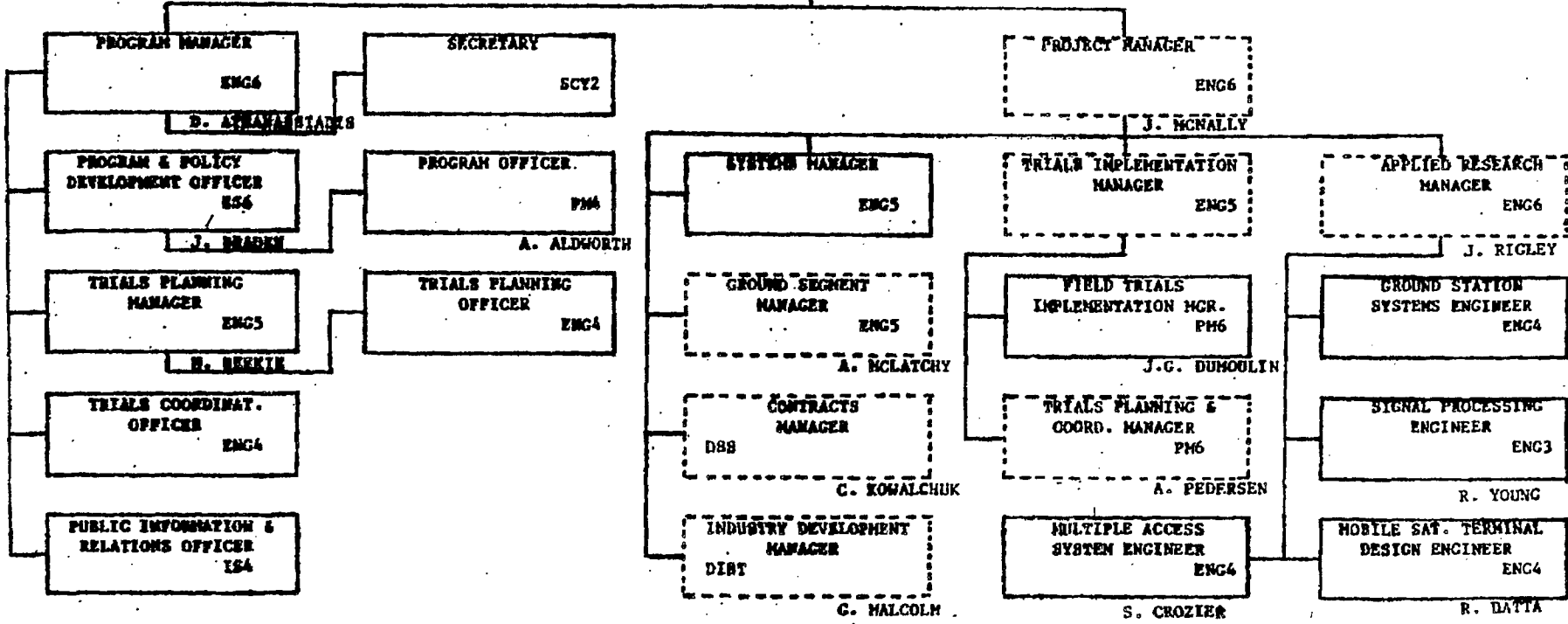
Reporte To/Mémoire de	DCRC
Title/Titre	DMSAT
Effective Date/Date d'entrée en vigueur	01-04-89

Branch/Direction	DCRC EX3
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Chart Title/Titre de l'organigramme	MSAT ORGANIZATION
Page # of # Pages	
Approved By/Approuvé par	<i>R. Breithaupt</i> 10/13/89

R. BREITHAUPT	
DMSAT	EK1
D. BUCHANAN	

SECRETARY	SCY3
V. GOYETTE	

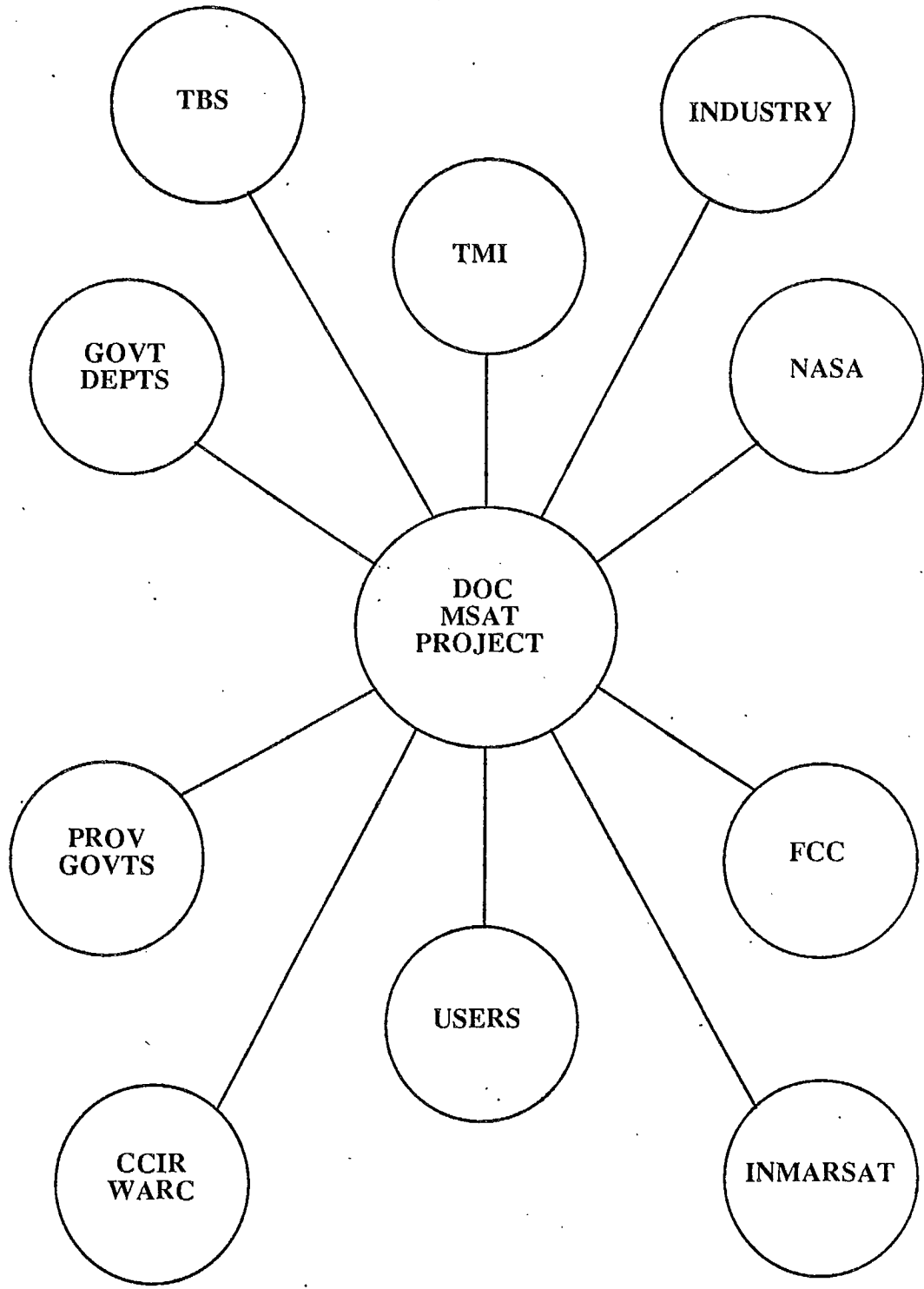


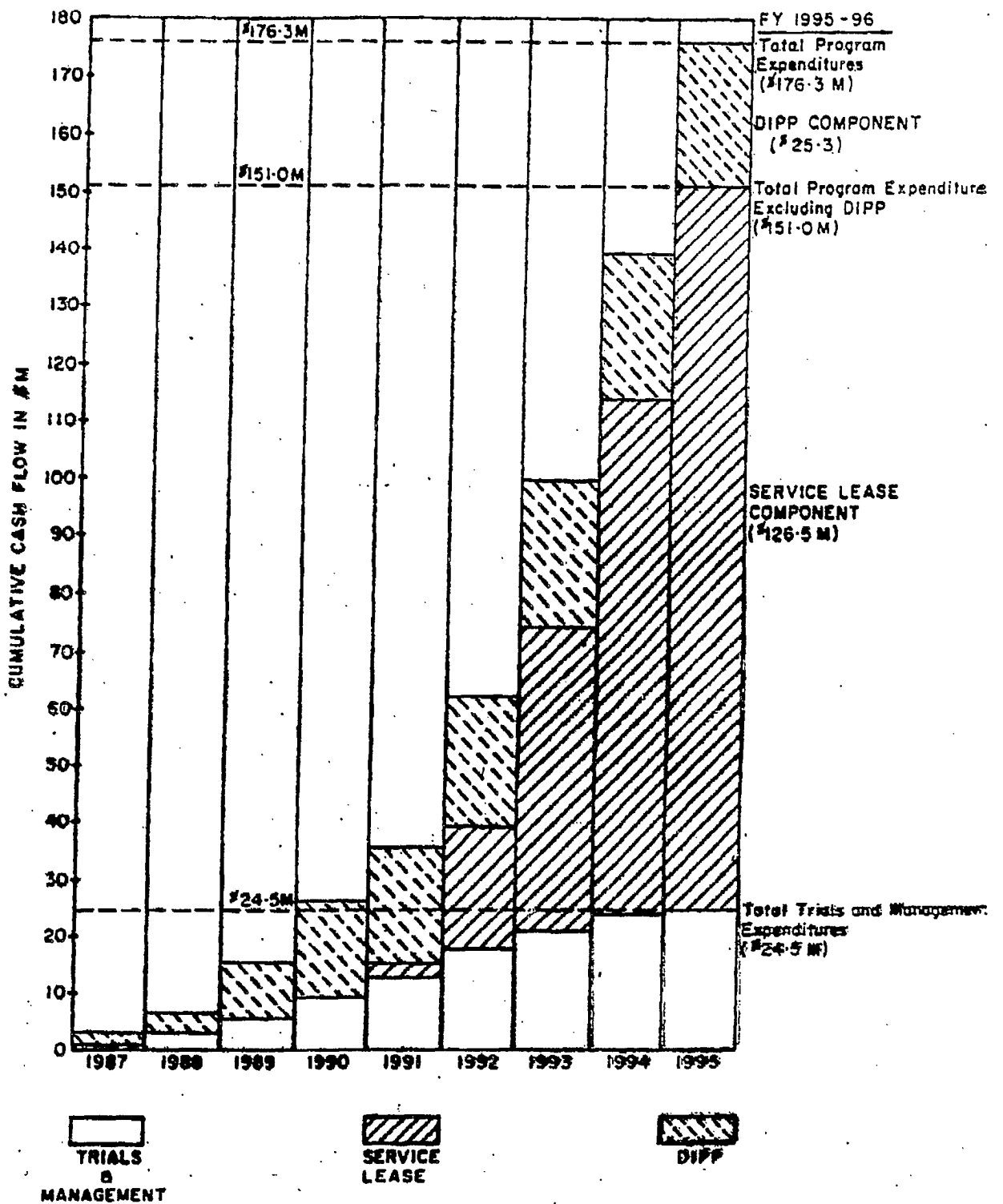
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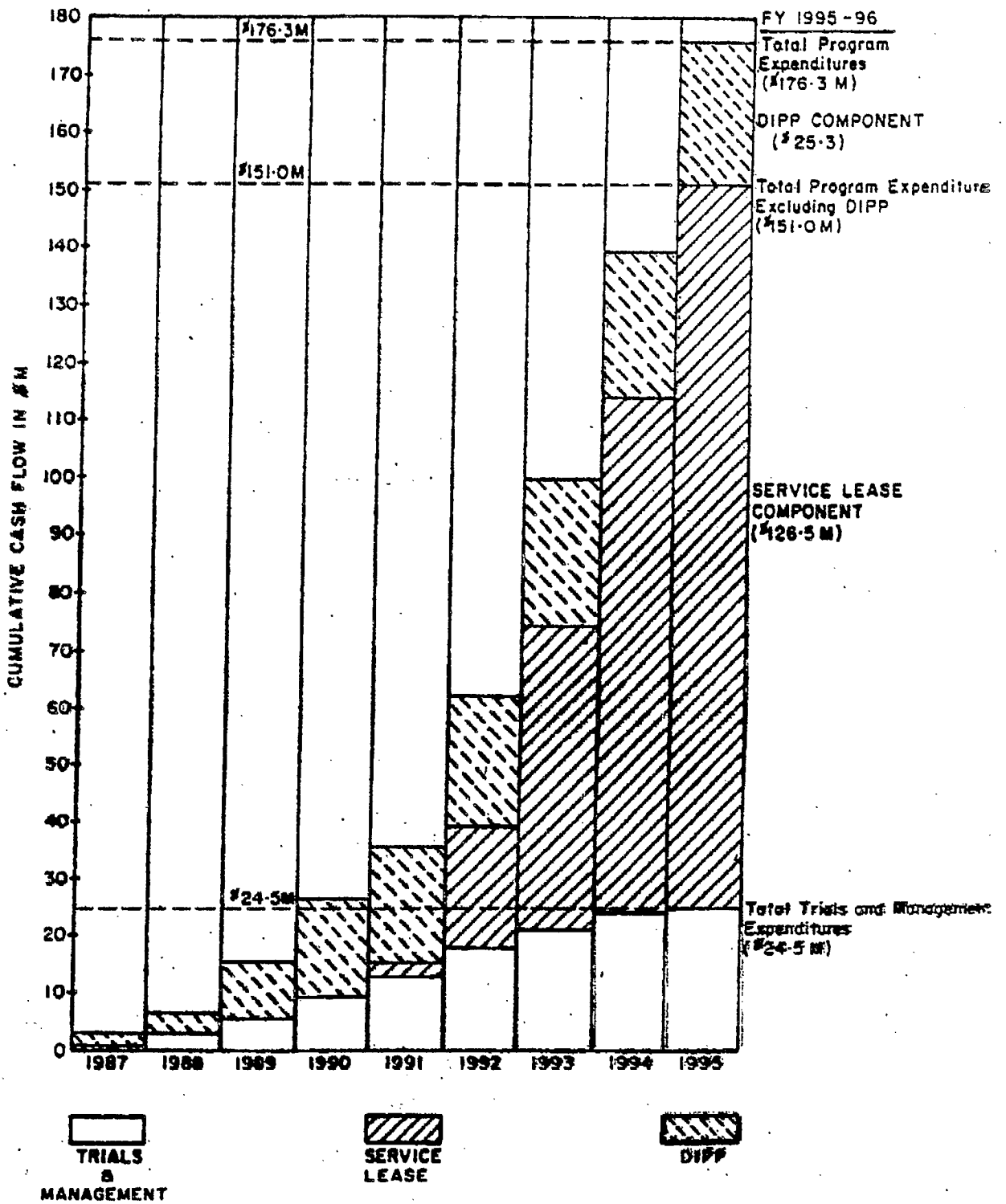
DMSAT / FMSM / MVA / ...

EXTERNAL LINKAGES





PHASE C/D CUMULATIVE CASH FLOW BY CLASS OF EXPENDITURE



PHASE C/D CUMULATIVE CASH FLOW BY CLASS OF EXPENDITURE

ENABLING RESEARCH AND TECHNOLOGY

FUNDAMENTAL TO COMMERCIAL VIABILITY IS THE TRAFFIC CAPACITY OF A PRACTICALLY-SIZED SATELLITE, THE PERFORMANCE OF THE CIRCUIT, AND THE COST AND PORTABILITY OF USER TERMINALS. ENABLING R&D WAS CARRIED OUT AS FOLLOWS:

- IN-HOUSE AT CRC
 - CHARACTERIZATION OF THE CHANNEL AND FADING ENVIRONMENT
 - DEVELOPMENT OF VOICE MODULATION TECHNIQUES SUITED TO THE CHANNEL
 - DEMONSTRATION THAT THE MOST ROBUST TECHNIQUE (ACSSB) IS TECHNICALLY AND ECONOMICALLY FEASIBLE
 - DEVELOPMENT AND DEMONSTRATION OF STEERABLE ANTENNA CONCEPTION FOR LAND AND AERONAUTICAL APPLICATIONS
- CONTRACTED OUT
 - SATELLITE LINEAR POWER AMPLIFIERS AT L-BAND
 - MULTIPLE SPOT BEAMS FOR FREQUENCY REUSE AND RECONFIGURATION

TECHNOLOGY TRANSFER AND INDUSTRY DEVELOPMENT

TO REALIZE INDUSTRIAL BENEFITS, AN APPROPRIATE CANADIAN INDUSTRY INFRASTRUCTURE MUST BE FOSTERED. WORKING WITH DRIE FUNDING (\$25.3 MILLION) THE FOLLOWING AREAS WERE ADDRESSED:

SPACE SEGMENT

EARLY DEVELOPMENT OF SYSTEM CONCEPT, POWER AMPLIFIERS, RECEIVERS, FILTERS, AND ANTENNAS AT 1.5/1.6 GHZ AND 11/13 GHZ. SPAR IS NOW AT THE FOREGROUND OF L-BAND PAYLOAD DEVELOPMENT

GROUND SEGMENT

- MOBILES AS A RESULT OF CRC TECHNOLOGY TRANSFER AND SUPPORT FUNDING TRANSPORTABLE TERMINALS ARE AVAILABLE NOW AND TRUE MOBILES ARE IN PRE-PRODUCTION. DATA TERMINALS ARE IN PRODUCTION
- ANTENNAS DATA SERVICE ANTENNAS IN PRODUCTION. VOICE SERVICE ANTENNAS EXIST AT CRC AS PROTOTYPES. INDUSTRIAL PARTNER BEING SOUGHT
- CENTRAL CONTROL (DAMA) ONLY NOW BEING SERIOUSLY ADDRESSED. ESSENTIALLY A SWITCHING/SOFTWARE CHALLENGE AND WILL PROBABLY REQUIRE PARTNERS OUTSIDE OUR TRADITIONAL CLIENTELE

SUPPORT TO THE COMMERCIAL OPERATOR

- MSAT IS NOT INITIALLY VIABLE AS A PURELY COMMERCIAL VENTURE IN EITHER THE U.S. OR CANADA AS THE PREDICTED PAYBACK PERIOD IS BEYOND COMMERCIAL HORIZONS.

- U.S. SOLUTION

NASA PROVIDES A FREE LAUNCH (\$US 97M) TO AMSC IN RETURN FOR SATELLITE TIME

- CANADIAN SOLUTION

DOC PRE-PURCHASES ANTICIPATED SERVICE ON BEHALF OF ALL GOVERNMENT USERS (\$126.5M)

DOC UNDERTAKES A TRIALS PROGRAM (\$20M) TO SPEED USER AND MARKET DEVELOPMENT

- THE LEASE WAS SUCCESSFULLY NEGOTIATED IN 1988
- THE TRIALS PROGRAM IS UNDERWAY AND IN ADDITION IS FACILITATING THE ESTABLISHMENT OF INTERIM DATA AND VOICE SERVICE BY LEASING L-BAND SATELLITE ASSETS (INMARSAT) AND ESTABLISHING A SUPPLIER BASE BY PURCHASING EQUIPMENT
- BECAUSE OF THE MINIMAL FINANCIAL IMPACT OF INDIVIDUAL USERS (\$145/MONTH) THE TRIALS FOCUS IS ON COMMERCIAL SERVICE PROVIDERS AND OTHER PROSPECTIVE MULTIPLE USERS

POLICY AND REGULATORY DEVELOPMENT

- FREQUENCY ALLOCATIONS AT WARC 87
- COORDINATION WITH U.S., USSR, INMARSAT
- TYPE I/TYPE II CARRIER DISTINCTION AND
CONDITION OF LICENSE FOR TYPE II CARRIERS
USING U.S. FACILITIES
- FOREBEARANCE FROM REGULATION BY THE CRTC
- COORDINATION WITH FCC
- DOMESTIC COORDINATION OF SHARED 11/13 GHZ

IMPACT

- ENABLING R&D MADE MSAT TECHNICALLY FEASIBLE
- 87 WARC MADE MSAT INTERNATIONALLY FEASIBLE
- BULK LEASE MADE MSAT ECONOMICALLY FEASIBLE AND LEVERAGED A \$400 MILLION INVESTMENT
- FOREBEARANCE FROM REGUALTION MADE MSAT COMMERCIALY FEASIBLE
- TECH TRANSFER AND INDUSTRY DEVELOPMENT ACTIVITY HAS POTENTIAL TO ESTABLISH A SOUND CANADIAN SUPPLIER BASE WITH EXPORT OPPORTUNITIES
- TRIALS PROGRAM MAKES INTERIM SERVICE REMUNERATIVE AND THAT SERVICE CAPTURES A SIGNIFICANT EARLY MARKET BASE FOR MSAT

CURRENT ISSUES

° TECHNOLOGY

- ° ACSSB VERSUS DIGITAL VOICE. MSAT LAUNCH IN EARLY 1994. DIGITAL VOICE TECHNIQUES CAN ONLY IMPROVE WHILE ACSSB PERFORMANCE IS PROBABLY OPTIMIZED NOW. DID WE BACK THE RIGHT TECHNOLOGY?

° INDUSTRY

- ° PROCUREMENT. TO WHAT EXTENT SHOULD TMI BE EXPECTED TO FACILITATE THE INDUSTRIAL POLICIES OF THE GOVERNMENT
- ° DAMA SYSTEM IS UNIQUE AND IT IS DIFFICULT TO IDENTIFY DOWNSTREAM BENEFITS THAT WOULD MERIT MAJOR GOVERNMENT SUPPORT

° POLICY

- ° CROSS-BORDER REVENUE AND SPECTRUM SHARING STILL TO BE RESOLVED
- ° WHILE TYPE I/TYPE II POLICY IS CLEAR, PRACTICALITIES DICTATE SOME DEGREE OF FLEXIBILITY IN DEALING WITH NON-CONFORMING TYPE II CARRIERS AND INMARSAT MARITIME AND AERONAUTICAL SERVICES
- ° DYNAMIC ALLOCATION OF AERONAUTICAL CHANNELS MUST BE RESOLVED
- ° NORTH AMERICA-WIDE AERONAUTICAL PUBLIC CORRESPONDENCE IS STILL TO BE ADDRESSED

PRIORITIES

PRESENT

- ° INDUSTRIAL BENEFITS - PROCUREMENT, SUPPLIER BASE

- ° PURSUE INTERIM VOICE SERVICE AND LEASE AND
RELOCATE MARISAT

- ° CONVINCING AERONAUTICAL COMMUNITY AND ITS
REGULATOR OF THE FEASIBILITY OF DYNAMIC ALLOCATION

- ° FOSTER THE DEVELOPMENT OF SERVICE PROVIDERS

FUTURE


- ° DEVELOP GOVERNMENT USER BASE TO EFFECTIVELY USE
THE \$126.5 MILLION SERVICE

- ° INVESTIGATE SECOND GENERATION CONCEPTS AND PROGRAMS
- PERSONAL COMMUNICATIONS

- ° PREPARE FOR WARC 92 AND DEFINITIVE MOBILE ALLOCATIONS

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