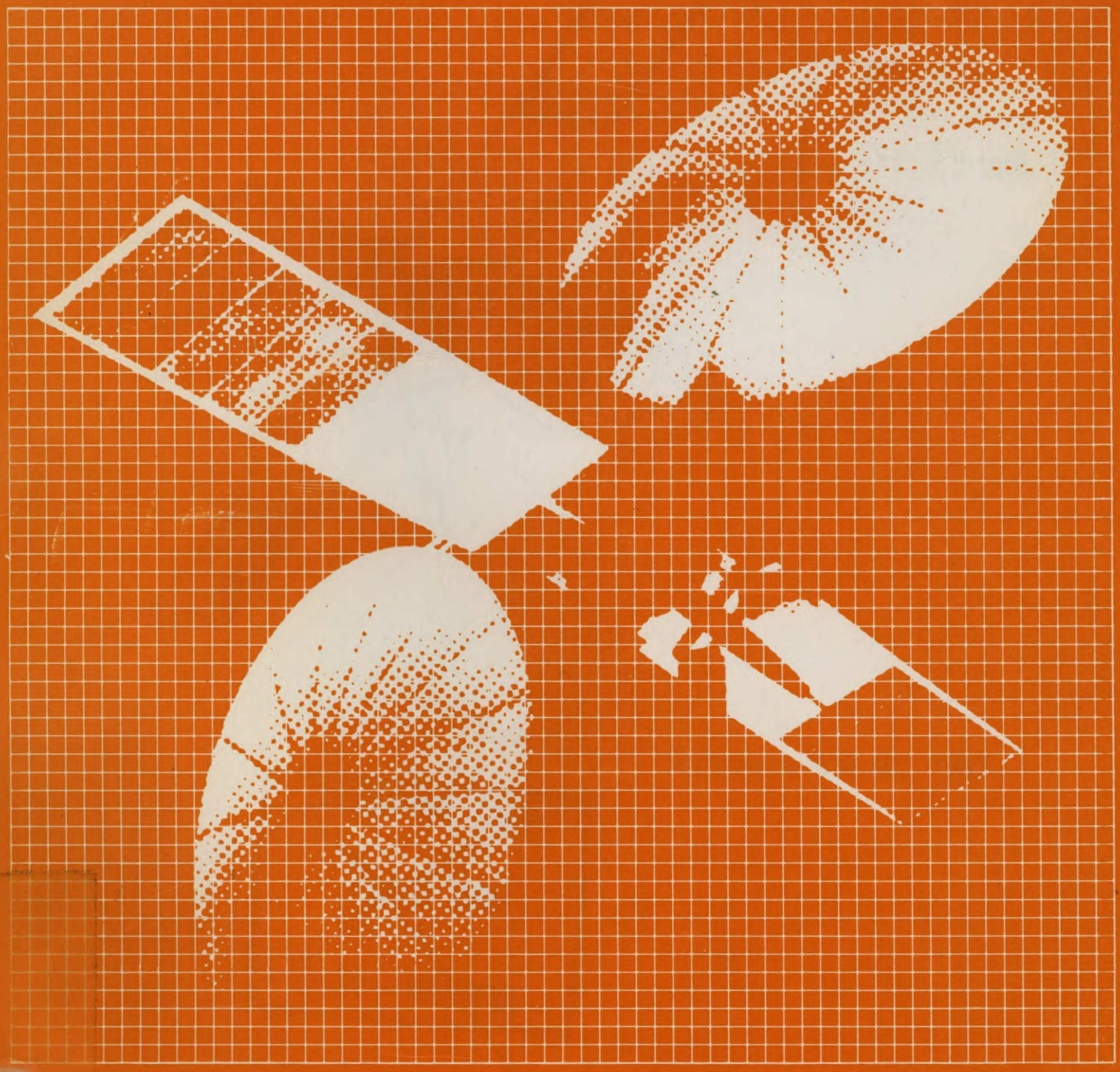
MSAT PHASE B
INDUSTRY BRIEFING
DAY 2

Government of Canada
Department of Communications

Gouvernement du Canada
Ministère des Communications



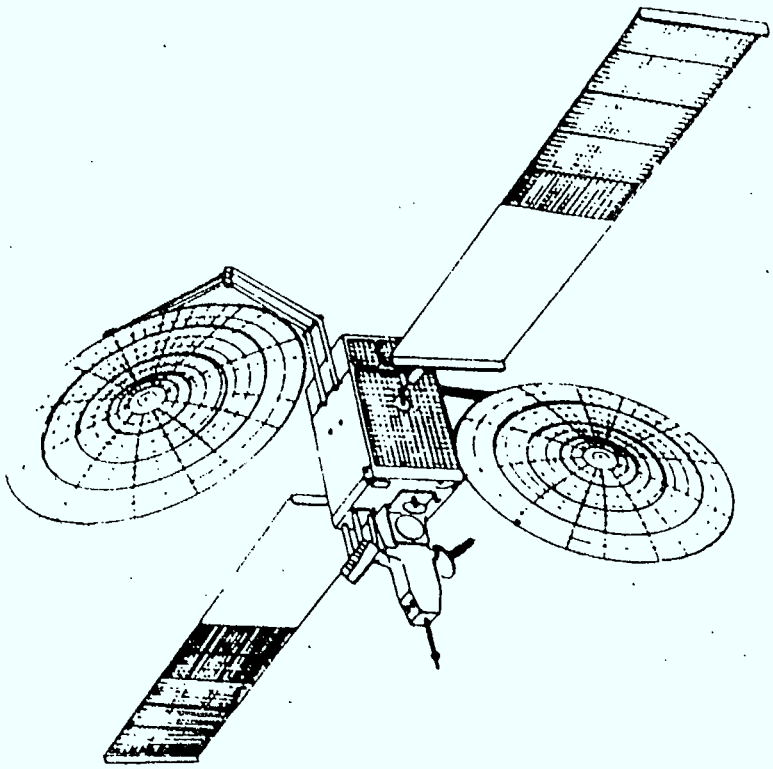
MOBISAT

Canada

L-SAT PHASE B

INDUSTRY BRIEFING

DAY 2



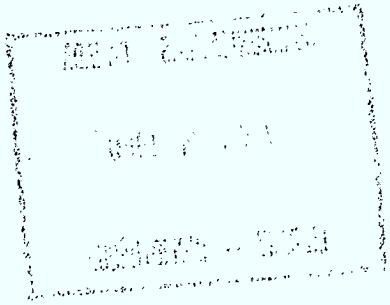
SEPTEMBER 9 & 10, 1982

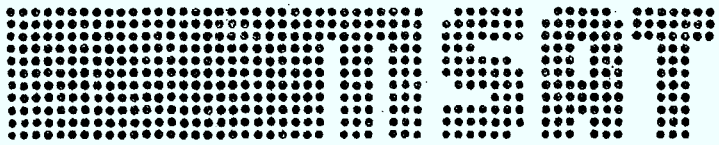
GOVERNMENT OF CANADA
DEPARTMENT OF COMMUNICATIONS

SPACE PROGRAM

GOUVERNMENT DU CANADA
MINISTÈRE DES COMMUNICATIONS

PROGRAMME SPATIAL

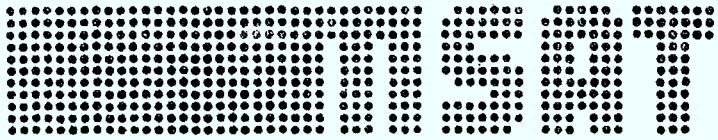




MSAT PHASE A STUDIES
INTRODUCTION

R.W. BREITHAUPT

AGENDA ITEM 1



MARKET STUDY

WOODS GORDON

AGENDA ITEM 2

MSat MARKET STUDY

PRESENTATION OF RESULTS

10 September 1982

Woods Gordon
MANAGEMENT CONSULTANTS

Woods Gordon

MSat MARKET STUDY

PRESENTATION AGENDA

1. INTRODUCTION AND STUDY OBJECTIVES
2. DEVELOPMENT OF POTENTIAL MARKET SIZE
   - LICENCE DATA
   - SURVEY RESULTS
3. PROJECTED MARKET PENETRATION FOR MSat
4. CURRENT SYSTEM DEFICIENCIES AND USER REQUIREMENTS

Woods Gordon

INTRODUCTION AND STUDY OBJECTIVES

OBJECTIVE

A MARKET STUDY TO IDENTIFY USER REQUIREMENTS FOR A SATELLITE SYSTEM PROVIDING MOBILE COMMUNICATION SERVICES IN THE 806 - 890 MHz BAND

Woods Gordon

FOUR ESSENTIAL COMPONENTS

1. IDENTIFICATION OF SERVICES REQUIRED BY USERS

2. PROJECTION OF PROBABLE USAGE OF MOBILE COMMUNICATIONS TO THE YEAR 2000

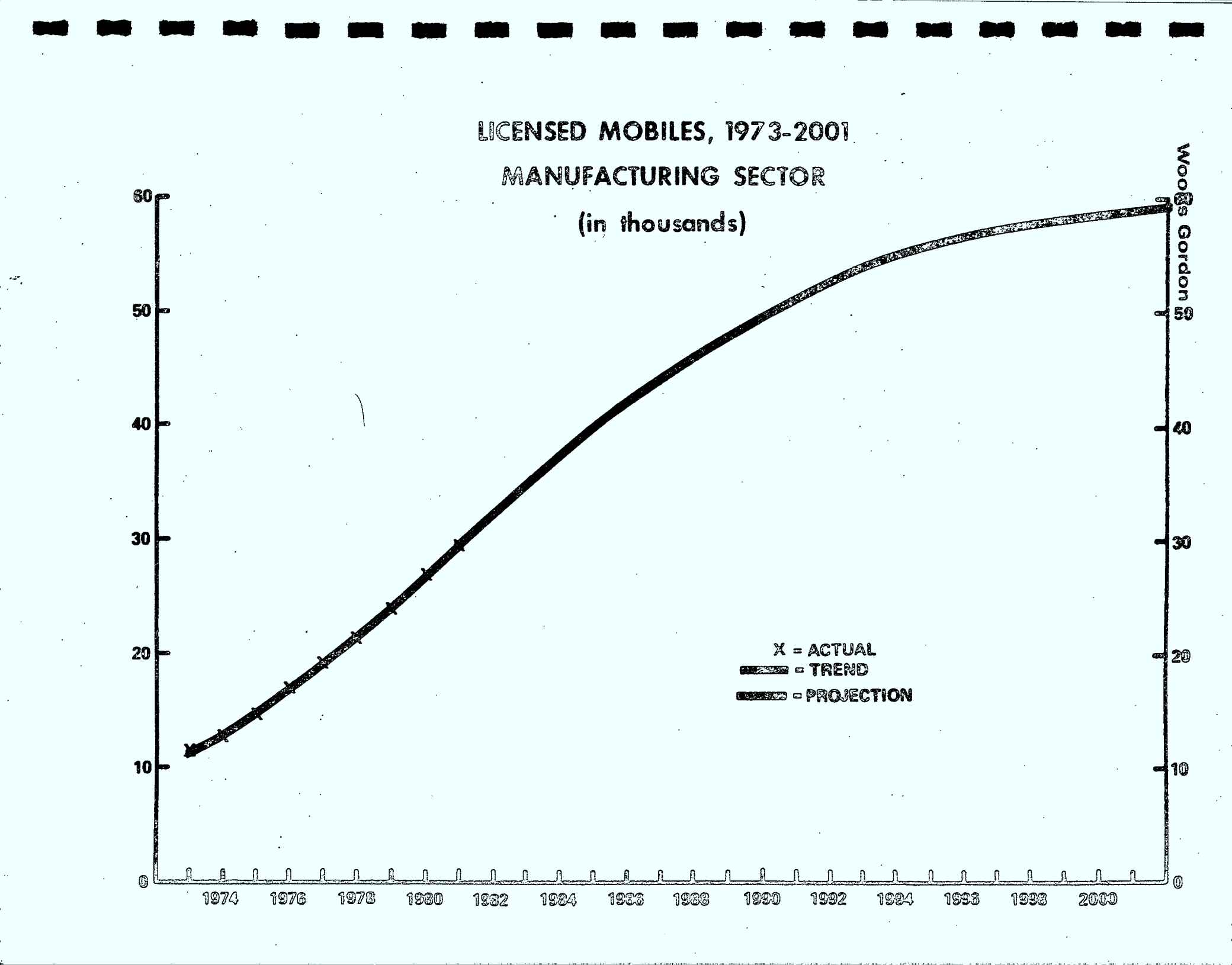
3. ESTIMATION OF THE PENETRATION LIKELY TO BE ACHIEVED BY THE SATELLITE SYSTEM

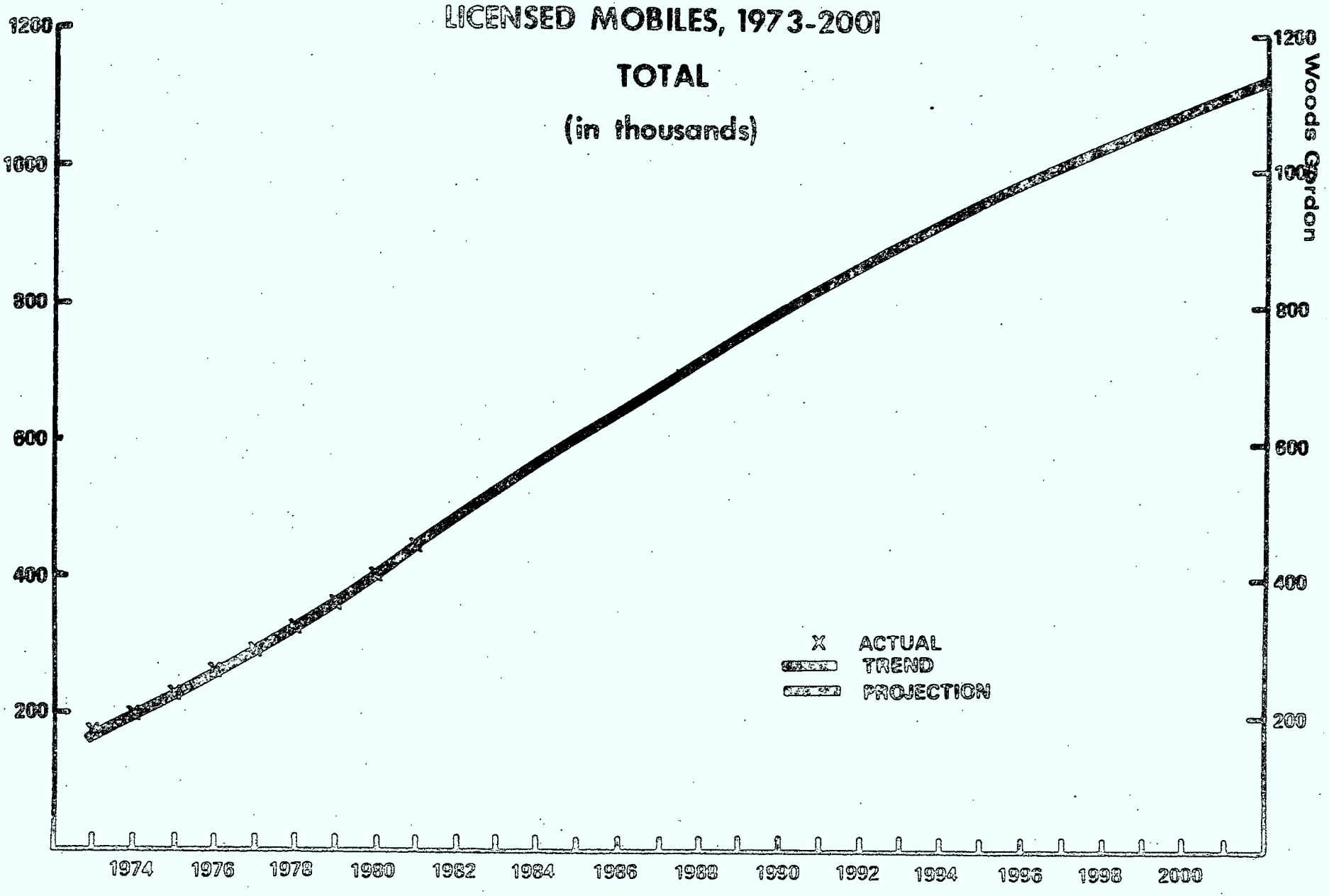
4. ESTIMATION OF THE PRICE USERS WOULD PAY

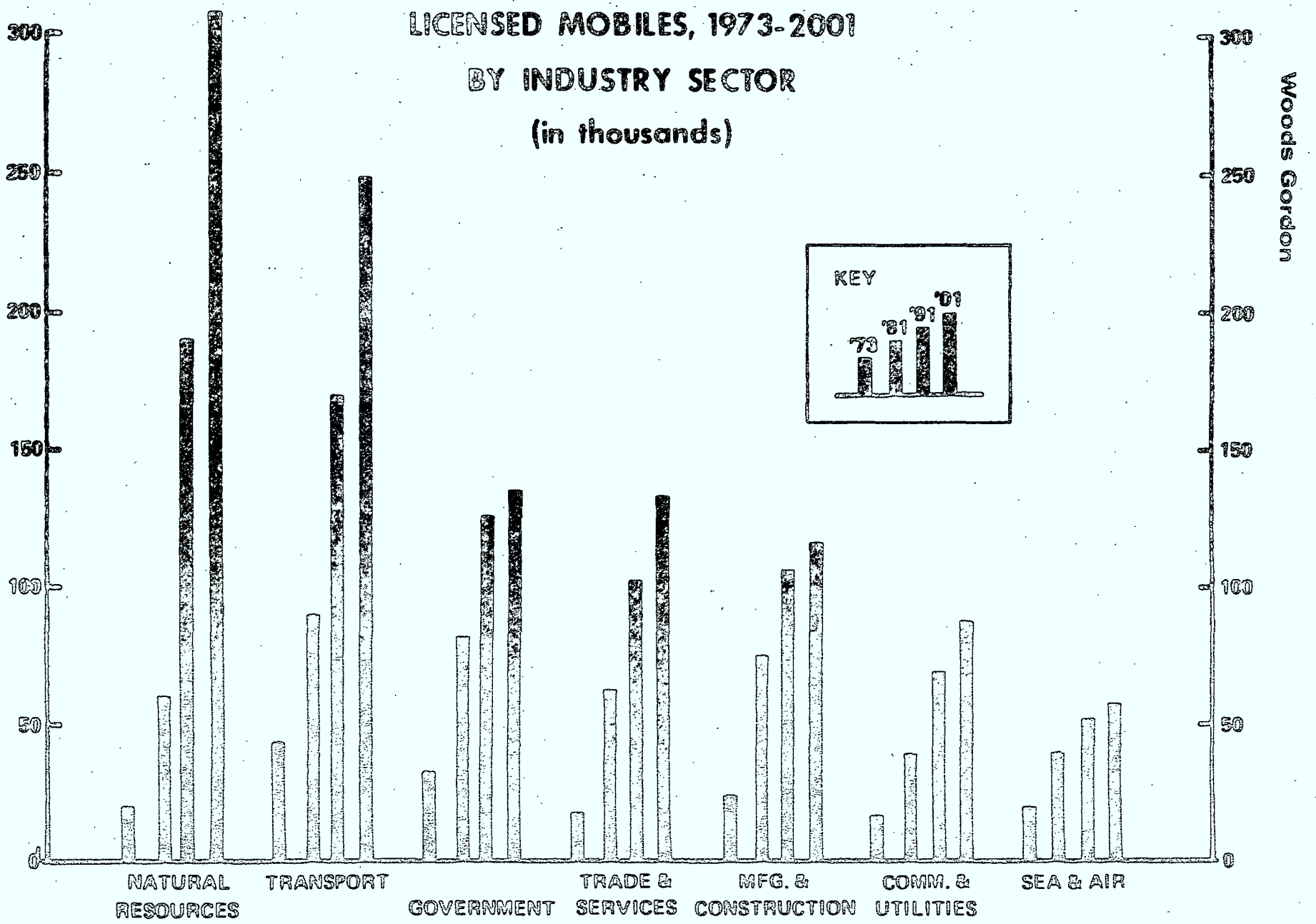
Woods Gordon

DEVELOPMENT OF POTENTIAL

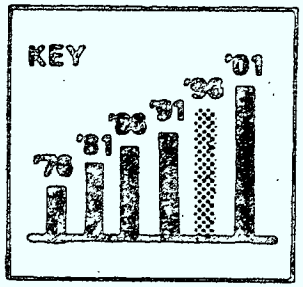
MARKET SIZE


LICENSED MOBILES, 1973-2001
MANUFACTURING SECTOR
(in thousands)
Woods Gordon
60
50
40
30
20
10
0
1974
1976
1978
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
X = ACTUAL
= TREND
= PROJECTION


LICENSED MOBILES, 1973-2001
TOTAL
(in thousands)
1200
1000
800
600
400
200
1974
1976
1978
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
X ACTUAL
TREND
PROJECTION
Woods Gordon


LICENSED MOBILES, 1973-2001
BY INDUSTRY SECTOR
(in thousands)
KEY
'73
'81
'91
'01
300
250
200
150
100
50
0
NATURAL RESOURCES
TRANSPORT
GOVERNMENT
TRADE & SERVICES
MFG. & CONSTRUCTION
COMM. & UTILITIES
SEA & AIR
Woods Gordon

LICENSED MOBILES, 1976-2001
BY REGION
(in thousands)



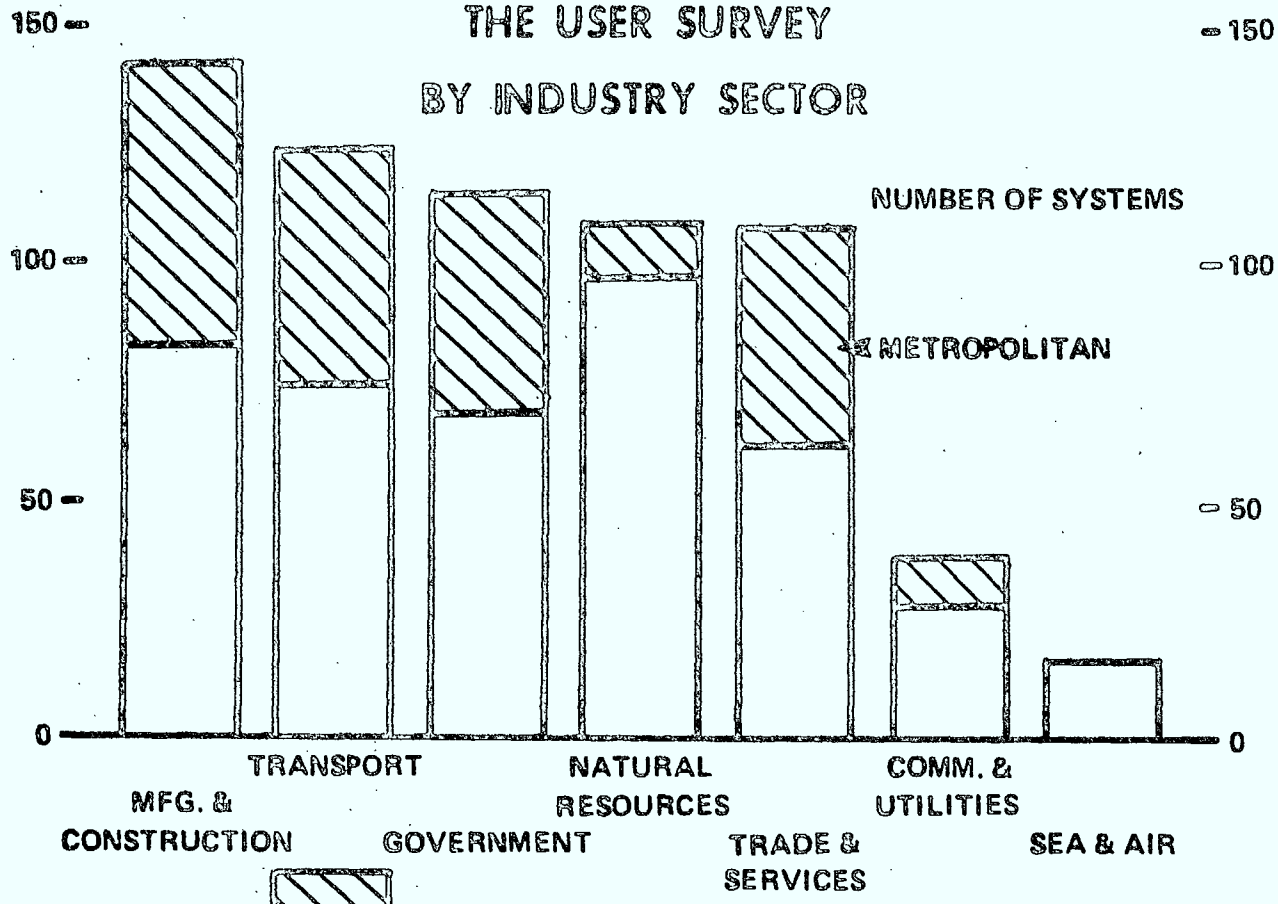
350
300
250
200
150
100
50

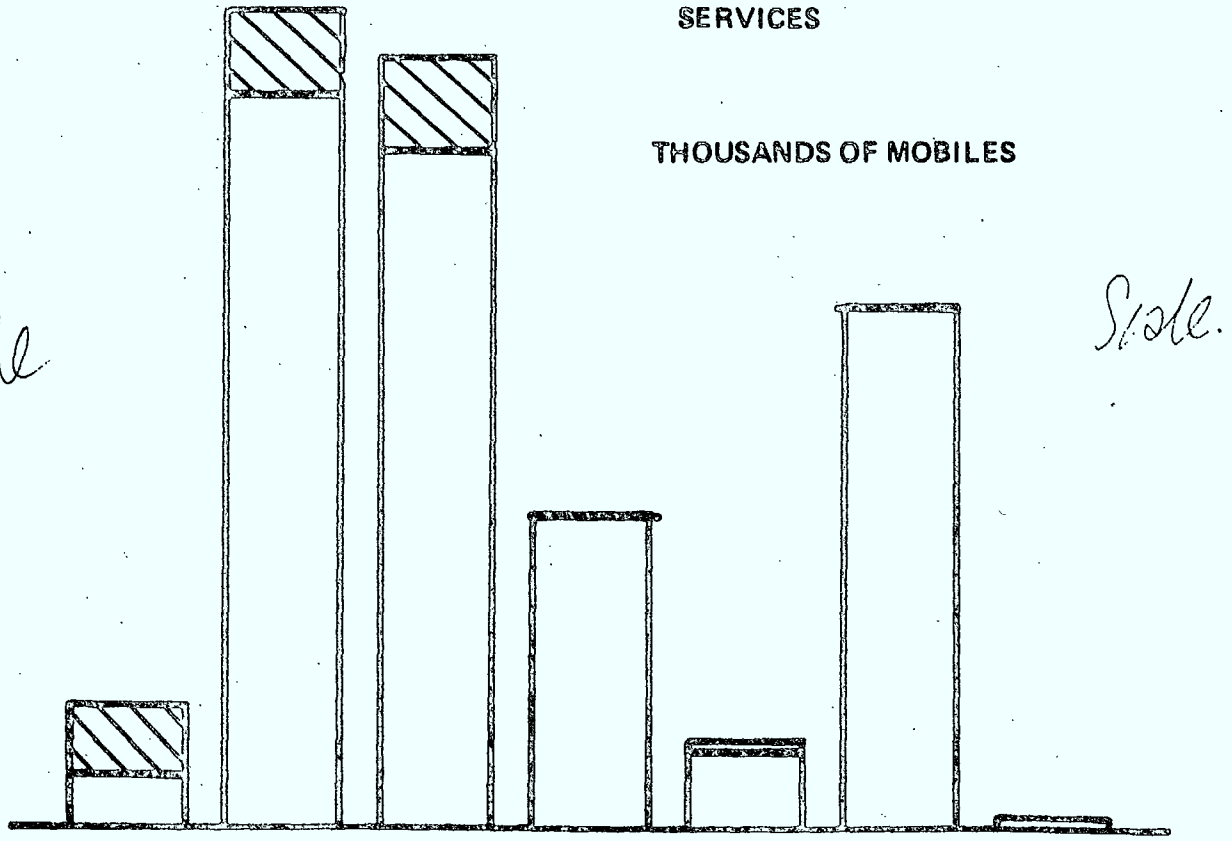
B.C. & YUKON
PRAIRIES & N.W.T.
ONTARIO
QUEBEC
ATLANTIC

Woods Gordon

Woods Gordon

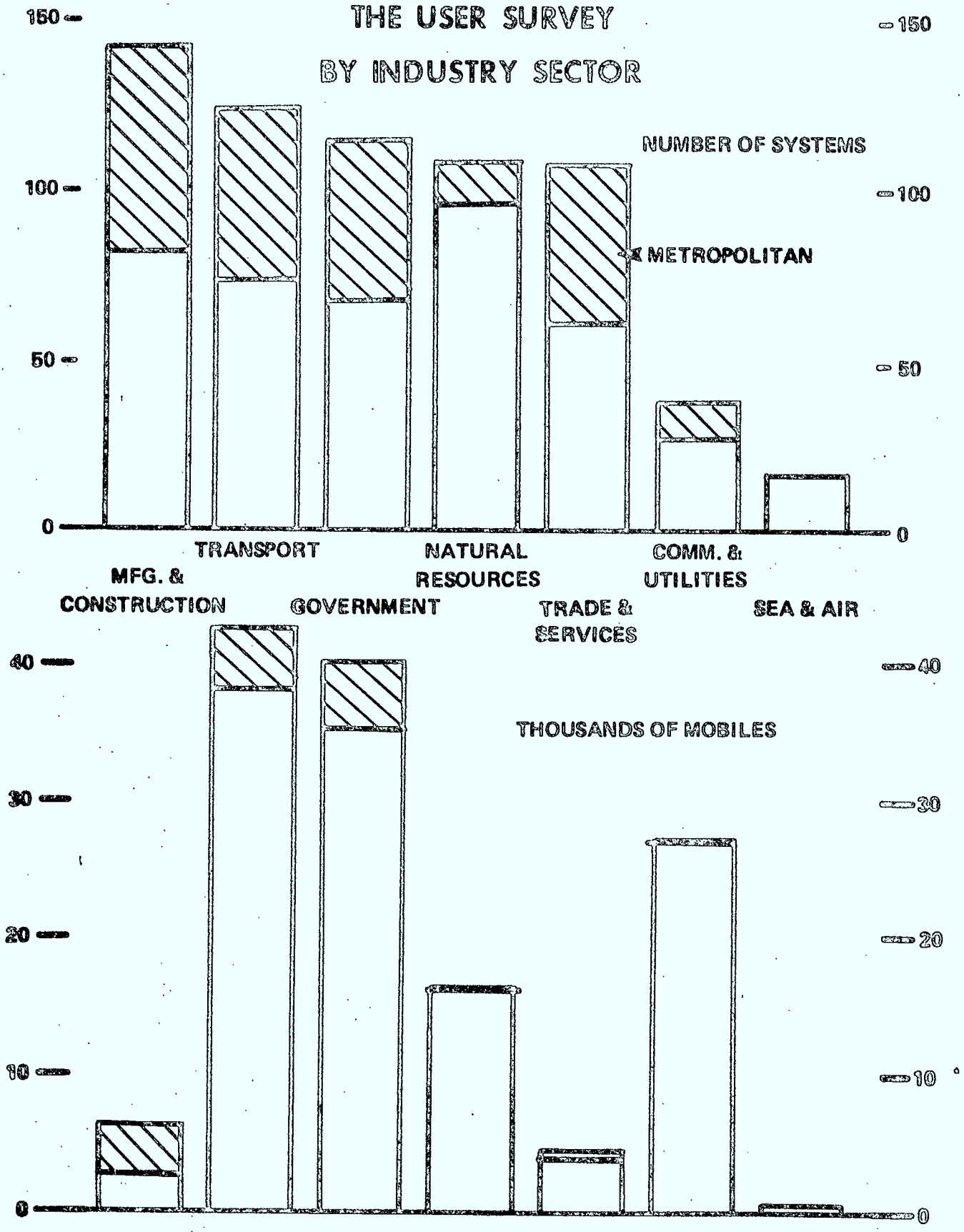
THE USER SURVEY
BY INDUSTRY SECTOR





Scale

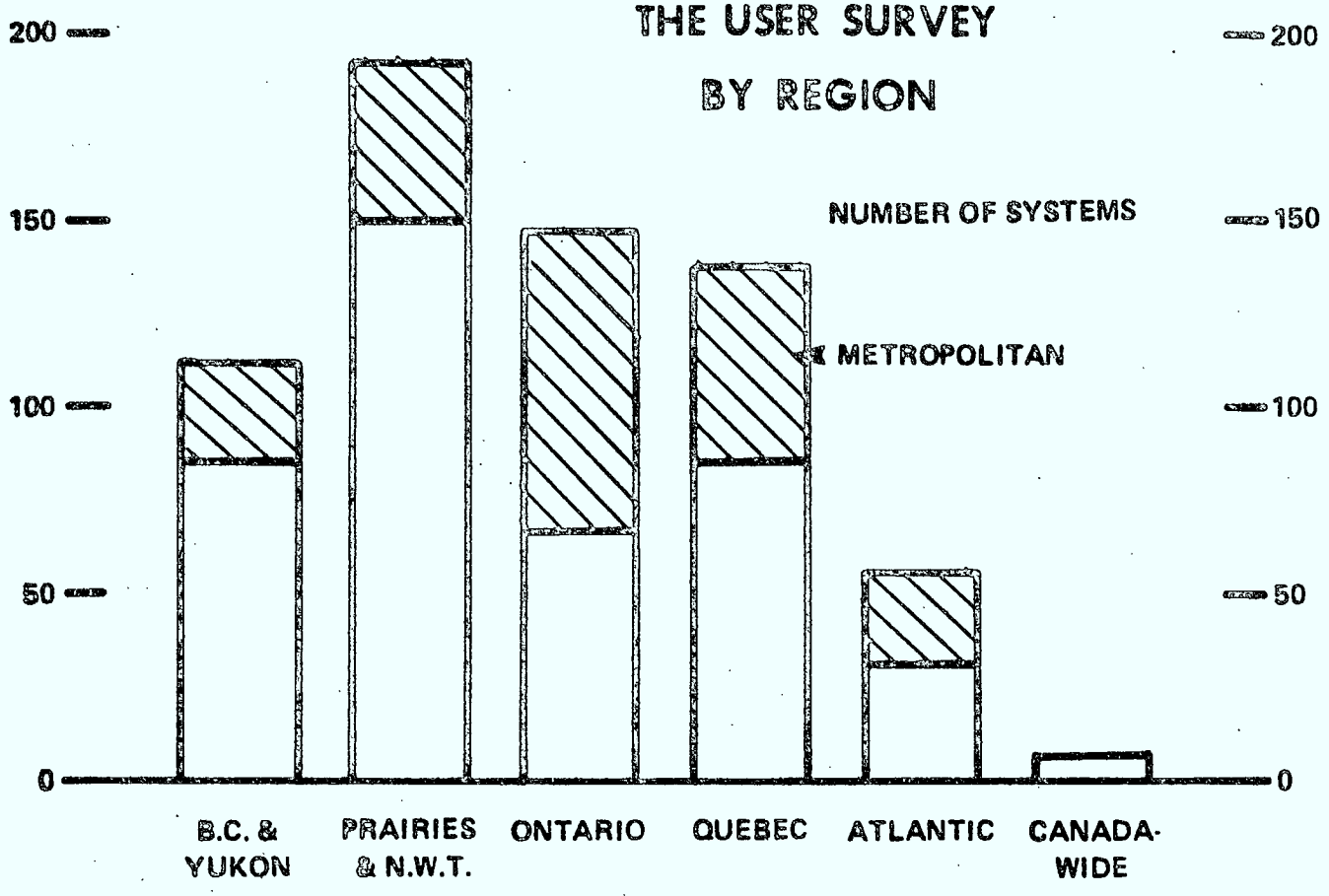
Scale.

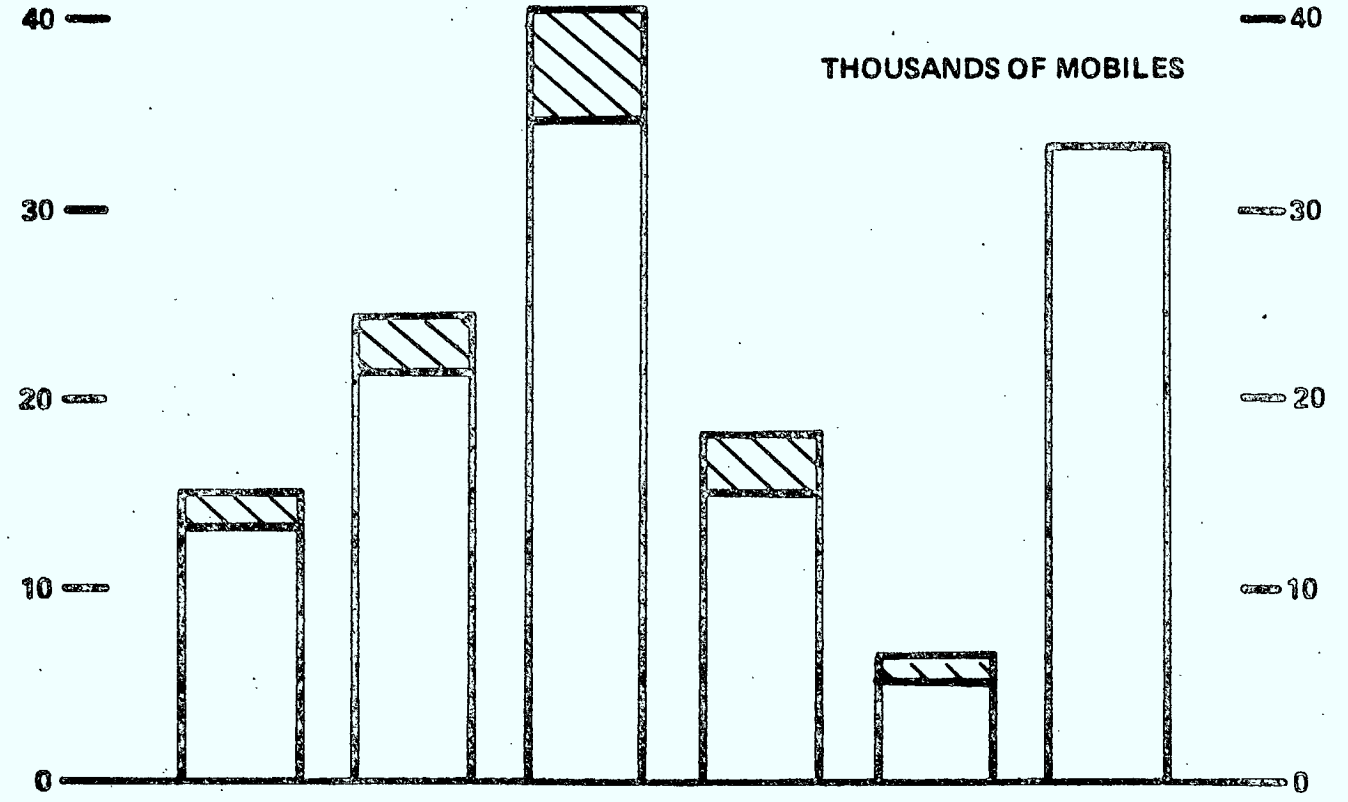


Woods Gordon

Woods Gordon

THE USER SURVEY BY REGION





Woods Gordon

MSAT POTENTIAL MARKET

TRAFFIC VOLUME

	AIRTIME (million minutes/month)
TOTAL NON-METROPOLITAN AIRTIME	105.0
LESS SHORT RANGE SYSTEMS	39.3
	65.7
LESS SYSTEMS WITH MORE THAN 25% METRO AREA USAGE	1.7
MSat POTENTIAL AIRTIME	64.0

REDUCTION FROM TOTAL NON-METRO AIRTIME = 40%

Woods Gordon

PROJECTED MARKET PENETRATION

FOR MSat

KEY MARKET PENETRATION ASSUMPTIONS

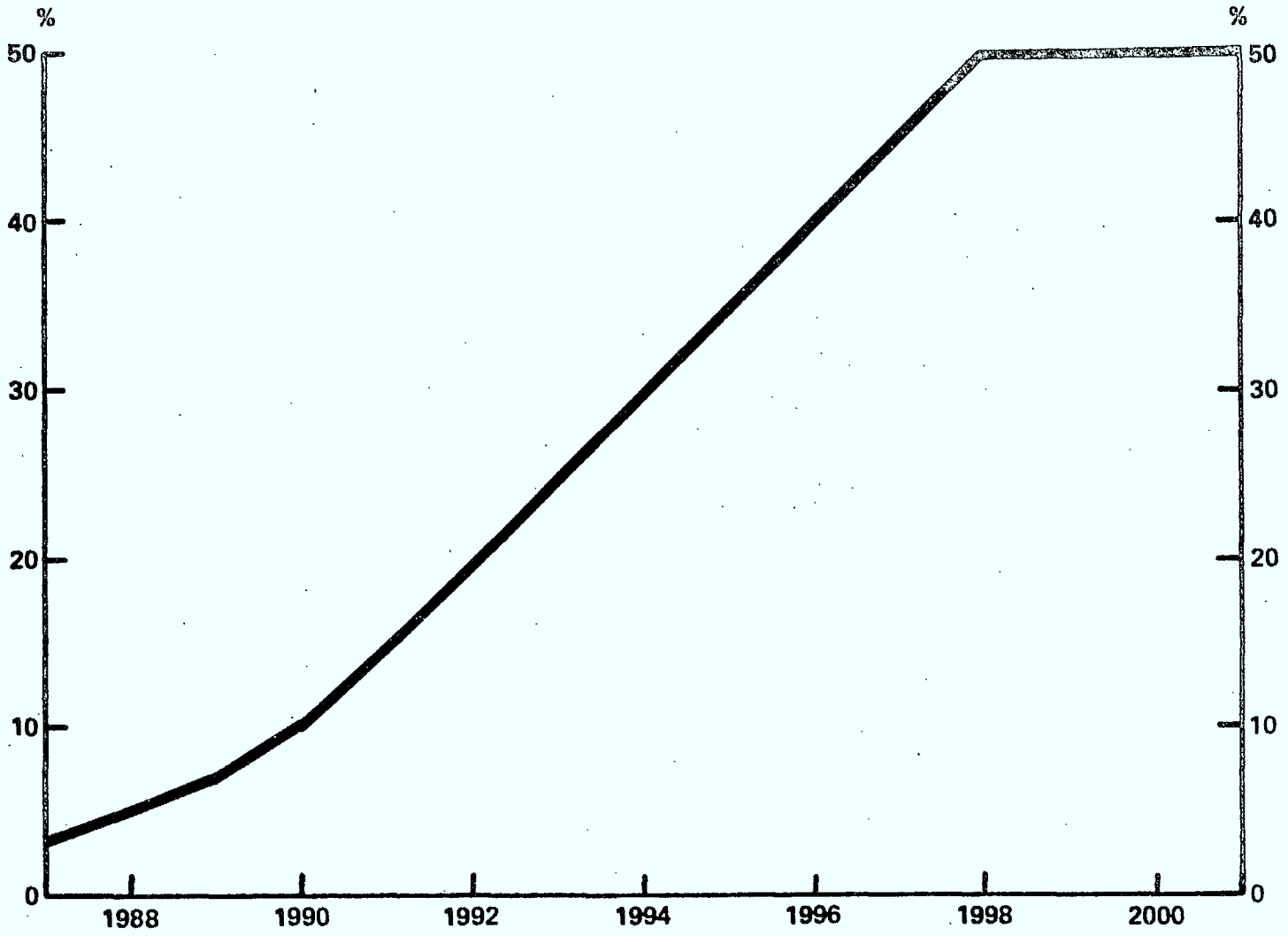
1. COMPETITIVE COST
2. FLEXIBLE PRICING POLICIES
3. NO UNANTICIPATED NEW TECHNOLOGIES
4. TELCOS ADOPT MSat
5. NO PRIVATE SATELLITE SYSTEMS
6. PENETRATION RATE

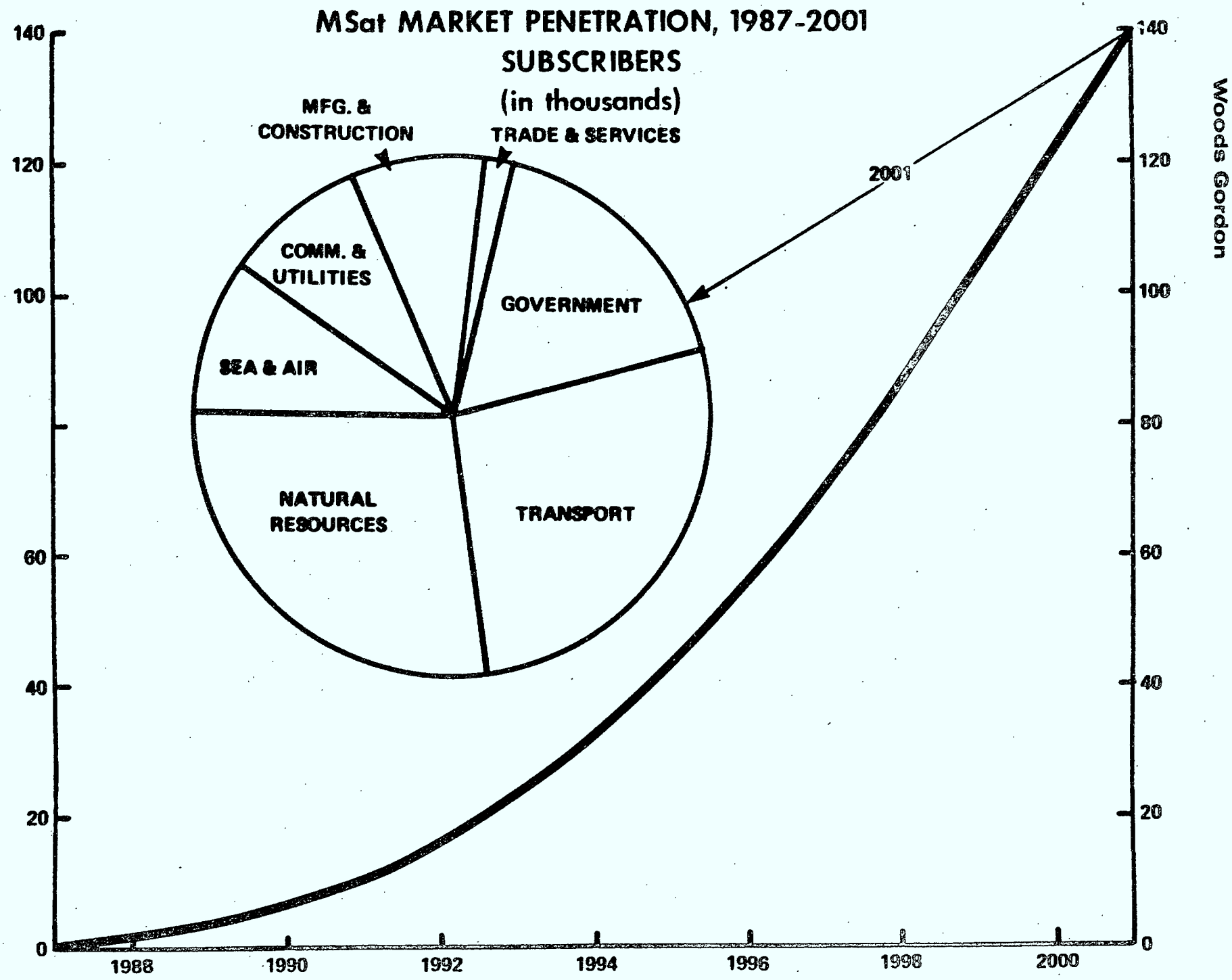
Woods Gordon

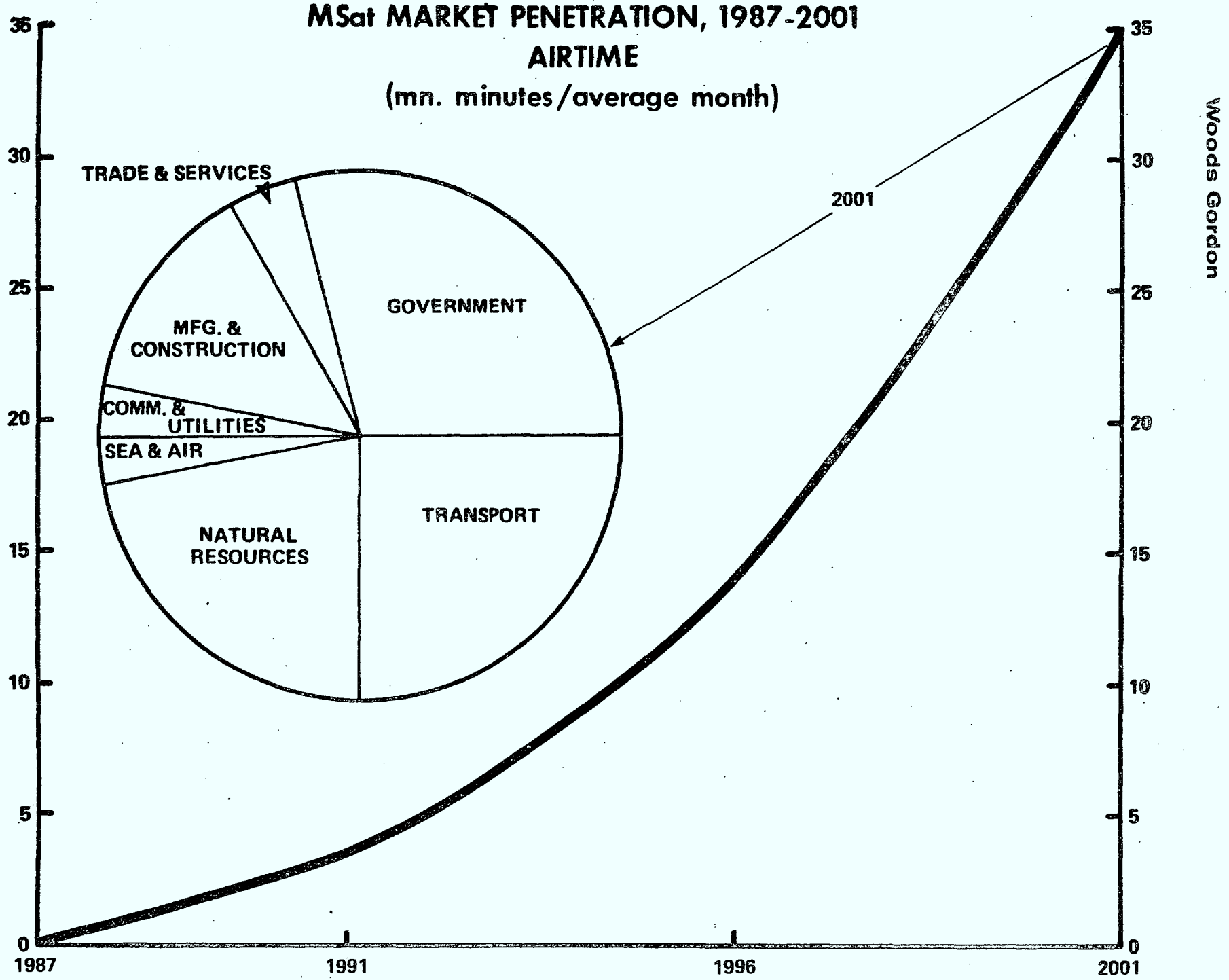
MSat MARKET PENETRATION

1987-2001

(% of mobiles being replaced)



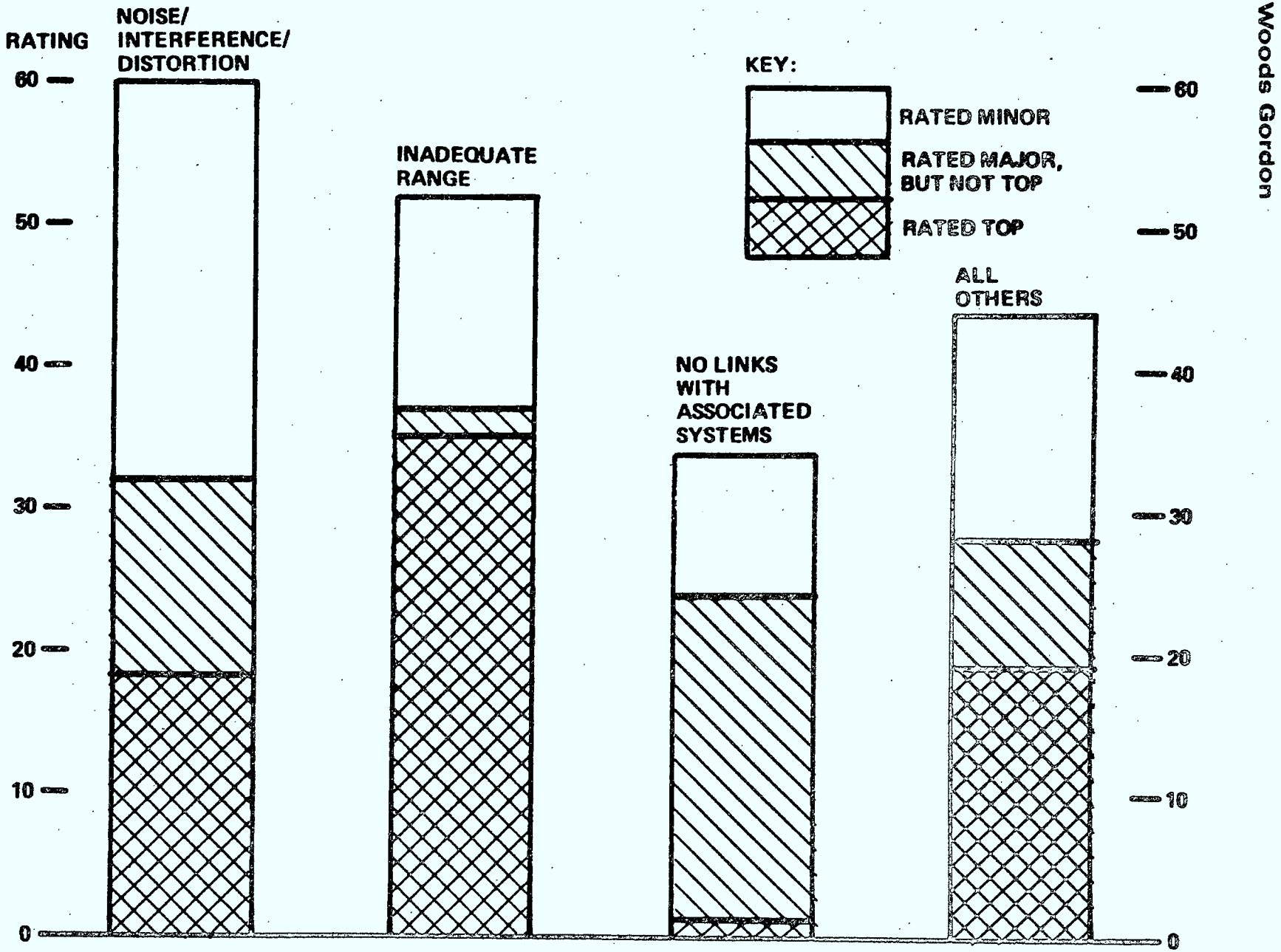

MSat MARKET PENETRATION, 1987-2001
SUBSCRIBERS
(in thousands)
MFG. & CONSTRUCTION
TRADE & SERVICES
COMM. & UTILITIES
GOVERNMENT
SEA & AIR
NATURAL RESOURCES
TRANSPORT
2001
140
120
100
80
60
40
20
0
1988
1990
1992
1994
1996
1998
2000
Woods Gordon


MSat MARKET PENETRATION, 1987-2001
AIRTIME
(mn. minutes/average month)
TRADE & SERVICES
GOVERNMENT
MFG. & CONSTRUCTION
COMM. & UTILITIES
SEA & AIR
NATURAL RESOURCES
TRANSPORT
2001
Woods Gordon
0
5
10
15
20
25
30
35
1987
1991
1996
2001

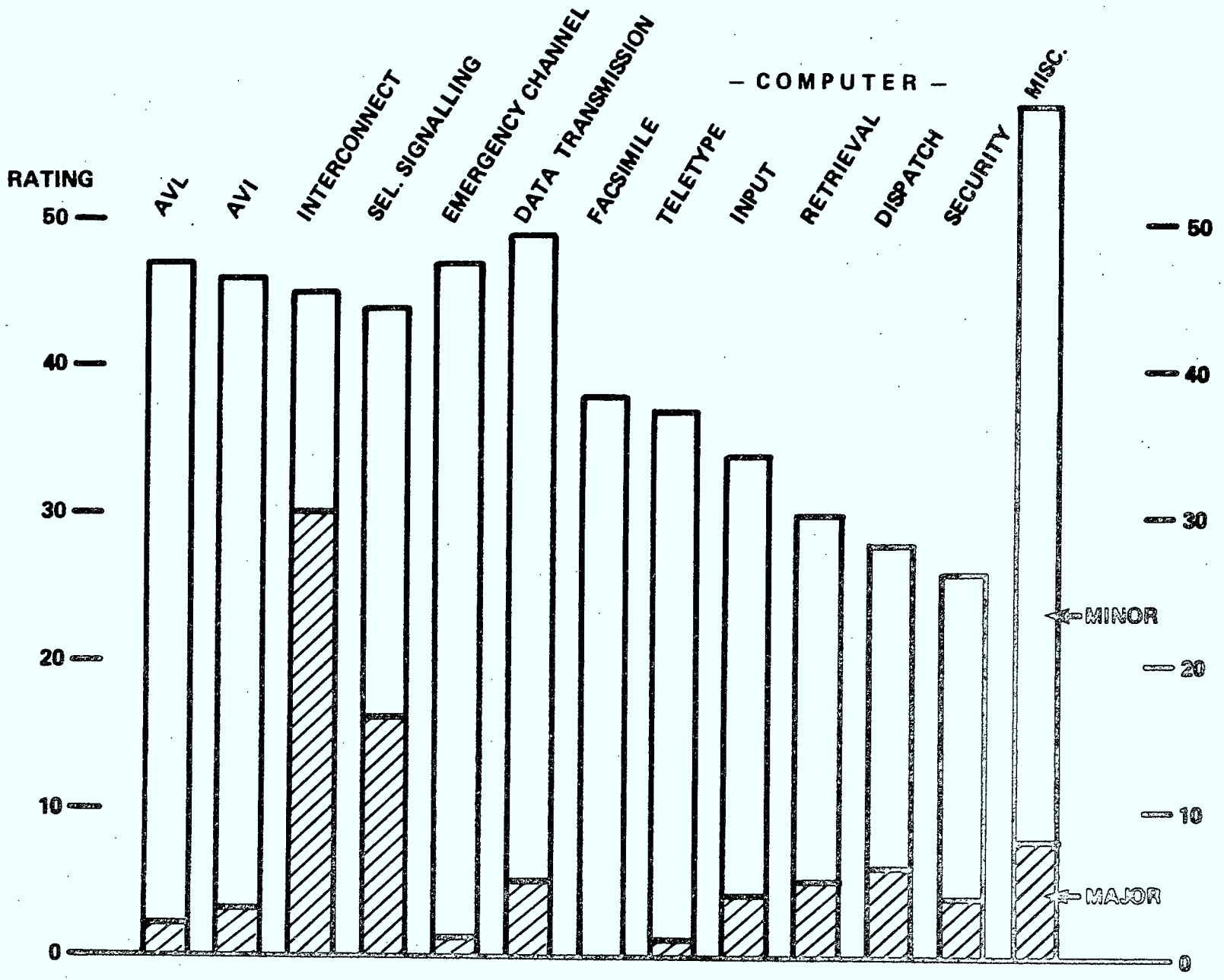
Woods Gordon

CURRENT SYSTEM DEFICIENCIES AND USER REQUIREMENTS

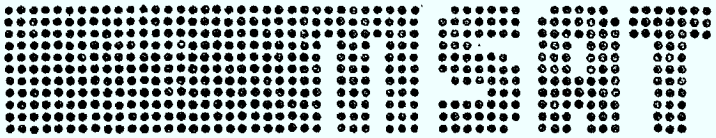
RATINGS OF TECHNICAL FAILINGS



RATINGS OF DESIRED ADDED FEATURES



Woods Gordon



COMMERCIAL VIABILITY STUDY

ADGA

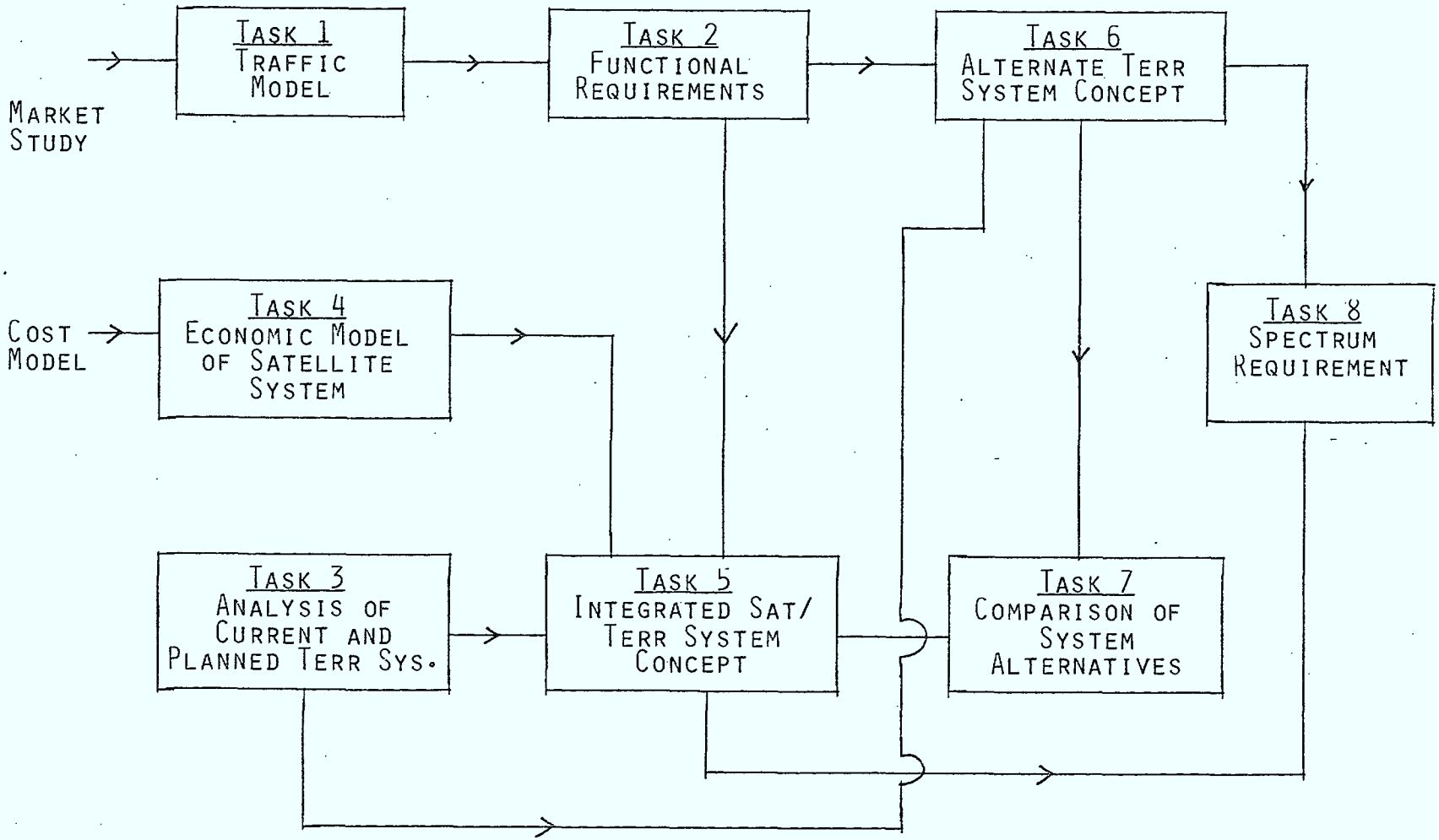
AGENDA ITEM 3

MSAT PHASE A STUDY REPORT

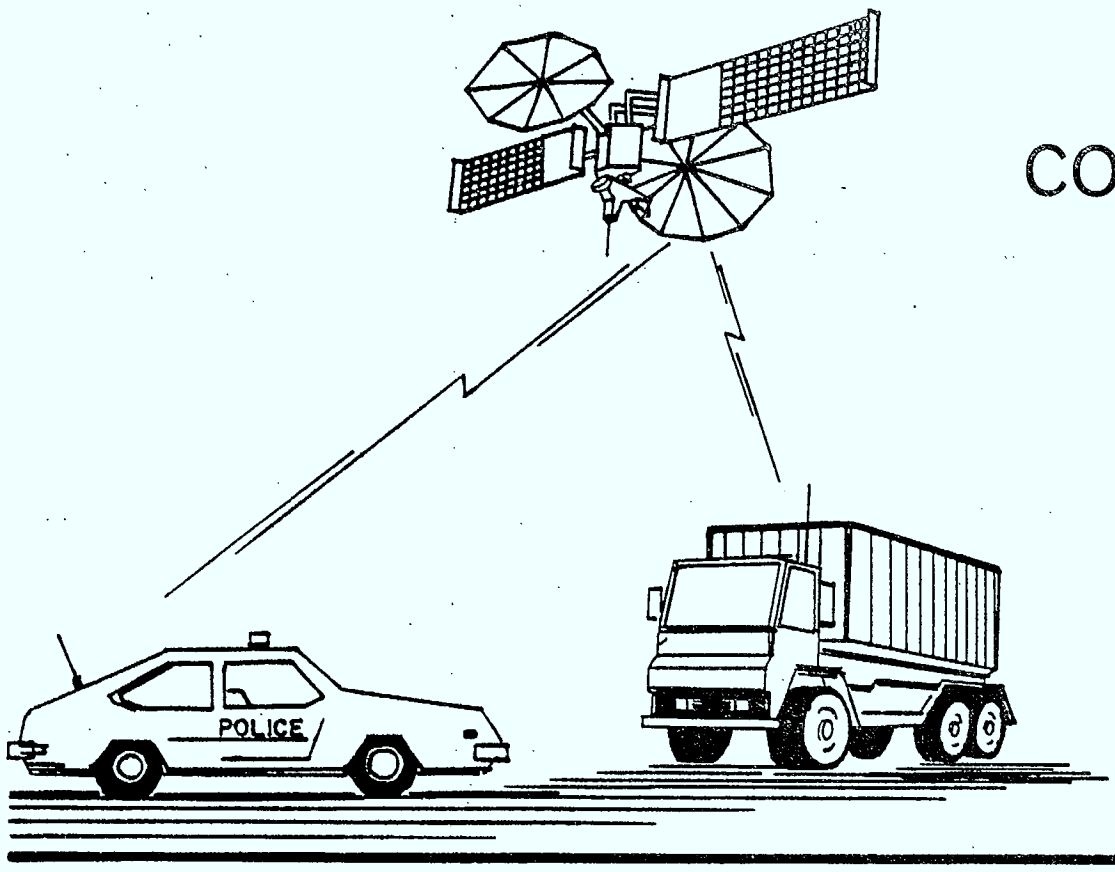
COMMERCIAL VIABILITY STUDY OF AN INTEGRATED SATELLITE/TERRESTRIAL MOBILE COMMUNICATIONS SYSTEM OPERATING IN THE 806 - 890 MHz BAND.

N-W-N

INTEGRATED SYSTEM STUDY FLOW CHART



INDUSTRY BRIEFING



MSAT COMMERCIAL VIABILITY STUDY

adga

Consulting Group

TOUCHE ROSS & PARTNERS

Management Consultants

OTTAWA, CANADA
SEPTEMBER, 1982

TASK BREAKDOWN

1. TRAFFIC MODEL
2. FUNCTIONAL REQUIREMENTS
3. ANALYSIS OF CURRENT AND PLANNED TERRESTRIAL SYSTEMS
4. ECONOMIC MODEL OF SATELLITE SYSTEM
5. INTEGRATED SATELLITE/TERRESTRIAL SYSTEM CONCEPT (COMPUTER MODEL)
6. ALTERNATIVE TERRESTRIAL SYSTEM CONCEPT
7. COMPARISON OF SYSTEM ALTERNATIVES
8. SPECTRUM REQUIREMENTS

MARKET PROJECTIONS

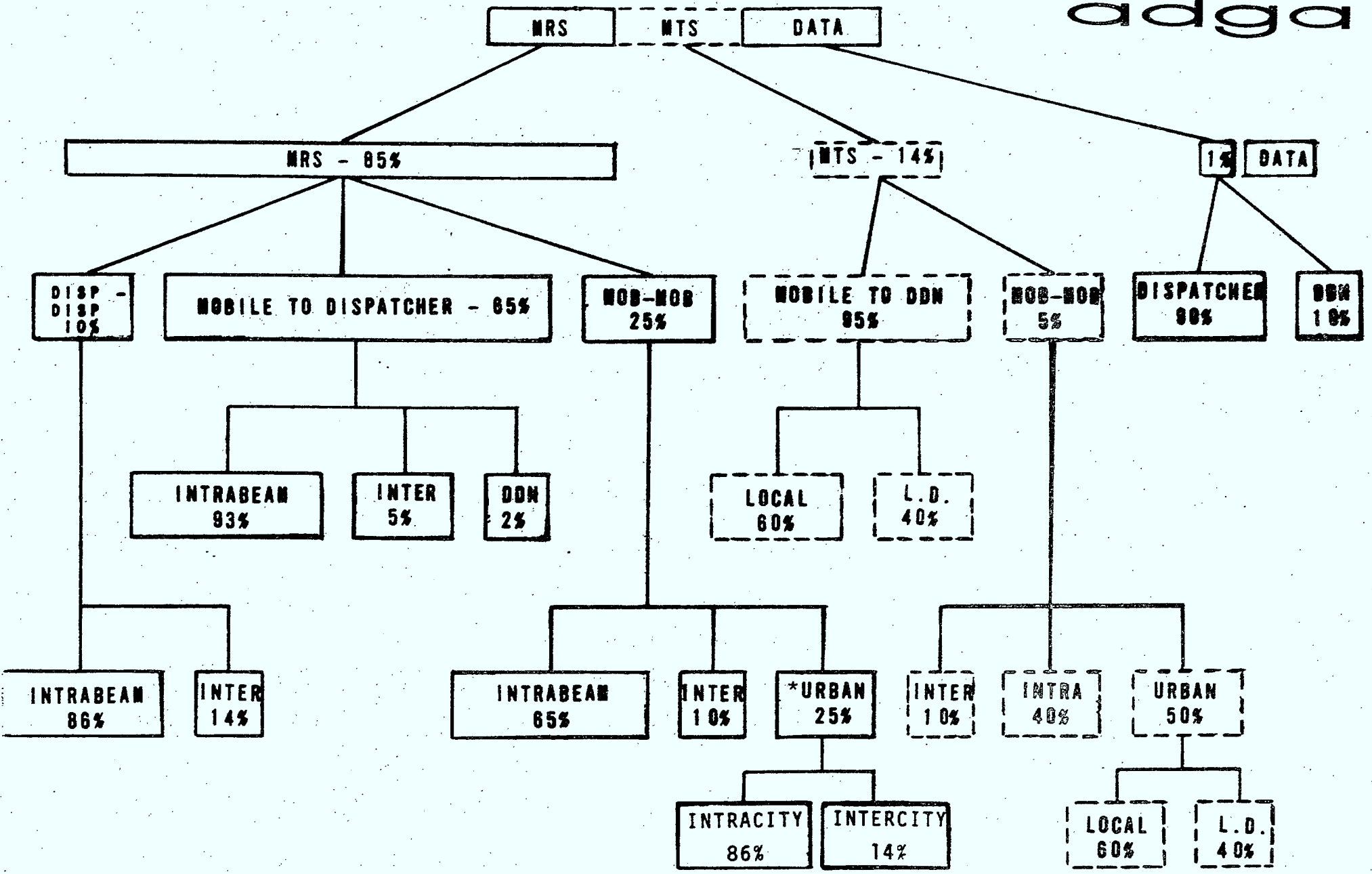
	1987	1991	1996	2001
AIRTIME PROJECTIONS (10 MINUTES/AVG. MONTH)	0.2	2.8	14.1	34.8
NUMBER OF MOBILES (THOUSANDS OF UNITS)	0.7	10.2	56.0	140.0

CLASSIFICATION OF SERVICE	VOLUME
• MOBILE TELEPHONE (MTS)	85%
• MOBILE RADIO (MRS)	14%
• ONE-WAY PAGING	N/A
• DATA	1%

CATEGORY	ACCEPTABLE BLOCKING(P)	MONTHLY AIRTIME (000's MINS.)
EMERGENCY SERVICE	0.005	2,538.55
LAW ENFORCEMENT	0.01	5,202.00
ESSENTIAL SERVICES	0.05	6,614.40
BUSINESS SERVICES	0.1	19,586.70
CONVENIENCE SERVICES	0.1	838.35

AIRTIME DISTRIBUTION WITH GRADE OF SERVICE (FINAL YEAR)

adga



DISTRIBUTION OF MSAT TRAFFIC

* SUBSEQUENT INDICATIONS ARE THAT THE MRS MOBILE-MOBILE URBAN TRAFFIC (25%) MIGHT BE REDUCED TO A MUCH LOWER LEVEL.

CITY SIZE	TOTAL MSAT TRAFFIC	MTS TRAFFIC	MRS TRAFFIC
2.5M	112 ERLANGS	15.7	96.3
1 M	45	6.3	38.7
500 K	22.5	3.15	19.35
200 K	9	1.26	7.74
50 K	3.6	0.5	3.1

MSAT TRAFFIC FROM URBAN AREAS.

REQUIREMENTS FOR CANADA WIDE SYSTEM

1. NATIONWIDE AND U.S. INTER-OPERABLE (AMPS)

2. PEAK CAPACITY TO SUIT METRO AREAS (0.28 BH ER/SQ. KM)*

3. FLEXIBLE SIZING TO SUIT LOCAL TRAFFIC

4. SYTEM CAPACITY 10303 BH ERLANGS
   (72,000 METRO USERS)
   (140,000 NON-METRO USERS)

5. SYSTEM COVERAGE - 1777M SQ. KM. (POPULATION DENSITY 1 PERSON/SQUARE KILOMETRE)

*METRO POPULATION 15,000 MOBILES AND 2500 SQ. KM AREA.

CALL DURATIONS

MTS	-	3 MINUTES
MRS	-	20 SECONDS
DATA	-	2 SECONDS
SIGNALLING AND CONTROL	-	100 MILLISECONDS/CALL OR DATA MESSAGE

FUNCTIONAL REQUIREMENTS SUMMARY - MOBILE

	MTS	MRS
GRADE OF SERVICE (BLOCKING AT OF LIFE)	0.1	0.01 EMERGENCY DISPATCH 0.15 NON-EMERGENCY DISPATCH, AVERAGE 0.048.
QUALITY OF SERVICE	TOLL, 26DB SUBJECTIVE S/N	COMMUNICATION 20DB SUBJECTIVE S/N
NUMBER OF CHANNELS	134 OR GREATER	829 OR GREATER
SERVICE AREA	NATIONWIDE	50 TO 700 MILES
MODE	FULL DUPLEX	HALF-DUPLEX
AUTOMATIC IDENTIFICATION	ESSENTIAL	ESSENTIAL
AUTOMATIC LOCATION	PHASE RANGING CAPABILITY DESIRABLE FOR AMPS COMPATIBILITY	NOT REQUIRED
MODULATION (VOICE)	NBFM(12)	NBFM(12), NBFM(5), SSB, ACSSB OR LPC (T.B.D.)
MODULATION (DATA)	10KBPS BINARY FSK	10KBPS BINARY FSK, 4.8KBPS QPSK OR 2.4KBPS BPSK T.B.D.
SELECTIVE CALLING	ESSENTIAL, 10 DIGIT	ESSENTIAL 6 + 4 DIGIT
FREQUENCY CONTROL (ACCESS) (VOICE)	CHANNEL SCANNING DEMAND ASSIGNED CHANNELS	PREASSIGNED CHANNEL DEMAND ASSIGNED CHANNELS
REGISTRATION	AUTOMATIC WITH MANUAL OVERRIDE	MANUAL
SECURITY	CAPABILITY USING EXTERNAL DEVICE	AS MTS

adga

CHARACTERISTICS	DATA ELEMENT	
LAUNCH MASS TO T.O.	2900	KILOGRAMS
ANTENNA SIZE	50	FEET
EOC GAIN	36.5	dB
FEED ASSEMBLY LOSSES	1.5	dB
NUMBER OF SPOT BEAMS	7	
MAXIMUM DC POWER	7	KILOWATT
HPA EFFICIENCY	33	%
PEAK RF POWER	2.3	KILOWATT
MAXIMUM THERMAL DISSIPATION	(2160)	2000 W AT 40°C
	(3690)	3000 W AT 70°C
MAXIMUM CONTINUOUS RF POWER (70°C)	(1845)	1500 WATTS
TOTAL BANDWIDTH	12	MHz (5±6 MHz)
FREQUENCY REUSE (SUB-BANDS)	(3)	4
CHANNEL BANDWIDTH MTS	30	KHz
CHANNEL BANDWIDTH MRS	5	KHz
C/(No + I) OBJECTIVE MTS	(53)53	dB Hz
C/(No + I) OBJECTIVE MRS	(42)47	Db Hz
ECLIPSE CAPABILITY	50	%
N.S. STATION KEEPING	7	YEAR

SPACECRAFT PERFORMANCE PARAMETERS

FEATURES OF ECONOMIC MODEL

- o DEVELOPS COSTING EQUATIONS FOR ENTITIES INVOLVED:
  - SATELITE ORGANIZATION
  - INTERMEDIARY OPERATING COMPANIES
  - END USER
- o SEE FIGURE 4 (E) FOR SCHEMATIC OF MODEL;
- o FOR THE SATELLITE ORGANIZATION, CAPITAL AND OPERATING COST EQUATIONS ARE SPECIFIED SO AS TO COMPUTE ANNUAL REVENUE REQUIREMENTS TO BE RECOVERED FROM INTERMEDIARIES;
- o INTERMEDIARY EQUATIONS ARE SPECIFIED TO ALLOW ADDITIONAL INTERMEDIARY COSTS TO BE ADDED ON:
  - THIS ENTAILED SPECIFICATION OF STRUCTURE OF LONG DISTANCE CHARGES AND CHARGES FOR USE OF SERVICES PROVIDED BY INTERMEDIARIES;
- o END USER INCURRED COSTS WERE SPECIFIED.

SCHEMATIC OF MODEL COMPONENTS

SUMMARY OF ECONOMIC MODEL (TASK IV)

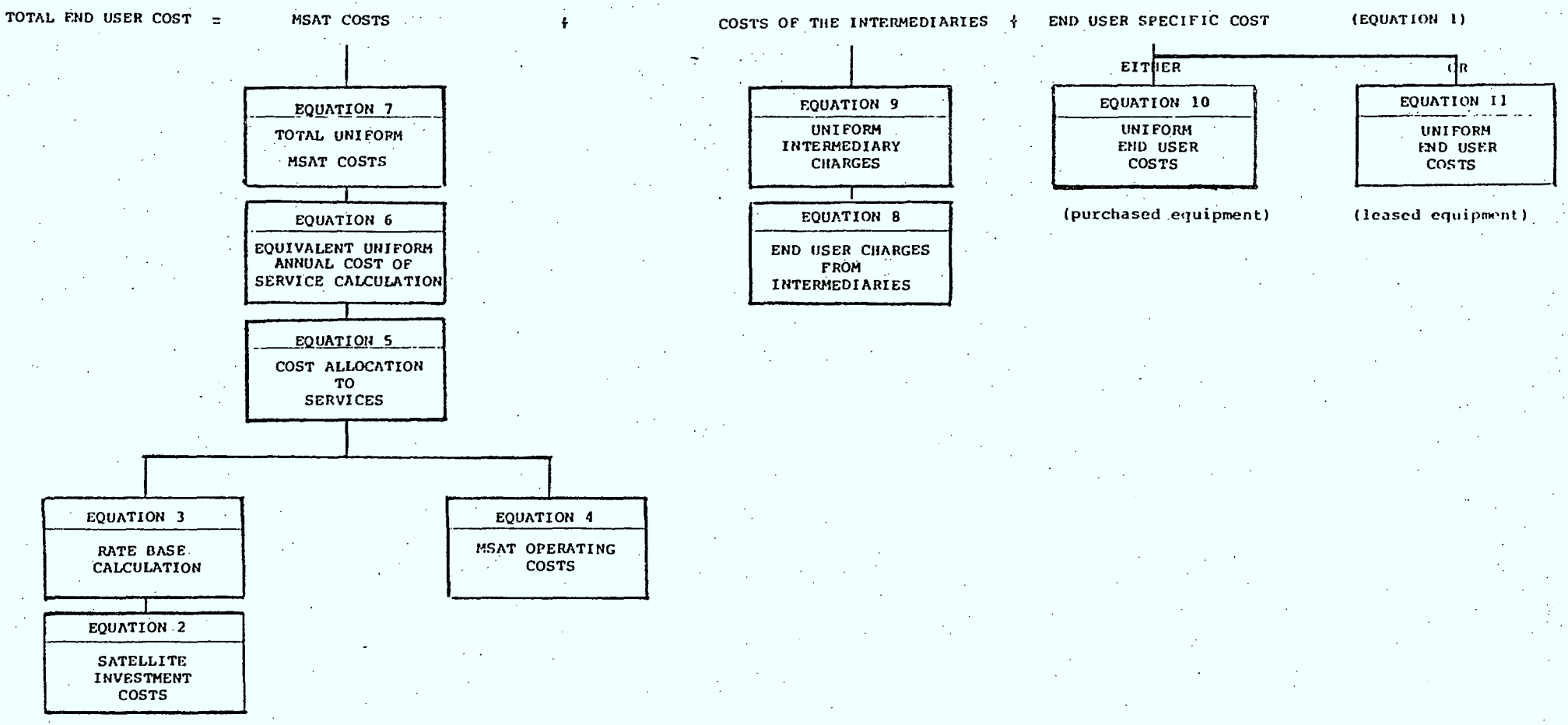
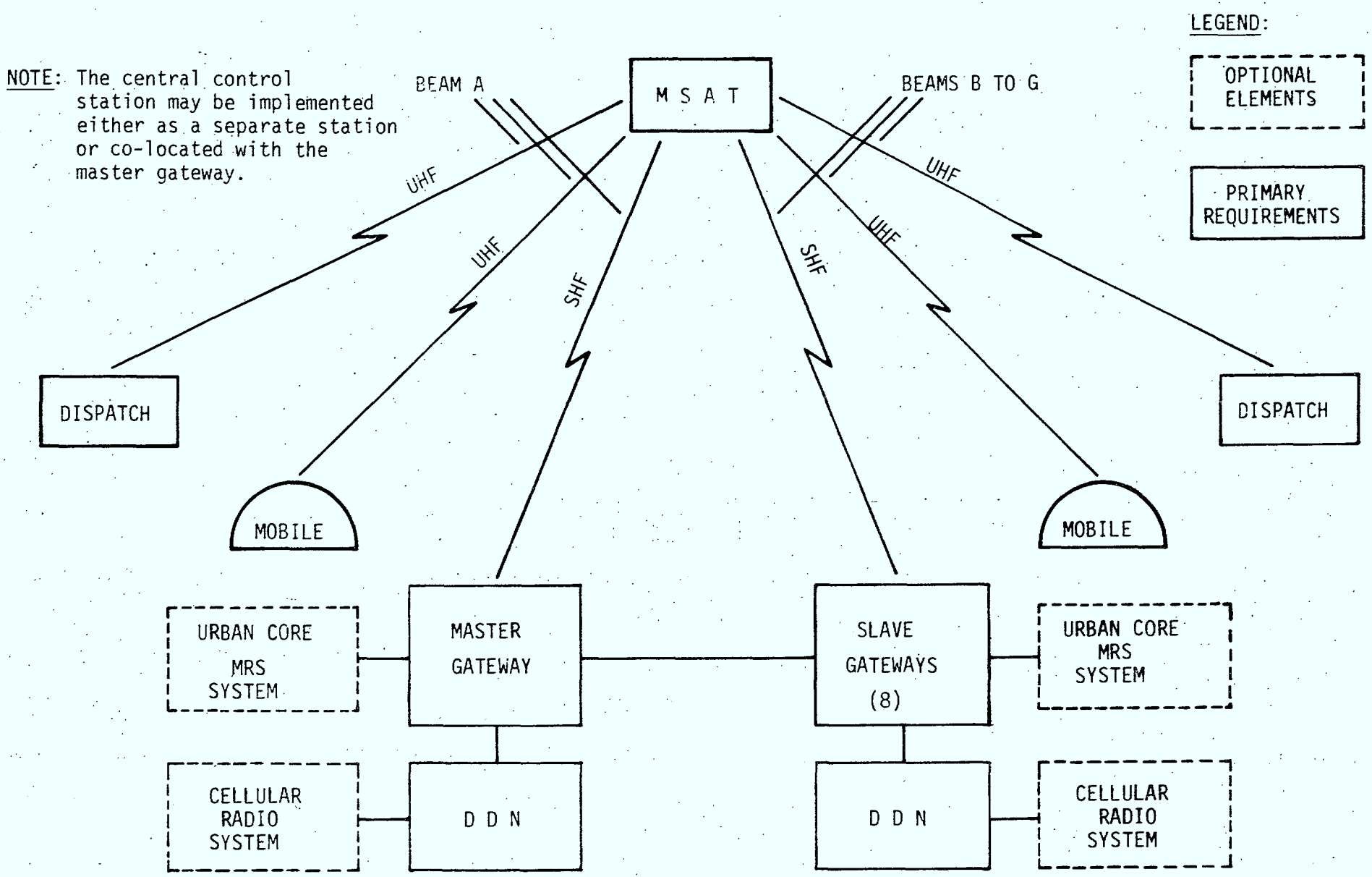
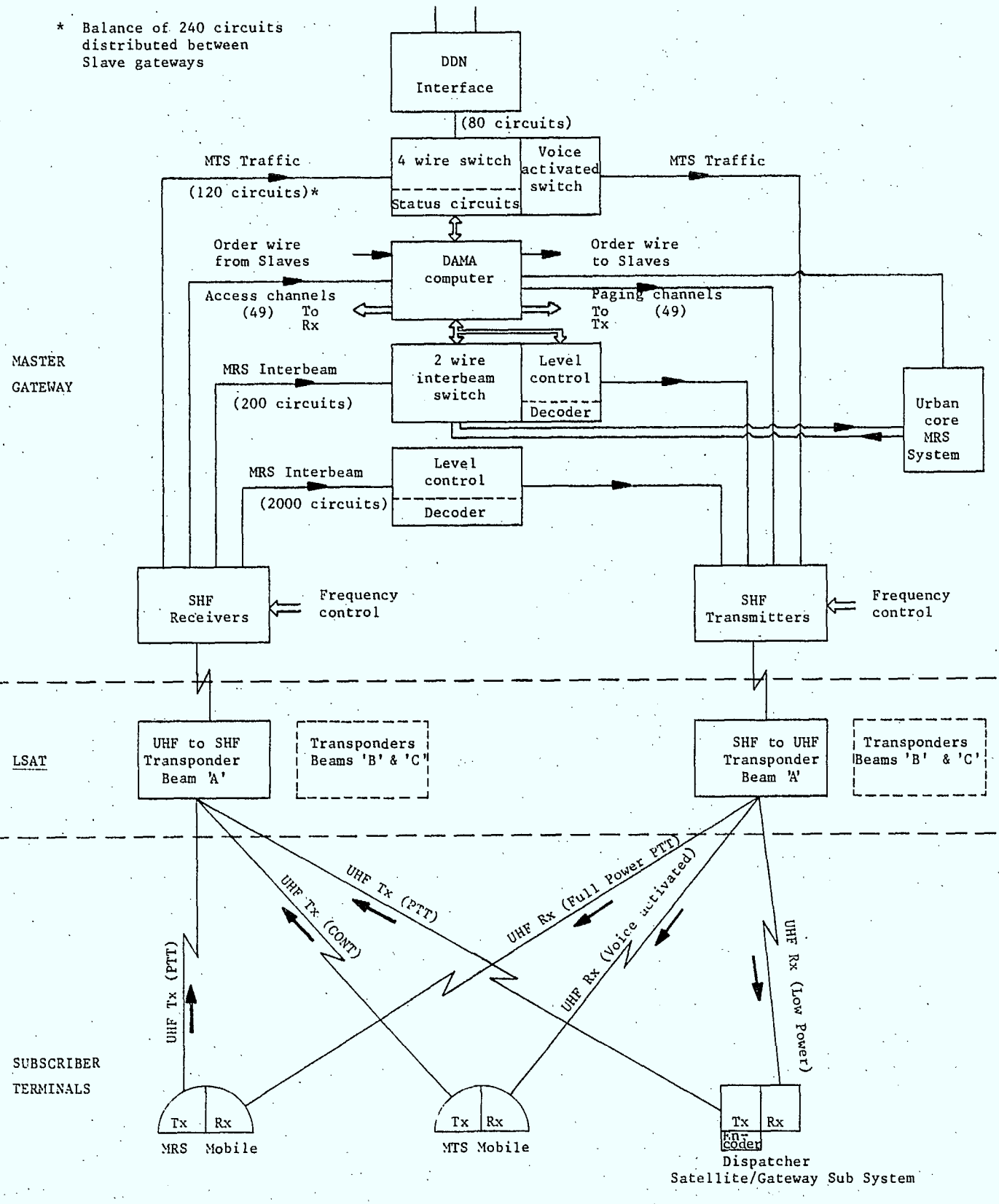


Figure 4(e)


LEGEND:
OPTIONAL ELEMENTS
PRIMARY REQUIREMENTS
NOTE: The central control station may be implemented either as a separate station or co-located with the master gateway.
BEAM A
M S A T
BEAMS B TO G
UHF
UHF
SHF
SHF
UHF
UHF
DISPATCH
DISPATCH
MOBILE
MOBILE
URBAN CORE MRS SYSTEM
MASTER GATEWAY
SLAVE GATEWAYS (8)
URBAN CORE MRS SYSTEM
CELLULAR RADIO SYSTEM
D D N
D D N
CELLULAR RADIO SYSTEM

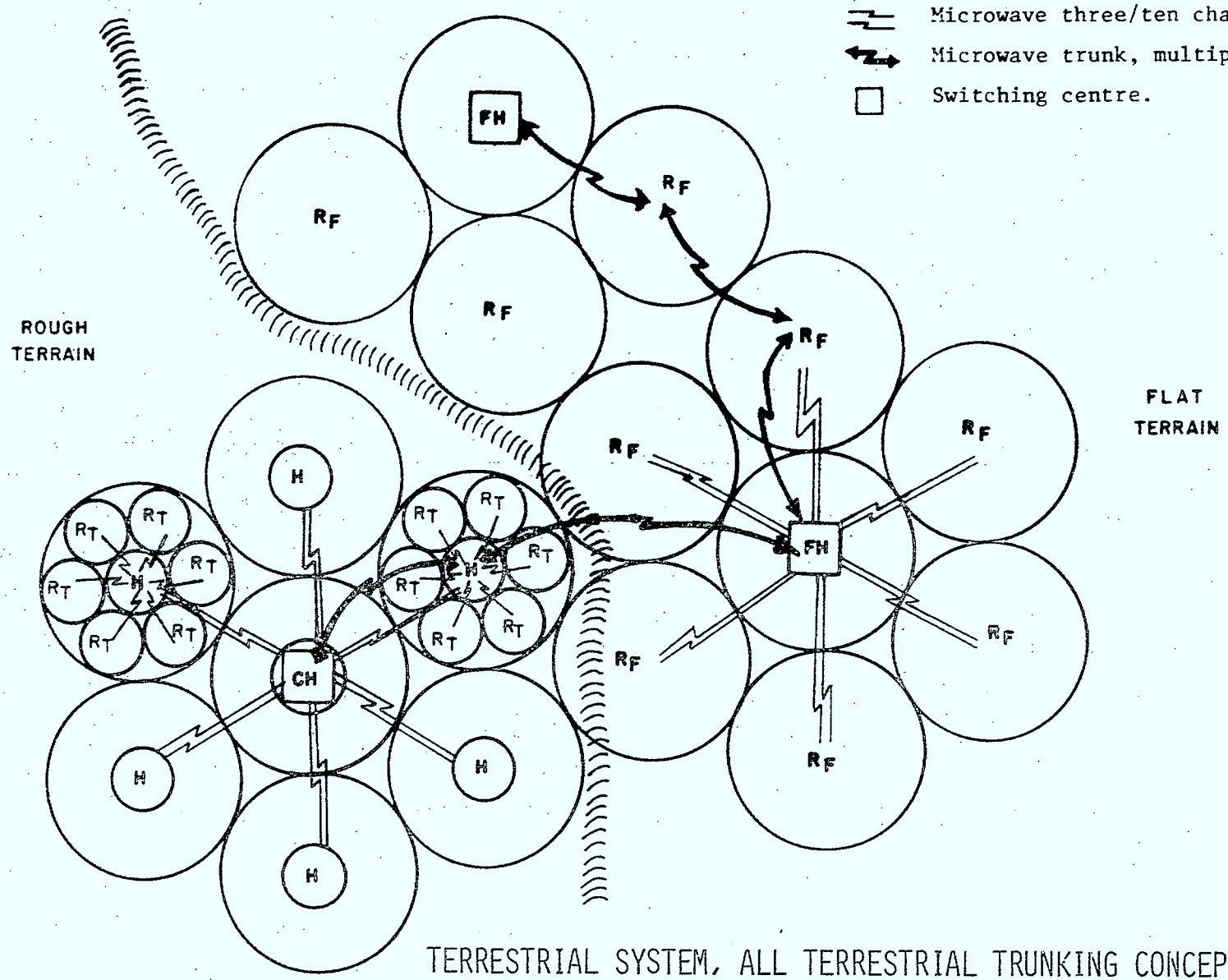


SIMPLIFIED FUNCTIONAL DIAGRAM

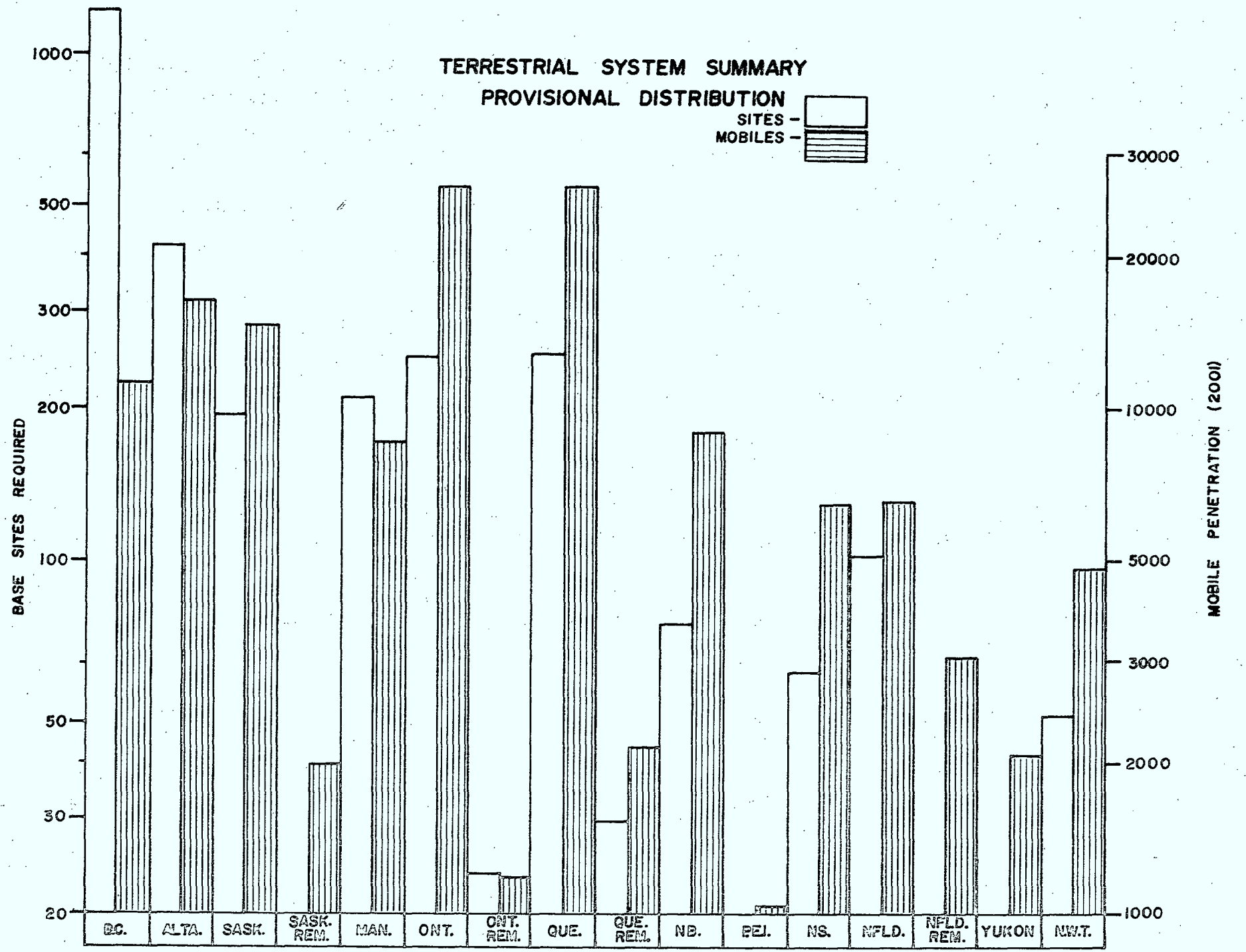
adga

LEGEND:-

- R_F Multichannel UHF/microwave repeater.
- R_T Single/dual channel UHF/microwave repeat.
- H Hub site and microwave collector.
- CH Central hub.
- FH Flat area hub.
- Microwave single/dual channel.
- Microwave three/ten channel hop.
- Microwave trunk, multiple hop.
- Switching centre.



TERRESTRIAL SYSTEM, ALL TERRESTRIAL TRUNKING CONCEPT


TERRESTRIAL SYSTEM SUMMARY
PROVISIONAL DISTRIBUTION
SITES –
MOBILES –
BASE SITES REQUIRED
1000
500
300
200
100
50
30
20
MOBILE PENETRATION (2001)
30000
20000
10000
5000
3000
2000
1000
BC.
ALTA.
SASK.
SASK. REM.
MAN.
ONT.
ONT. REM.
QUE.
QUE. REM.
NB.
PEI.
NS.
NFLD.
NFLD. REM.
YUKON
N.W.T.

SYSTEM COMPARISON (TECHNICAL)

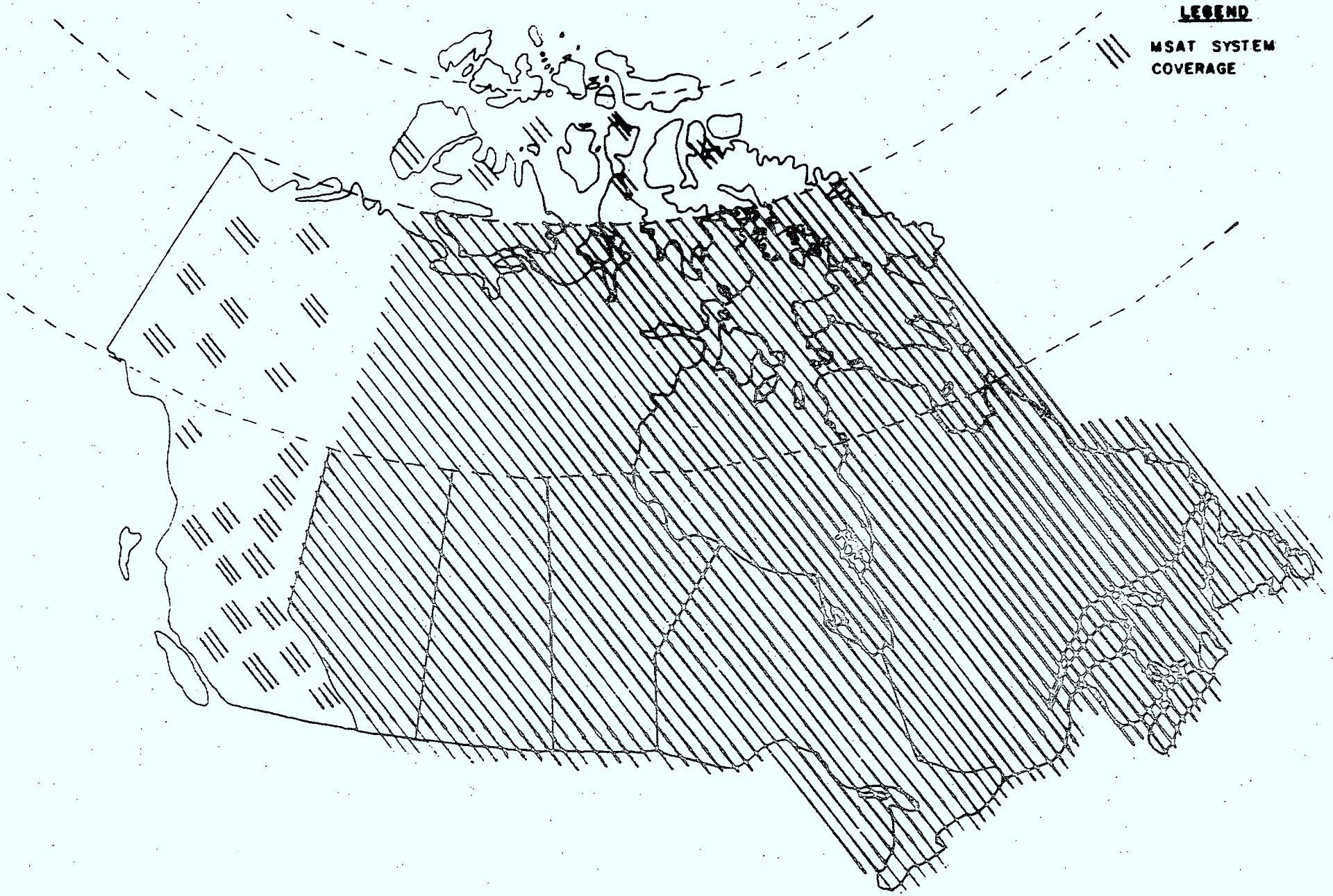
	MSAT	TERRESTRIAL
COVERAGE	CANADA WIDE	60%
SPECTRUM	4.3 MTS 4.4 MRS	EXISTING ALLOCATIONS
GROWTH (SHORT TERM)	EXCELLENT PEAK CAPACITY EARLY YEARS	POOR PEAK CAPACITY
(LONG TERM)	SATELLITE LIMITED	VERY GOOD GROWTH POTENTIAL
SERVICE TYPE	FLEXIBLE EXCEPT PORTABLES	BANDWIDTH LIMITED
GRADE OF SERVICE	EXCELLENT REDUCING TO 0.1 (FINAL YEAR)	0.1 (TENDANCY TO SATURATE)
QUALITY OF SERVICE	TOLL QUALITY DEPENDENT UPON MODULATION	TOLL
RISK, INDUSTRIAL BENEFITS	LOW FOR OPERATIONAL PHASE $887M	LOW $234M

	INTEGRATED SYSTEM		TERRESTRIAL SYSTEM	
ITEM	COMMENTS	RISKS($)	COMMENTS	RISK($)
MOBILE TERMINALS	NEW MOBILE DESIGN IN RESPECT TO Rx NOISE FIGURE, Tx POWER, FREQUENCY STABILITY, VOICE DIGITIZATION, MODEMS, BANDWIDTH.	25% OF MOBILE COST, REDUCES TO 5% FOR OPERATIONAL PHASE.	NO RISK	0
*SPACECRAFT	NEW SPACECRAFT DESIGN, CRITICAL AREAS ARE HPA EFFICIENCY, THERMAL DISSIPATION, ANTENNA SIZE, ANTENNA SIDE LOBES.	15% OF SPACECRAFT COST, REDUCES TO 5% FOR OPERATIONAL PHASE.	N/A	0
TERRESTRIAL RADIO STATIONS	N/A	0	NO RISK	0
COLLECTOR SYSTEM	N/A	0	NO RISK	0
SWITCHING DAMA	BASED UPON PROVEN DESIGN	5%	LOW RISK	5%
SYSTEM FAILURE	ADDITIONAL LAUNCH REQUIRED	$40M	ROUTINE	0

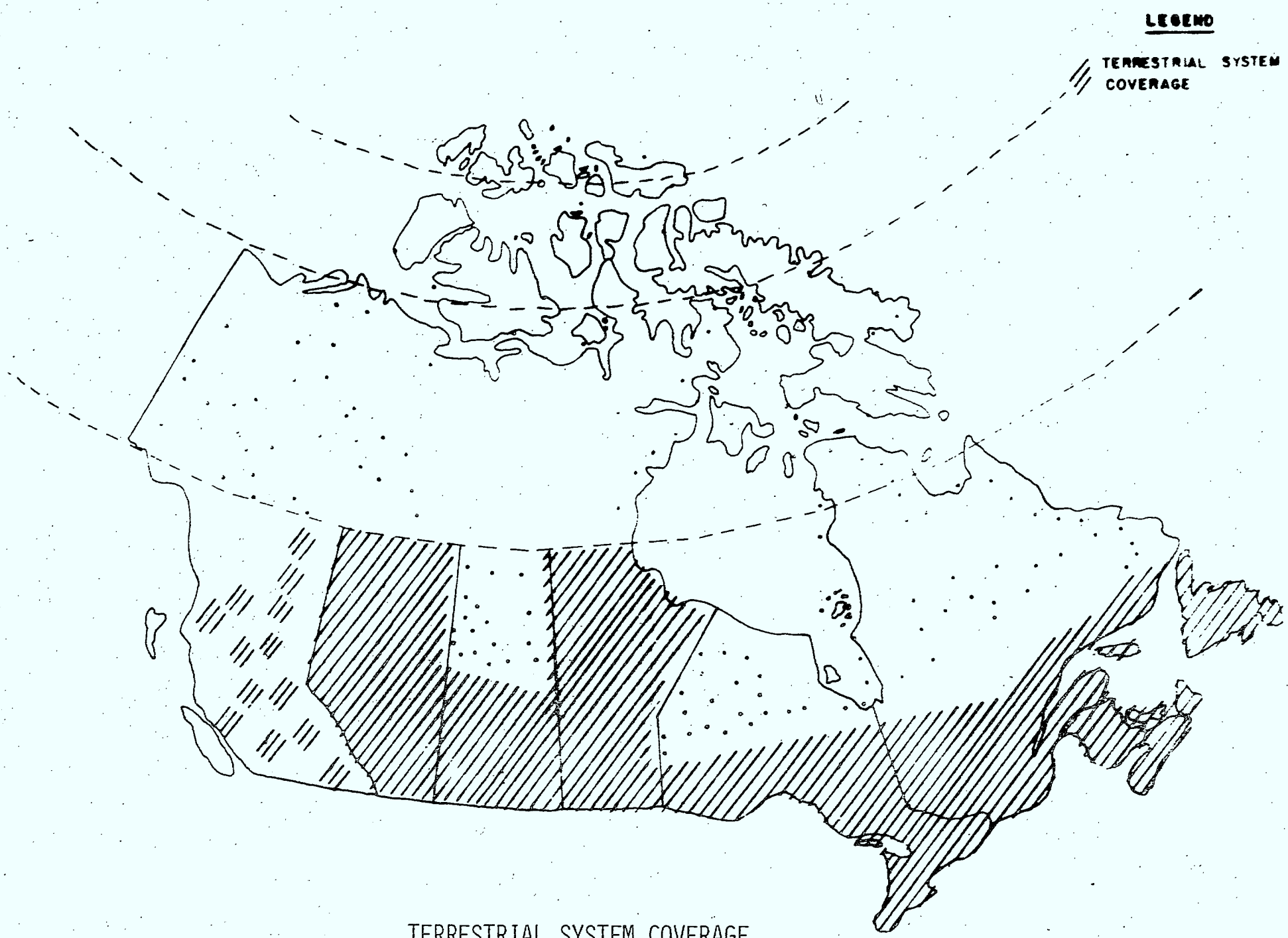
A SUMMARY OF TECHNICAL RISK

OTHER FACTORS

COVERAGE	$\simeq$ 75% OF CANADA PLUS AJOINING WATERS	$\simeq$ 25% OF CANADA
QUALITY	GOOD	EXCELLENT
FLEXIBILITY	EXCELLENT	GOOD
INDUSTRIAL BENEFITS	887$M	234$M



MSAT SYSTEM COVERAGE



TERRESTRIAL SYSTEM COVERAGE

adga

BASIC COST ELEMENTS (1981 C$)

INTEGRATED SYSTEM

SPACECRAFT	215 $M
LAUNCH	90 $M
GATEWAYS	34 $M
TERMINALS	3,750 $
MONEY	18%

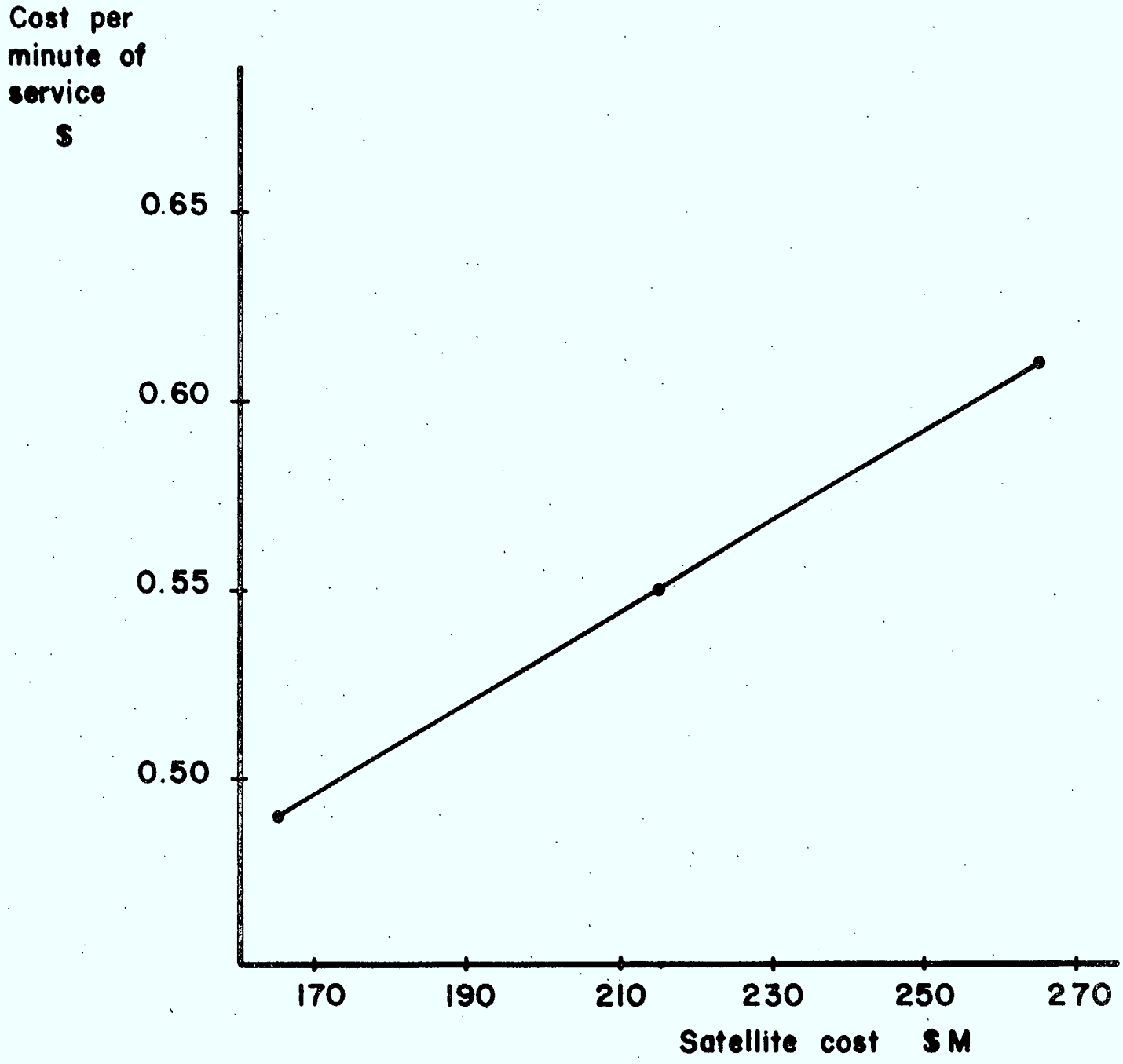
TERRESTRIAL SYSTEM

EQUIPMENT	446 $M
SITES, INSTALLATION	133 $M
TERMINALS	3,750$
MONEY	18%

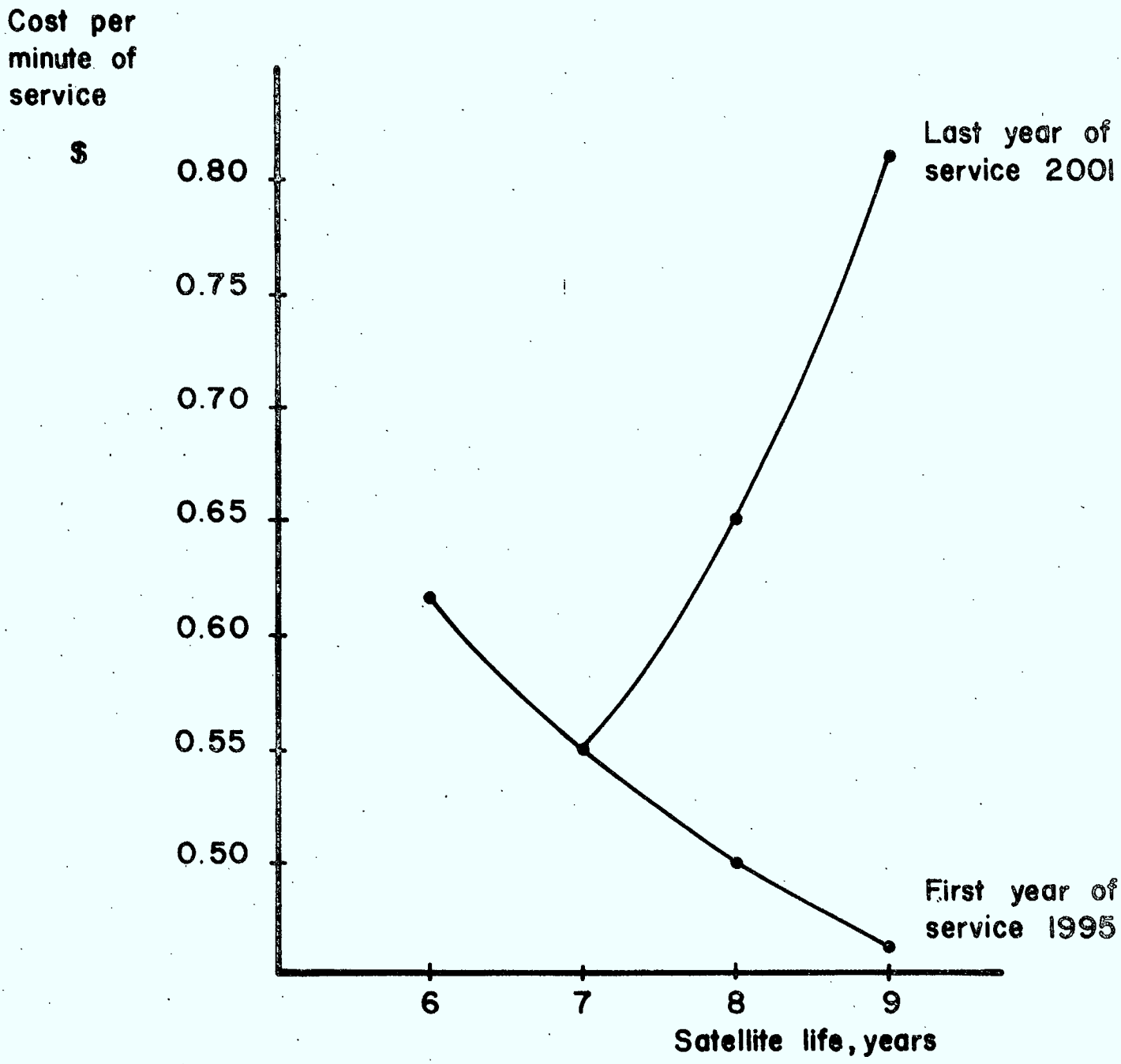
USER COST COMPARISON

- COST IN CENTS/MINUTE OF OPERATION IN 1995
- EXPRESSED IN 1981 DOLLARS

INTEGRATED	MRS	53
	MTS	84
TERRESTRIAL	MRS	92
	MTS	95
EXISTING	MRS	90



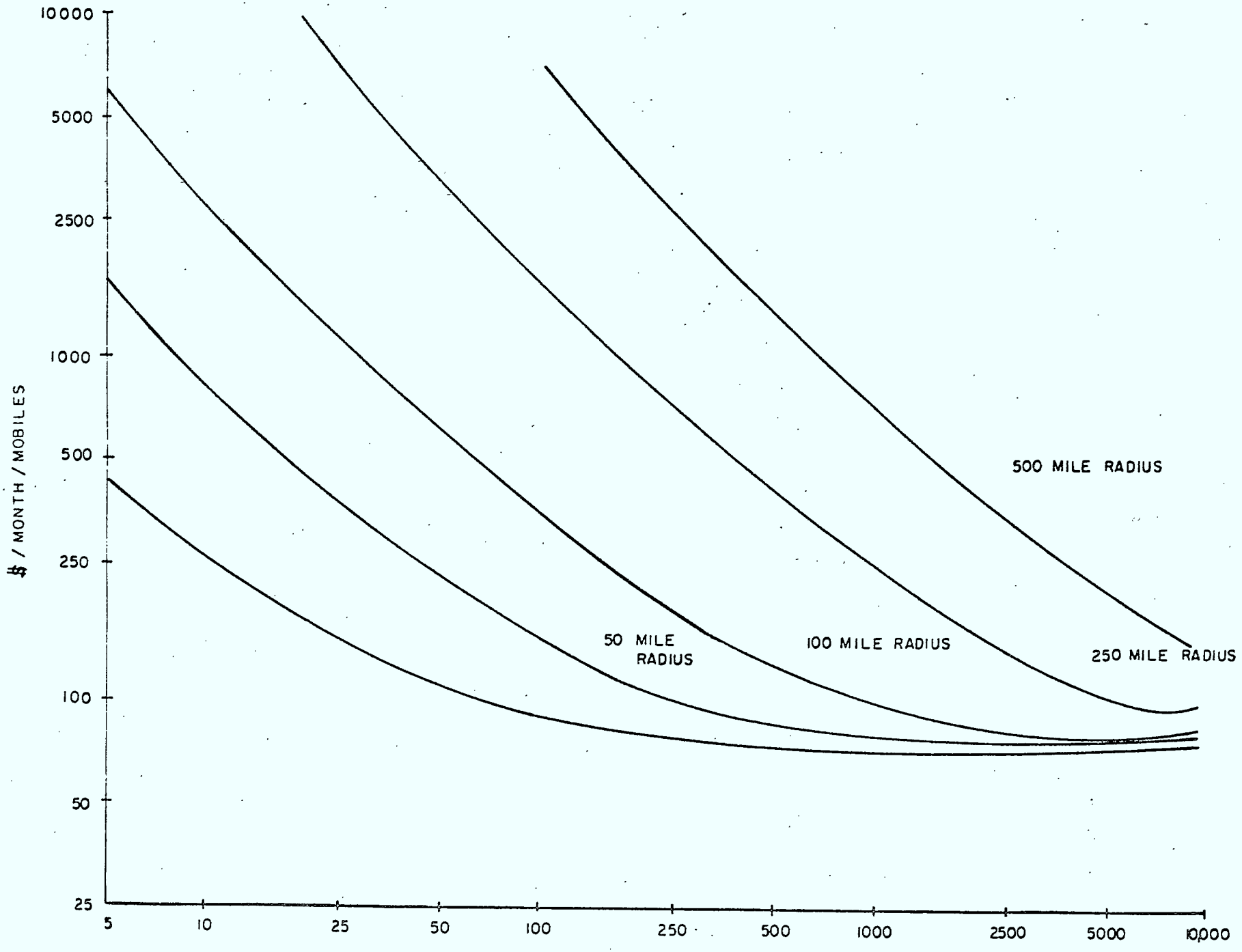
COST OF SERVICE V. SATELLITE COST



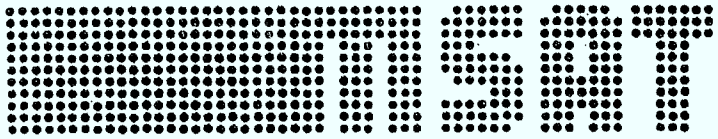
COST OF SERVICE V. SATELLITE LIFE

YEAR	1995	1996	1997	1998	1999	2000	2001
OPERATING COSTS	140	161	170	168	154	258	369
OPERATING REVENUE	53	79	127	194	285	409	576
OPERATING GAIN (LOSS)	(87)	(82)	(43)	26	131	151	207
INVESTMENT	73	134	101	53	0	0	0
TOTAL INVESTMENT (PRIOR INVESTMENT, 364)	437	571	672	725	725	725	725
DEPRECIATION	59	63	63	63	63	63	63
BOOK VALUE	374	449	488	477	414	351	288
OTHER COSTS	26	32	40	50	61	69	79
LIFECYCLE COST	166	359	569	787	1002	1329	1777

COST SUMMARY ($M)



Monthly Cost for Dedicated Area coverage terrestrial System.



USER COST BENEFIT STUDY

SYSTEMHOUSE

AGENDA ITEM 4

OBJECTIVE OF USER COST BENEFIT STUDY

TO DETERMINE IN QUANTATIVE TERMS THE BENEFITS MSAT USERS WILL EXPERIENCE VERSUS THE COST INCURRED BY USING AN OPERATIONAL MOBILE SATELLITE SYSTEM OPERATING IN 806-890 MHz BAND

USER COST BENEFIT STUDY

APPLICATION AREA	STUDY PARTICIPANTS
- MINERAL EXPLORATION	ESSO PETROCAN DOME GARNETT DRILLING
- FOREST INDUSTRIES	BC FOREST PRODUCTS
- RAILWAYS	CNR BC RAILWAYS CPR
- TRUCKING	CAN TRUCKING ASSOCIATION ONTARIO TRUCKING ASSOCIATION CP TRANSPORT

USER COST BENEFIT STUDY

APPLICATION AREA	STUDY PARTICIPANTS
- FOREST FIRE FIGHTING	ONTARIO MINISTRY OF NATURAL RESOURCES BC MINISTRY OF FORESTRY
- COASTAL FISHING	NATIONAL SEA PRODUCTS BC PACKERS
- EMERGENCY MEDICAL	NOVA-SCOTIA MINISTRY OF HEALTH ONTARIO MINISTRY OF HEALTH
- NETWORK, MAINTENANCE AND CONSTRUCTION	A.G.T. HYDRO QUEBEC
- LAW ENFORCEMENT	SQ RCMP OPP

CLASSES OF USER BENEFITS

- INCREASES BUSINESS AND PROFIT FOR USER
- USER COST SAVING
- TIME SAVING
- DAMAGE AVOIDED
- UNMEASURED BENEFIT
  - SAFETY
  - SECURITY
  - LIVES SAVED
  - LESS ISOLATION

GROSS BENEFITS

$3.3 BILLION

NET BENEFITS

$1.3 BILLION

INCOME TO MSAT

$1.1 BILLION

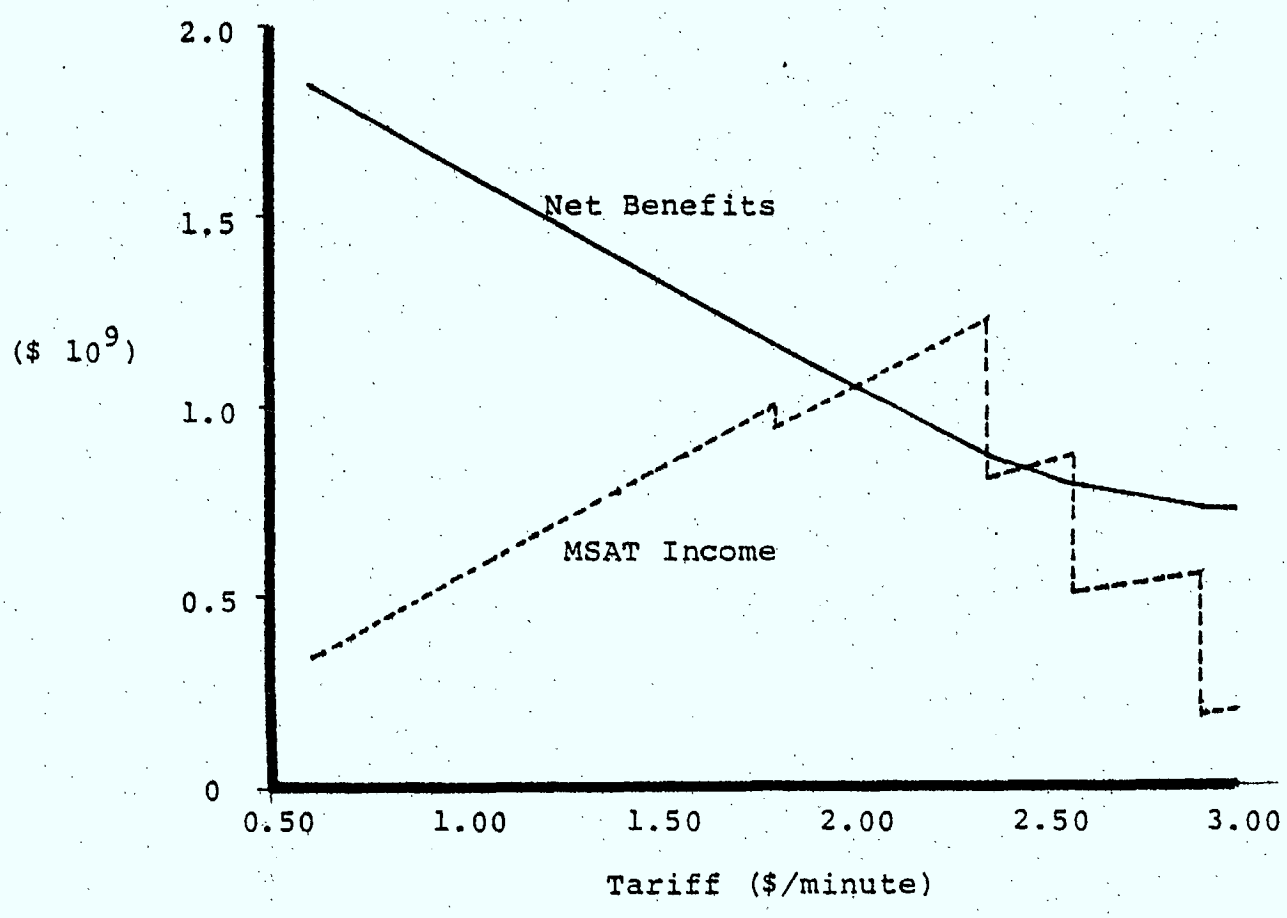
TEN YEAR DISCOUNTED VALUES

1981 DOLLARS

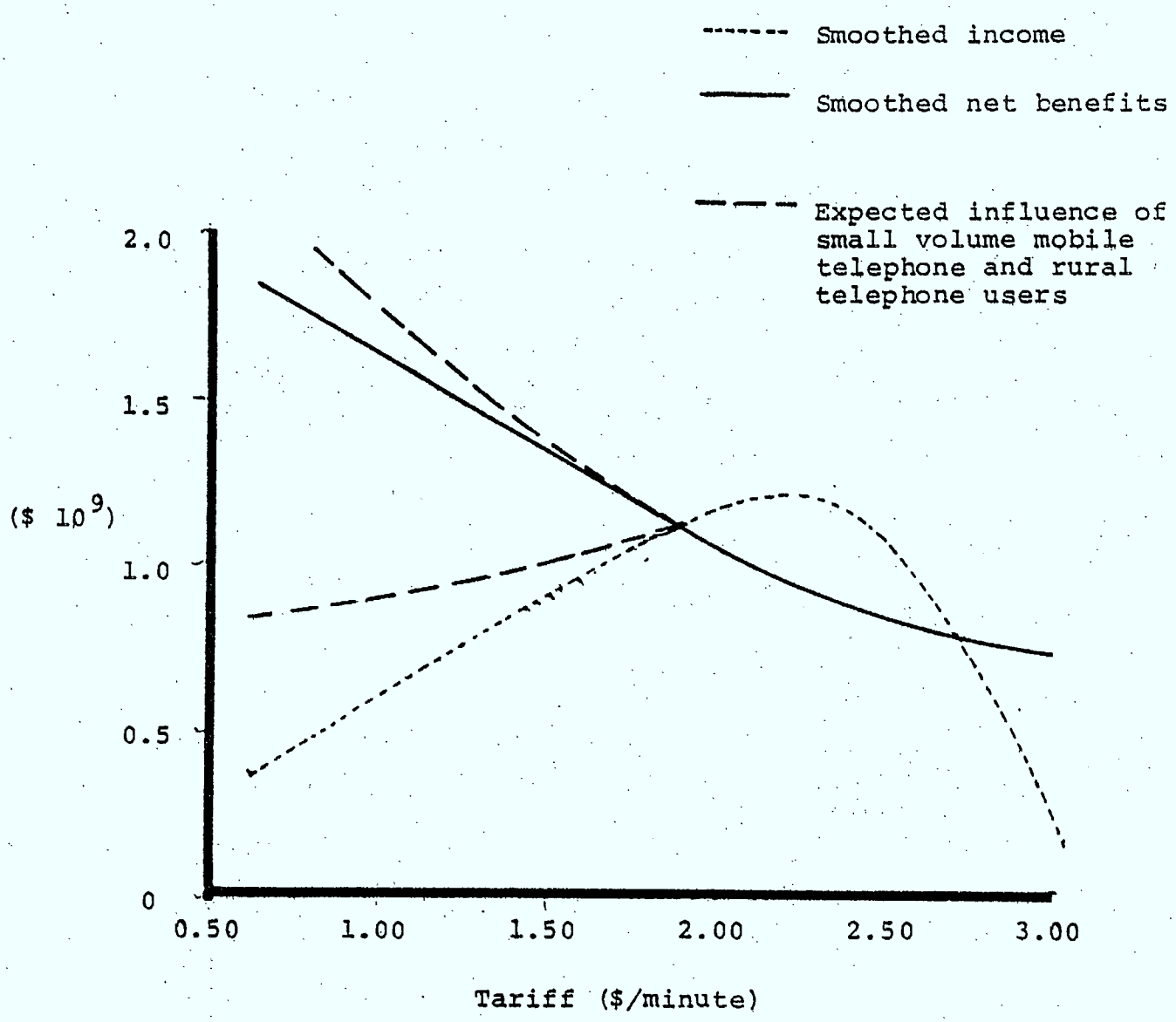
MSAT ASSUMPTIONS

- VALUE IS USER INDEPENDENT
- MOBILE EQUIPMENT HAS 10 YEAR LIFE
- 4800 BAUD
- COSTS: $2500, $5000, $1.50
- DISCOUNT: 15%
- FREQUENT GATEWAYS
- RATIONAL USERS

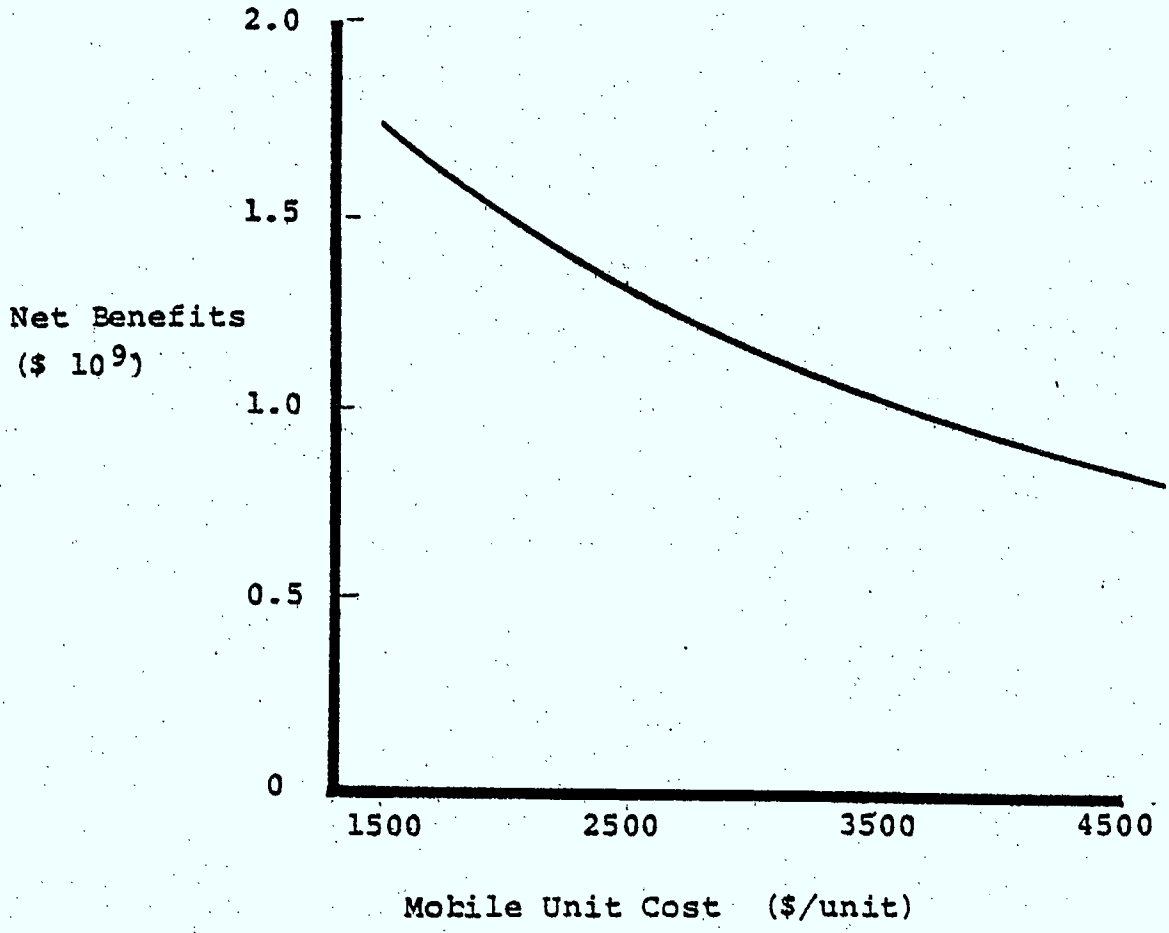
SENSITIVITY TO TARIFF



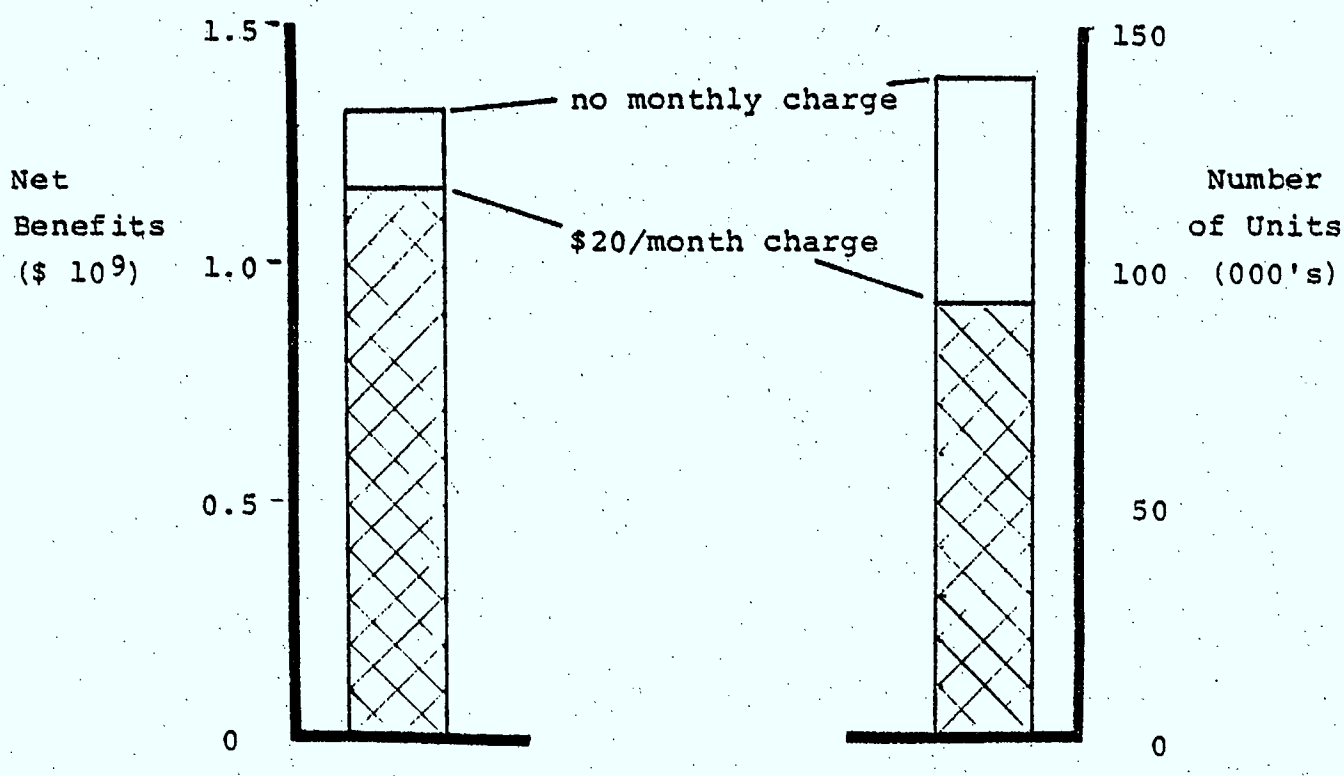
SMOOTHED EFFECT OF TARIFF



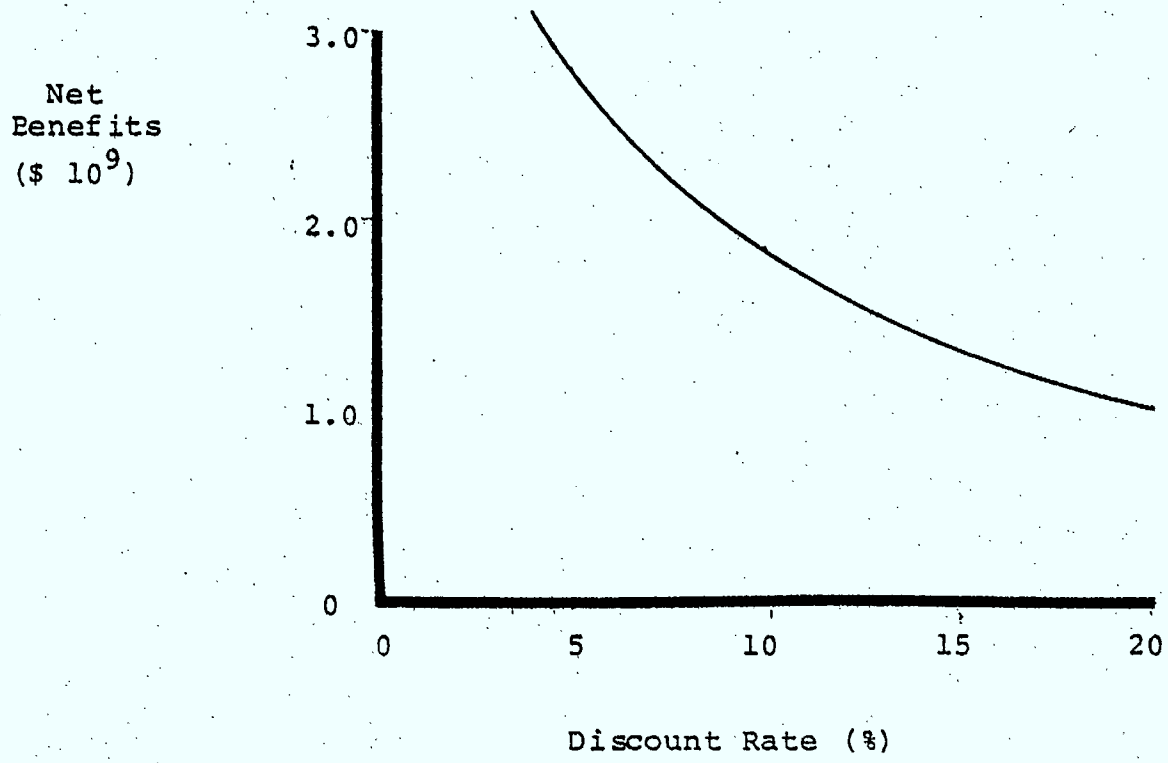
SENSITIVITY TO MOBILE UNIT COST



SENSITIVITY TO STANDBY CHARGE



SENSITIVITY TO DISCOUNT RATE



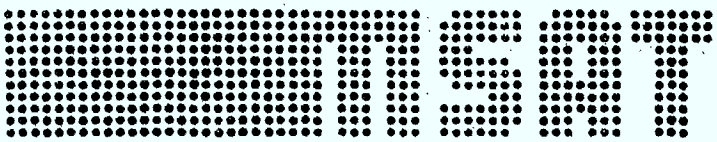
APPLICATION AREA BENEFITS

APPLICATION AREA	ANNUAL AIRTIME***	MSAT UNITS	GROSS BENEFITS*	MSAT COSTS*	NET BENEFITS*
Forest Fire Fighting	0.26	400	12.08	4.12	7.96
Coastal Fisheries	0.32	108	17.70	2.85	14.85
Medical Services	1.98	1,575	245.71	35.84	209.87
Networks	0.72	33,440	16.67	9.78	6.89
Forest Industry	0.09	96	5.35	1.14	4.21
Mineral Exploration	6.86	27,200	271.50	207.08	64.42
Law Enforcement	21.60	3,100	139.62	139.62	0
Railways	9.76	2,019	132.62	90.15	42.47
Trucking	7.96	21,807	202.45	146.21	56.24
DCP	0.01**	7,255**	65.05	27.29	37.76
	49.55 x 10^6	89,025	$1,108.75 x 10^6	$664.08 x 10^6	$444.67x$10^6$

* total 10-year discounted values
** not in totals
*** minutes/year

CONCLUSIONS

- EMERGENCY FREQUENCY
- INTERCONNECT
- COST-EFFECTIVE CONDITIONS
  - LARGE AREA, LOW VOLUME
  - REMOTE AREA
  - TRANSIENT OPERATIONS
- NOT IMMEDIATE REPLACEMENT
  - REGULATIONS
  - INDUSTRY STRUCTURE
- MINIMIZE LONG DISTANCE CHARGES
- TECHNICAL CONCERNS
  - SHADOWING
  - PRIVACY
  - ANTENNA SIZE
- COMPETITIVE COSTING
  - MINIMUM TO MEET NEEDS
  - SKEPTICAL OF SATELLITE COSTS
  - STANDBY CHARGES
- VARIETY OF TERMINALS
  - LOW COST, SINGLE CHANNEL
  - SOPHISTICATED DEMAND ASSIGNMENT
  - VOICE AND DATA
- TARIFF IN INELASTIC RANGE



SPACE SEGMENT STUDIES

H.R. RAINE

AGENDA ITEM 5

MSAT

PHASE A *

SPACE SEGMENT STUDIES (RELATED TO MSAT)

CONTRACTOR	SUBJECT
SPAR	SPACECRAFT CONCEPTS
CAL	ALTERNATIVE SPACECRAFT PLATFORMS
SPAR CAL	ADVANCED TECHNOLOGY
TELESAT SPAR	MISSION ANALYSIS/SYSTEM AVAILABILITY
GASTOPS	SOFTWARE REQUIREMENTS
CAL	SPACECRAFT SYSTEM MODELLING
UNIV MAN	DUAL FREQUENCY FEEDS
SPAR	SPACECRAFT CONTROL
ANCON DYNACON UNIV. SHERBROOKE KENDALL CAL	SPACECRAFT CONFIGURATION/CONTROL

* NOTE THAT ADDITIONAL STUDIES PRECEDED PHASE A

MSAT

PHASE A STUDIES

SPACECRAFT CONCEPTS

FINAL REPORTS: MSAT CANADIAN DEMONSTRATION SPACECRAFT - REPORT AND BASELINE PERFORMANCE DOCUMENT DOC-CR-SP-81-047
EXTENSION REPORTS DOC-CR-SP-82-004

SUMMARY:

NORTH AMERICAN - OPERATIONAL: 106 UHF BEAMS, 4 X FREQUENCY REUSE, 42.5M ANTENNA, 31 BACKHAUL BEAMS, DRY WT.= 3500 KG, PWR. = 8 KW

CANADIAN #1 - OPERATIONAL: 26 UHF BEAMS, 4 X FREQUENCY REUSE, 30M ANTENNA, 9 BACKHAUL BEAMS, DRY WT. = 1900 KG, PWR. = 4.8 KW

#2 - OPERATIONAL: 9 OR 10 UHF BEAMS, 2 X 15M ANTENNA, 3 X FREQUENCY REUSE, DRY WT. = 1400 KG, PWR. = 4 KW

#3 DEMO - 4, 5 OR 6 UHF BEAMS, 2 X 9M ANTENNA, 3 X FREQUENCY REUSE, DRY WT. = 1100 KG, PWR. = 2 KW

MSAT

PHASE A STUDIES

ALTERNATIVE PLATFORM

CONTRACTOR: CANADIAN ASTRONAUTICS LTD., OTTAWA

REPORTS: "ANALYSIS OF ALTERNATE SYSTEMS FOR CANADIAN COMMERCIAL AND MILITARY MOBILE SATELLITE SERVICES" DOC-CR-SP-82-009, MARCH 1982

SUMMARY:

MISSION REQUIREMENTS REVIEWED

EXISTING BUSES EVALUATED

PARAMETRIC SENSITIVITY ANALYSIS PERFORMED

CONCEPTUAL DESIGNS OUTLINED

CRITICAL NEW TECHNOLOGY IDENTIFIED

DEVELOPMENT SCHEDULES AND PROGRAM COSTS ESTIMATED

BUSES EXAMINED FOR MSAT

BAE LSAT

RCA SATCOM

FORD INTELSAT

HUGHES LEASAT

TRW TDRSS

TRW FLTSATCOM

GE DSCS III

SPAR ANIK-D

FORD INSAT

MAMSAT

INFORMATION GATHERED AND CRITERIA EVALUATED FOR:

- AVAILABILITY
- PAYLOAD CAPACITY
- DC POWER CAPABILITY
- EASE OF CONTRACTURAL ARRANGEMENTS
- CANADIAN CONTENT
- BUS COST
- LAUNCH VEHICLE COMPATIBILITY/AVAILABILITY
- LAUNCH COST
- ANTENNA MOUNTING AREA
- PAYLOAD MOUNTING AREA
- PROPELLANT CAPACITY
- POINTING ACCURACY
- LIFETIME
- EXISTING SIMILAR PAYLOAD COMPLEMENT
- MATURITY OF DESIGN
- SPACECRAFT HARDENING
- AUTONOMOUS SPACECRAFT OPERATION

PHASE A STUDIES

ADVANCED TECHNOLOGY

SUBJECT AREAS

- HIGH POWER, LINEAR SOLID STATE UHF R.F. AMPLIFIERS
- FREQUENCY GENERATION
- SIGNAL PROCESSING
- POWER CONTROL
- APPLICATIONS OF MICROPROCESSORS
- ATTITUDE CONTROL
- ACTIVE THERMAL CONTROL
- LARGE SPACECRAFT TESTING
- ANTENNA TECHNOLOGY
- EHF COMPONENTS
- UHF DESIGN CONSIDERATIONS
- NICKEL HYDROGEN BATTERIES

MSAT

PHASE A STUDIES

MISSION ANALYSIS/SYSTEM AVAILABILITY

CONTRACTOR: TELESAT

REPORTS: MISSION & OPERATION ANALYSIS FOR MSAT
DOC-CR-SP-82-005, FEB. 82

SYSTEM AVAILABILITY STUDY FOR MSAT
DOC-CR-SP-82-006, FEB. 82.

SUMMARY:

- REALISTIC LAUNCH WINDOWS DETERMINED
- PRE-LAUNCH ACTIVITIES IDENTIFIED
- IN ORBIT PRE-OPERATIONAL ACTIVITIES IDENTIFIED
- ON STATION OPERATIONS EXAMINED
- SUPPORT REQUIREMENTS ESTIMATED
- OVERALL AVAILABILITY REQUIREMENTS PROPOSED
- SPACE SEGMENT RELIABILITY ESTIMATED FOR
  - PAYLOAD
  - PLATFORM
  - TOTAL SPACECRAFT
- GROUND SEGMENT AVAILABILITY PREDICTED
- MSAT SYSTEM AVAILABILITY PREDICTED

ARAMSAT

PHASE A STUDIES

MISSION ANALYSIS

CONTRACTOR: SPAR AEROSPACE SPCTD 5016, MARCH 82

SUMMARY:

- HERMES MISSION REVIEWED
- TRANSFER ORBIT VISIBILITY & OPTIMIZATION STUDIES (ARRIVE & STS)
- LAUNCH WINDOW ANALYZED (ARRIVE & STS)
- STATION ACQUISITION STUDIED (ARRIVE & STS)
- SPACECRAFT FUEL BUDGET ESTIMATED
- MISSION OUTLINE GENERATED

MSAT

PHASE A STUDIES

SOFTWARE REQUIREMENTS

CONTRACT: GASTOPS

REPORTS: MSAT GROUND-SEGMENT COMPUTER STUDY DOC-CRC-SP-81-044, SEPT. 81

FINAL REPORT OF A DEMONSTRATION MSAT GROUND SEGMENT COMPUTING REQUIREMENTS STUDY, DOC-CR-SP-82-015, MAR. 82

SUMMARY:

- COMPUTING SYSTEM REQUIREMENTS AND DEVELOPMENT STUDIES FOR: SPACECRAFT REAL-TIME COMPUTING SYSTEMS, REAL-TIME SIMULATION SYSTEMS, AND SPACECRAFT TEST AND INTEGRATION COMPUTING SYSTEMS
- COST ESTIMATES DEVELOPED BASED ON VARIOUS PROGRAMMATIC SCENARIOS
- TYPES OF COMPUTER EQUIPMENT STUDIED THAT WOULD SATISFY PROJECT REQUIREMENTS

PHASE A STUDIES

SPACECRAFT SYSTEM MODELLING

CONTRACTOR: CANADIAN ASTRONAUTICS LIMITED

REPORT: COMSATMOD USERS' MANUAL DOC-CR-SP-82-025 MARCH 1982

- UPDATED & UPGRADED " COMSATMOD", A COMPUTER PROGRAM THAT DEVELOPS MASS, COST & RELIABILITY ESTIMATES, IN THE FOLLOWING MAIN AREAS:

  - CURRENT SPACECRAFT TECHNOLOGIES
  - CURRENT LAUNCH VEHICLES
  - CURRENT COSTS
  - IMPROVED UHF ANTENNA MODELLING
  - INCORPORATE NARROWBAND REPEATER CONCEPTS
  - EXPANDED FREQUENCY RANGE
  - IMPROVED PROGRAMMATICS
  - IMPROVED EDIT CAPABILITY
  - IMPROVED EASE OF USE

MSAT

PHASE A STUDIES

DUAL FREQUENCY FEEDS

CONTRACTOR: UNIV. OF MANITOBA

REPORT: "INVESTIGATION OF USE OF THE PROPOSED MSAT LARGE ANTENNA FOR BOTH LOW UHF (200 TO 400 MHZ) AND HIGH UHF (800 TO 900 MHZ) BANDS" DOC-CR-SP-81-034, MAY 81.

SUMMARY:

AN EXAMINATION MADE INTO THE FEASIBILITY OF A FEED SYSTEM FOR MULTIPLE HIGH UHF BEAMS PROVIDING ONE OR MORE LOW UHF BEAMS SIMULTANEOUSLY.

- FEASIBILITY QUESTIONABLE WITH MULTIPLE CONTIGUOUS SHAPED BEAMS
- PERFORMANCE COMPROMISES APPEAR INEVITABLE

2-5-10

MSAT

PHASE A STUDIES

SPACECRAFT CONTROL

CONTRACTOR: SPAR, REMOTE MANIPULATOR SYSTEMS DIVISION, TORONTO

REPORT: "FINAL REPORT - STUDY ON CONTROL OF LARGE SPACECRAFT" DOC-CR-SP-81-013, MAY 81

"FINAL REVIEW THIRD GENERATION SPACECRAFT/MSAT BUS - TECHNOLOGY DEVELOPMENT STUDIES" MARCH 81

SUMMARY:

- METHODS REVIEWED OF CONTROL OF LARGE SPACECRAFT WITH FLEXIBLE APPENDAGES
- RECOMMENDATIONS MADE FOR THE MSAT CONTROL SYSTEM REQUIREMENTS

2-5-11

MSAT

PHASE A STUDIES

SPACECRAFT CONTROL

CONTRACTOR: SPAR, REMOTE MANIPULATOR SYSTEMS DIVISION, TORONTO

REPORT: "FINAL REPORT - STUDY ON THE STATE OF THE ART OF ELECTRIC PROPULSION AND ITS APPLICATION TO LARGE SPACECRAFT" DOC-CR-SP-81-014, APRIL 81

SUMMARY:

- ALTERNATIVE TECHNOLOGIES AND PRINCIPAL CHARACTERISTICS OF DEVELOPED DEVICES REVIEWED
- USE FOR AUXILIARY PROPULSION ADDRESSED
- OPERATIONAL REQUIREMENTS AND CONSTRAINTS FOR LARGE COMMUNICATION SATELLITES REVIEWED
- QUALIFICATION STATUS REPORTED FOLLOWING VENDOR MEETINGS
- A CONFIGURATION OF ELECTRIC THRUSTERS DEVISED FOR MSAT TO MEET NORTH/SOUTH STATIONKEEPING REQUIREMENTS, SOME EAST/WEST STATIONKEEPING AND MOMENTUM DUMPING
- SIGNIFICANT BENEFITS OUTLINED OF ELECTRIC PROPULSION FOR LARGE SPACECRAFT

3-5-12

MSAT

PHASE A STUDIES

SPACECRAFT CONTROL

CONTRACTOR: SPAR, REMOTE MANIPULATOR SYSTEMS DIVISION, TORONTO

REPORTS: "MSAT THERMAL STUDY FINAL REPORT"
DOC-CR-SP-81-105, APRIL 1981
"ACTIVE THERMAL CONTROL STUDY FINAL REPORT"
SPAR R1130, MAY 82

SUMMARY:

- THE NEED ASSESSED FOR ACTIVE THERMAL CONTROL TECHNIQUES FOR MSAT
- DESIGN COMPLETED OF AN INTERLEAVED VAPOUR CONTROLLED HEAT PIPE PANEL SYSTEM
- TEST PLANS PREPARED FOR VERIFICATION OF THE DESIGN AND COMPARISON TO LOUVRE SYSTEMS
- A LOUVRE SIMILAR TO THOSE OF GPS PROCURED FROM FAIRCHILD SPACE AND ELECTRONICS DIVISION, GERMANTOWN, MARYLAND

MSAT

PHASE A STUDIES

SPACECRAFT CONFIGURATION/CONTROL

CONTRACTOR: ANCON SPACE TECHNOLOGY CORP., THORNHILL

REPORTS: "STAR SENSORS AND COMPONENTS - A VENDOR SURVEY REPORT" DOC-CR-SP-81-016, MARCH 81

"STAR SENSORS - A LITERATURE REVIEW" DOC-CR-SP-81-017, APRIL 81

"SPACECRAFT ATTITUDE STABILIZATION METHODS - FINAL REPORTS" DOC-CR-SP-81-018, APRIL 81

SUMMARY:

- TWO CLASSES OF STAR SENSORS IDENTIFIED: STAR SCANNERS AND STAR TRACKERS
- ONLY TRACKERS SUITABLE FOR THE 3 AXIS STABILIZED SPACECRAFT
- DATA COLLECTED FOR THE NASA STANDARD STAR TRACKER MANUFACTURED BY BALL BROTHERS
- POTENTIAL SOLID STATE DEVELOPMENT COULD RESULT IN HIGHER ACCURACIES AND A SMALLER APERTURE
- METHODS ASSESSED FOR MAINTAINING ATTITUDE OF SPACECRAFT WITH LARGE FLEXIBLE APPENDAGES; RECOMMENDATIONS MADE FOR MSAT.

2-5-14

MSAT

PHASE A STUDIES

SPACECRAFT CONFIGURATION/CONTROL

CONTRACTOR: DYNACON ENTERPRISES LIMITED, THORNHILL

REPORT: "MSAT STRUCTURAL AND CONTROL ASSESSMENT" DOC-CR-SP-81-005, MARCH 81

"A DYNAMICS MODELING PLAN FORM MSAT" DOC-CR-SP-81-006, MARCH 81

"MSAT STRUCTURAL DYNAMICS MODEL FOR CONTROL SYSTEM EVALUATION" DOC-CR-SP-82-022, MARCH 1982

"COMPUTER CODE FOR MSAT STRUCTURAL DYNAMICS MODEL (PRELIMINARY)" DOC-CR-SP-82-023, MARCH 82

SUMMARY

- OPERATIONAL MSAT ATTITUDE CONTROL REQUIREMENTS REVIEWED AND ASSESSED
- SUB-STRUCTURE MODELS DEFINED FOR THE SOLAR ARRAY, SUPPORT TOWERS AND LARGE REFLECTORS
- SUB-STRUCTURE MODELS ANALYTICALLY COMBINED INTO AN OVERALL SPACECRAFT STRUCTURAL DYNAMICS MODEL
- COMPUTER CODE PROVIDED FOR THE LAZY CONFIGURATION

ASTROMAST

PHASE A STUDIES

SPACECRAFT CONFIGURATION CONTROL

CONTRACTOR: UNIVERSITÉ DE SHERBROOKE, SHERBROOKE

REPORT: "IDENTIFICATION METHODS FOR DETERMINATION OF STRUCTURAL PROPERTIES OF SATELLITE SUB STRUCTURE" DOC-CR-SP-82-019, MARCH 82

SUMMARY:

- AVAILABLE METHODS OF PARAMETER IDENTIFICATIONS ASSESSED RELATIVE TO SUITABILITY FOR GROUND TEST OF LARGE FLEXIBLE SUBSTRUCTURES IN VACUUM (IE. WHERE INPUT EXCITATION AND INSTRUMENTATION ARE LIMITED)
- CANDIDATE TEST METHOD CHOSEN AND ASTROMAST TEST PLAN STARTED
- PROGRESS MADE ON A FINITE ELEMENT MODEL OF THE ASTROMAST

MSAT

PHASE A STUDIES

SPACECRAFT CONFIGURATION/CONTROL

CONTRACTOR: James D. Kendall Consultants Ltd., Mississauga

REPORT: "Development of Configurational Software for the Demonstration Mobile Communications Satellite" DOC-CR-SP-81-037, July 81

SUMMARY:

- CTS/Hermes mass properties software updated for MSAT
- Computer graphics capabilities assessed
- Configurational software requirements reviewed
- Recommendations made for software development

MAMSAT

PHASE A STUDIES

SPACECRAFT CONTROL

CONTRACTOR: CANADIAN ASTRONAUTICS LTD.

REPORTS: ADVANCED BATTERY MANAGEMENT UNIT, 1981

SUMMARY:

- TECHNIQUES FOR IMPROVED BATTERY MANAGEMENT INVESTIGATED
- BREADBROAD SYSTEM DEVELOPED AND TESTED
- NiH2 CELLS PROCURED IN A SUPPLEMENTARY CONTRACT

MAMSAT

TITLE: A STUDY OF THE APPLICATION OF TDMA FOR MSAT
DOC-CR-SP-82-011 MARCH 26, 1982

CONTRACTOR: MILLER COMMUNICATIONS SYSTEMS LTD.

OBJECTIVE: TO DEMONSTRATE THE VIABILITY OF TDMA FOR CIVILIAN MOBILE USERS

RESULTS:

- NETWORK TOPOLOGIES PROPOSED FOR BOTH DEMONSTRATION AND OPERATIONAL PHASES OF MSAT PROJECT.
- SATELLITE-SWITCHED TDMA IS PRESENTED AS OPTIMUM METHOD OF PROVIDING GRACEFUL GROWTH CAPABILITY AND FLEXIBLE INTERCONNECTIVITY FOR OPERATIONAL SYSTEM.
- ERROR CORRECTION CODING AND HYBRID FDMA/TDMA TECHNIQUES INVESTIGATED.
- PEAK POWER REQUIREMENTS NEEDED TO SUPPORT OFFERED TRAFFIC LOAD AND THE SYNCHRONIZATION REQUIREMENTS TO MAINTAIN ORDERED ACCESS OF SATELLITE WERE EXAMINED.

TITLE:	TRANSMISSION OF SPEECH INFORMATION USING A VOCODER WITH MULTIDIMENSIONAL CODING (DICTIONARY)
CONTRACTOR:	UNIVERSITY OF SHERBROOKE
OBJECTIVE:	TO DEMONSTRATE THE PERFORMANCE ACHIEVABLE USING A VOCODER WITH MULTIDIMENSIONAL CODING APPLIED TO THE RESIDUAL RESULTING FROM LPC
RESULTS:	THE VOICE QUALITY RESULTING FROM THE CONSTRUCTION OF DICTIONARIES AND THE SIMULATION OF CODING-DECODING OPERATION THROUGH SOFTWARE DEVELOPMENT WAS DEMONSTRATED. MULTIDIMENSIONAL CODING OF SPEECH IS A TECHNIQUE OF SIGNAL QUANTIZATION APPLICABLE TO LOW BIT RATES (BELOW 5000 B/SEC). IT CAN BE USED JOINTLY FOR THE CODING OF THE PREDICTIVE FILTER AND FOR THE CODING OF THE RESIDUAL SIGNAL WAVEFORM. ITS USE IN CONJUCNTION WITH LPC IS VERY PROMISING.

MARISAT

GROUND SEGMENT

J. SYDOR/ADGA

AGENDA ITEM 6

MSAT

GROUND SEGMENT

CENTRAL CONTROL STATION PHASE A STUDY

OBJECTIVES:
- To specify CCS system requirements
- Determine system costs, manpower requirements, etc.
- Identify major development areas and/or regulatory problems

CONTRACTOR: SED Systems, Saskatoon DOC Report DOC-CR-SP-81-050

MAJOR FINDINGS:

• TT&C System	M.M.	L.O.C.	Est. Cost ($M 1981 CDN)
- Spacecraft Operations and Control System:	226	39,200	4.4
- Communications Operation and Control System:	155	23,900	1.7
- Station Monitor and Control System:	71	10,000	.7
- Real Time Simulation Package System:	227	39,200	2.0
TOTALS	728	112,300	$8.8M

WARNSAT

CCS CONTINUED

- STAFFING REQUIREMENTS: - 28 FULL TIME PERSONNEL (24/7 OPERATION)
  - 20 FULL TIME PERSONNEL (24/7 OPERATION) FOR REDUCED MILITARY ROLE
- PHYSICAL PLANT: 7000 SQ. FT. AT COST $1.0M
- FREQUENCY CONTROL RECOMMENDATION: USE SATELLITE LOCAL OSCILLATOR AS AN OVERALL SYSTEM STANDARD
- MTBF ANALYSIS
- SUMMARY OF COSTS:

- ANTENNA SYSTEM (10M. DISH 7/8 GHz)	$1.7M
- Rx/Tx EQUIPMENT	.4M
- RF TEST AND INTEGRATION	.9M
- FACILITY PHYSICAL PLANT	1.0M
- TT&C SOFTWARE AND HARDWARE	8.8M
TOTAL CCS COST (WITH REDUCED MILITARY OPTION)	$12.8M

MAMSAT

GROUND SEGMENT

GATEWAY STATION PHASE A STUDY

OBJECTIVES:
- To determine channel unit requirements (NBFM (AMPS COMPATIBLE) and LPC/DIGITAL)
- Size a DAMA System
- Detail inter-Gateway orderwire, STN interface, billing, physical plant and other system requirements
- Determine general specifications and costs
- Identify major development areas or regulatory problems

CONTRACTOR: SED Systems, Saskatoon DOC Report DOC-CR-SP-81-049

MAJOR FINDINGS & RECOMMENDATIONS:

- Use single hop mode for some mobile to mobile/base station operations
- Colocate Gateways with Telco system class 4/5 switching office
- NBFM (AMPS) cannot be accommodated in single hop mode; difficult and costly to implement otherwise
- Digital system most economical to implement
- MTBF analysis conducted
- Sample costs for a complete Gateway:
  - 32 Trunk NBFM amps compatible system $3.2M
  - 32 Trunk digital system $ .5M

GROUND SEGMENT

MSAT PHASE A STUDIES

LAND MOBILE VEHICLE ANTENNA DEVELOPMENT

OBJECTIVES

MAJOR PERFORMANCE GOALS FOR THE CIRCULARLY-POLARIZED OMNIDIRECTIONAL - AZIMUTH ANTENNA WERE SET AT:

- 4 dBi MINIMUM GAIN AT 15 DEGREES ELEVATION FALLING TO -1 dBi AT 60 DEGREES
- GAIN TO FALL-OFF AS-RAPIDLY AS POSSIBLE BELOW 15 DEGREES

METHODOLOGY

A LITERATURE SEARCH IDENTIFIED THREE PROMISING PROTOTYPE ANTENNAS WHICH WERE THEN DEVELOPED FOR THIS APPLICATION:

- DROOPING CROSS-DIPOLE
- CONICAL LOG-SPIRAL
- BACKFIRE QUADRIFIER HELIX

RESULTS

GOOD PERFORMANCE WAS OBTAINED WITH CROSSED-DIPOLE AND CLS ANTENNAS. BACKFIRE QUAD HELIX SHOWED POOR EFFICIENCY AND REQUIRES FURTHER DEVELOPMENT.

MSAT

GROUND SEGMENT

MSAT PHASE A STUDIES

ENVIRONMENTAL NOISE MEASUREMENT PROGRAM

OBJECTIVES

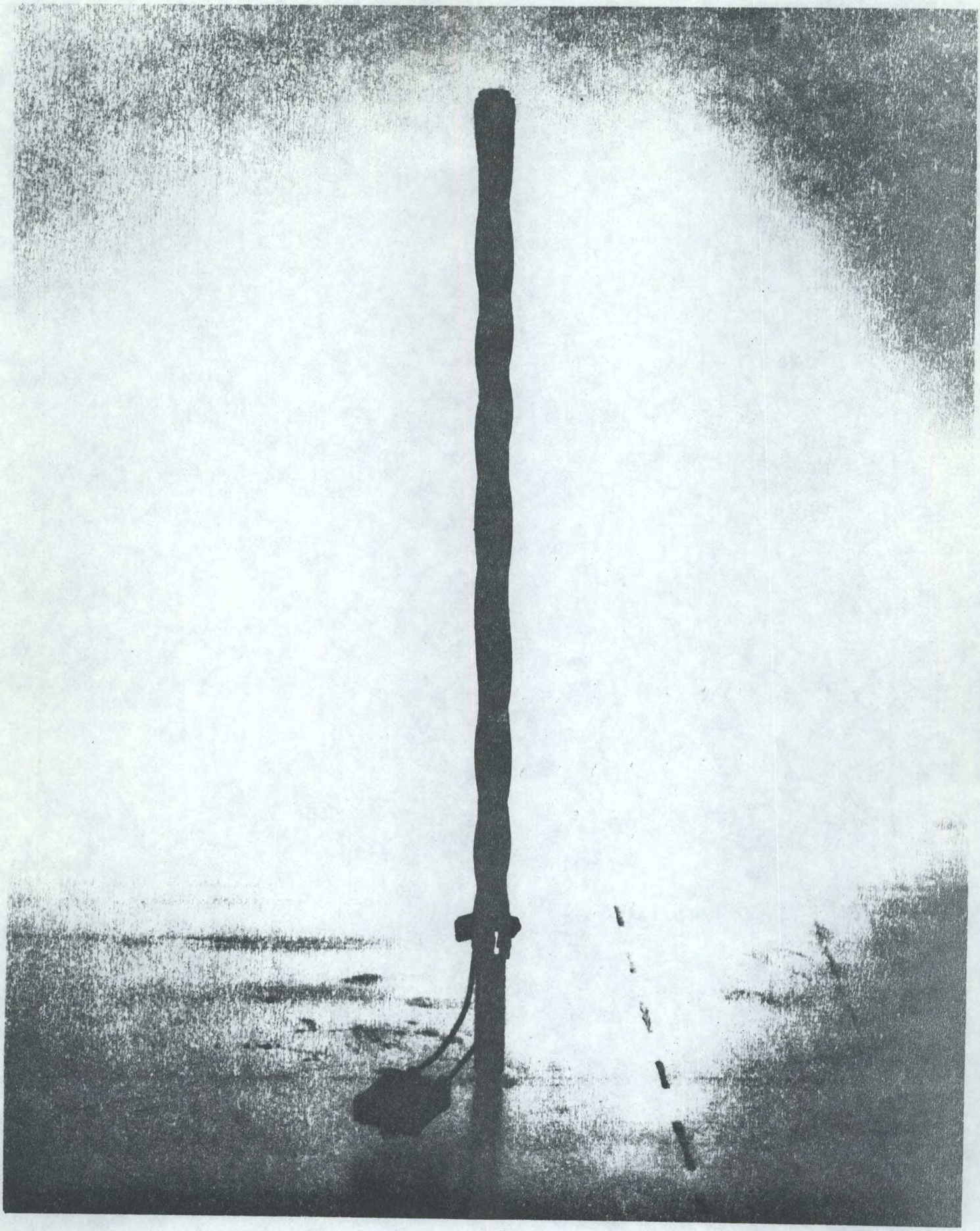
TO CHARACTERIZE MAN-MADE AND OTHER ENVIRONMENTAL NOISE IN THE 800 MHZ BAND USING BOTH A PROTOTYPE VEHICLE ANTENNA AND AN OMNIDIRECTIONAL ANTENNA.

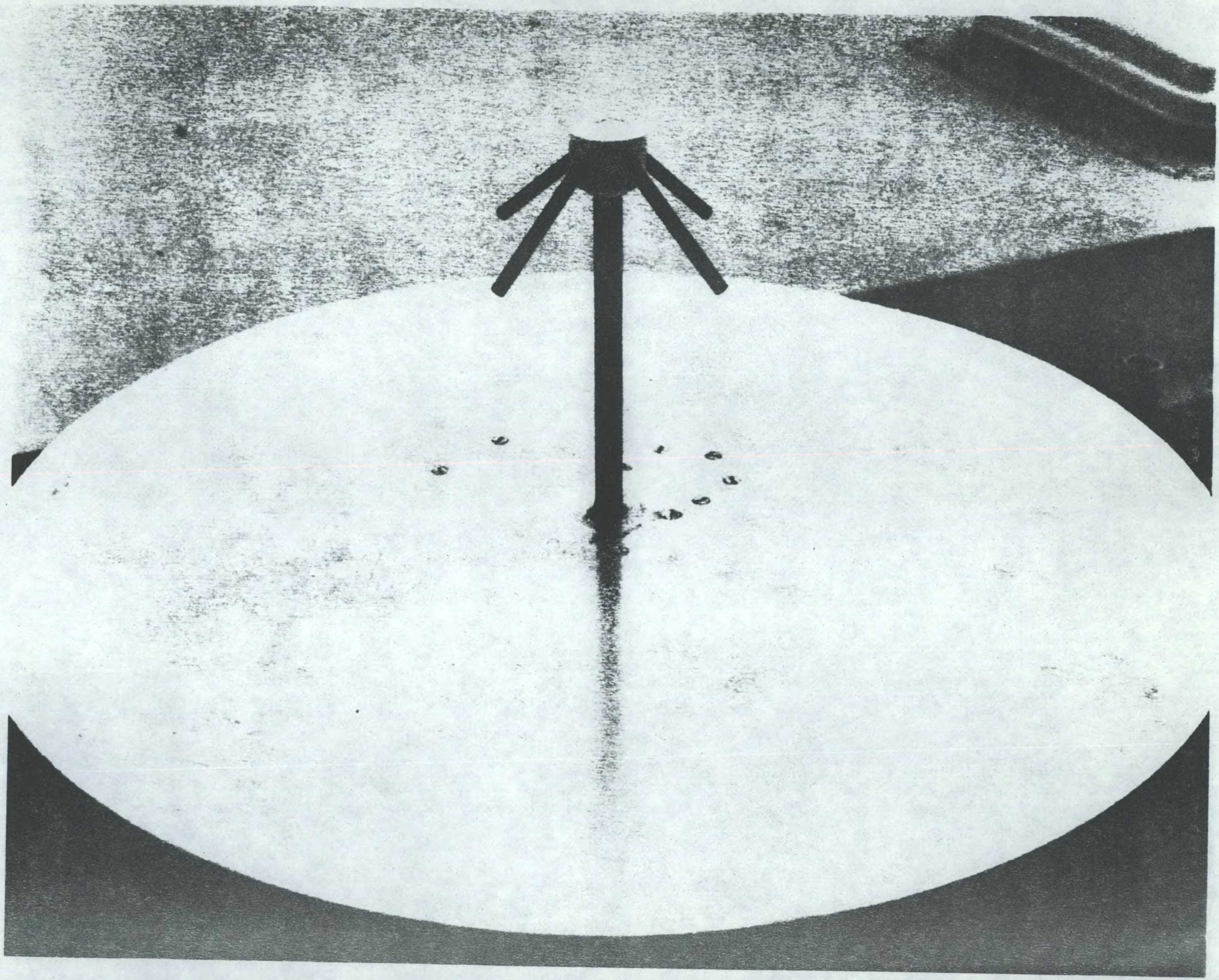
METHODOLOGY

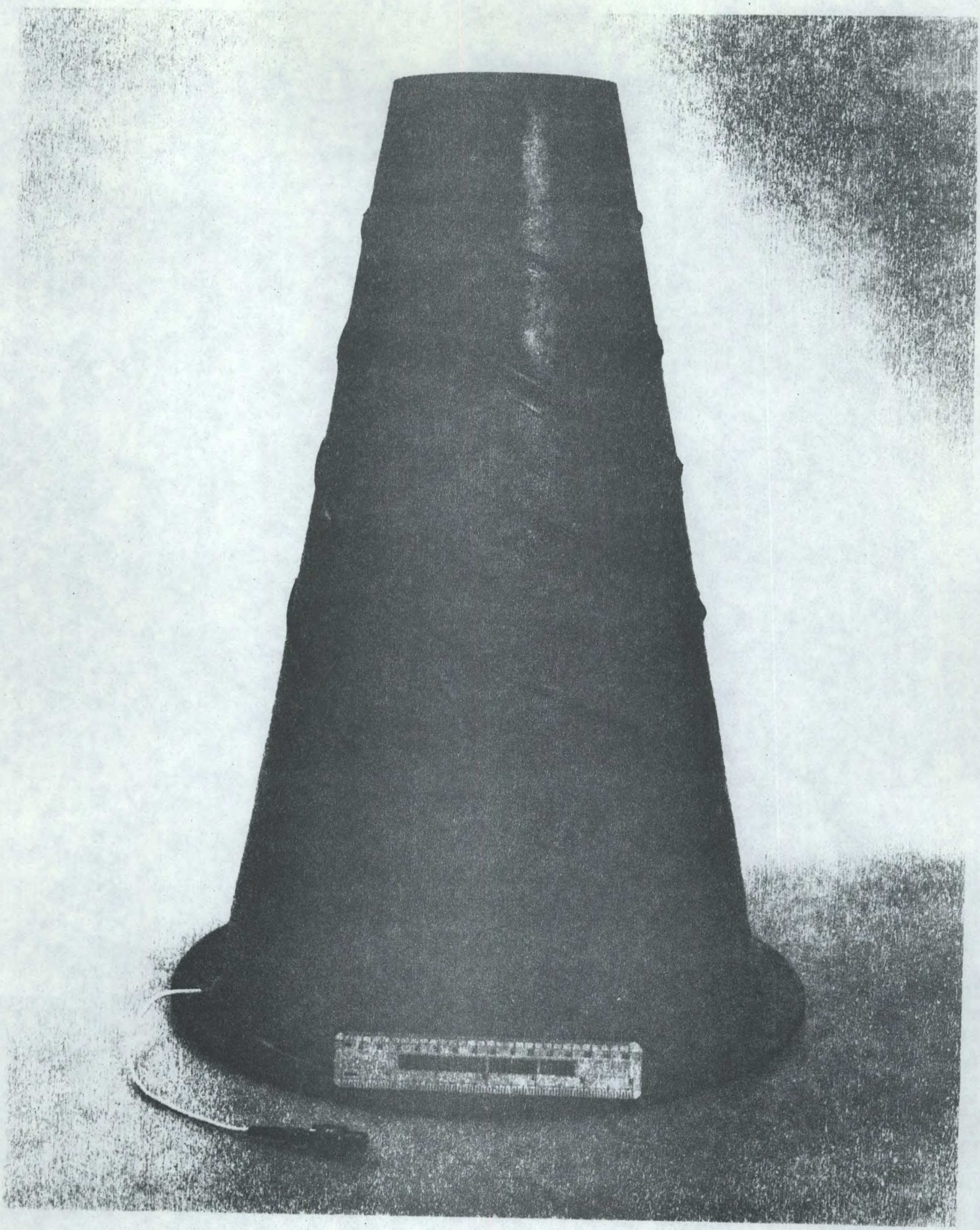
MEASUREMENTS WERE MADE IN BOTH SUBURBAN AND RURAL AREAS USING A BATTERY-POWERED RADIOMETER IN A MOBILE LABORATORY.

RESULTS

- THE LOW-ANGLE GAIN CUT-OFF OF THE VEHICLE ANTENNA RESULTED IN A PROPORTIONATE REDUCTION IN ENVIRONMENTAL NOISE PICK-UP.
- IN SUBURBAN AREAS, AN EQUIVALENT ENVIRONMENTAL NOISE TEMPERATURE OF MORE THAN 250K WAS OBSERVED ONLY 10% OF THE TIME.
- MEASUREMENTS IN RURAL AREAS INDICATED LESS THAN 200K (USUALLY BELOW RECEIVER THRESHOLD).







MSAT

GROUND SEGMENT

MSAT PHASE A STUDIES

PROPAGATION EFFECTS MEASUREMENT PROGRAM

OBJECTIVES

TO CHARACTERIZE EXCESS PATH LOSS FOR SUBURBAN AND RURAL AREAS, INCLUDING:

- MULTIPATH FADING EFFECTS,
- SHADOWING BY ROADSIDE TREES AND BUILDINGS.

METHODOLOGY

A SATELLITE SIGNAL SOURCE WAS SIMULATED BY A TRANSMITTER SUSPENDED FROM A TETHERED METEOROLOGICAL BALLOON.

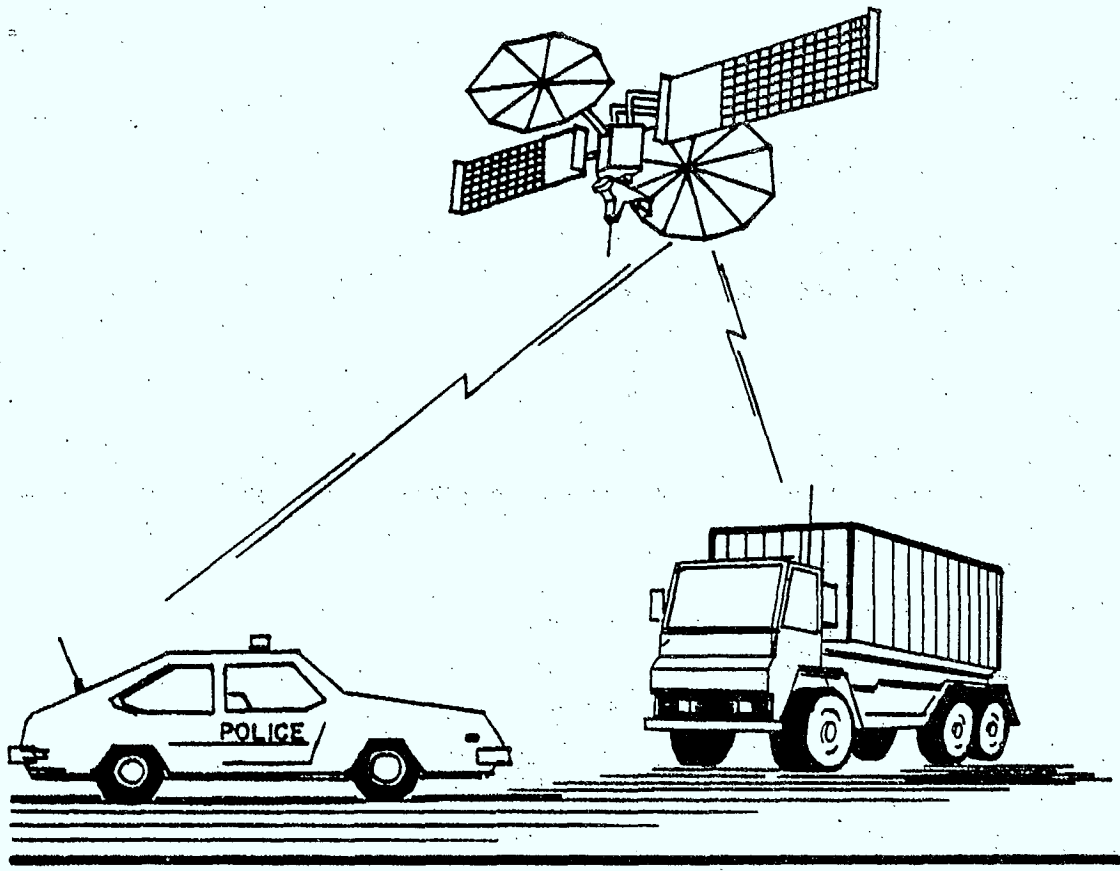
RESULTS

FADING: DIFFUSE MULTIPATH SIGNALS WERE FOUND TO BE TYPICALLY 10-12 dB BELOW THE LINE-OF-SIGHT SIGNAL. MODELLED BY RICE DISTRIBUTION.

SHADOWING: BY TREES CAN RESULT IN A MEDIAN ATTENUATION AS HIGH AS 8 dB, WITH A STANDARD DEVIATION OF 6 dB. MODELLED BY LOGNORMAL DISTRIBUTION.

STUDIES ARE CONTINUING.

INDUSTRY BRIEFING



MOBILE TERMINAL STUDY

adga

Consulting Group

OTTAWA, CANADA
SEPTEMBER , 1982

STUDY OBJECTIVES

- REVIEW AVAILABLE 806-890 MHz NBFM TERMINAL.

- REVIEW FEASIBILITY AND COST OF MODIFICATIONS NECESSARY FOR MSAT OPERATION USING NBFM.

- REVIEW FEASIBILITY AND COST OF MODIFICATIONS NECESSARY FOR ALTERNATIVE MODUALTION MODES.

- DETERMINE FEASIBILITY AND COST OF DEVELOPMENT OF TERMINAL WITHIN CANADIAN INDUSTRY.

STUDY APPROACH

- GENERATE FUNCTIONAL PERFORMANCE REQUIREMENTS
- SOURCE CANDIDATE TERMINALS
- REVIEW PERFORMANCE OF CANDIDATE TERMINALS
- DEVELOP MSAT TERMINAL CONCEPTS
- INDUSTRY BASED STUDY OF DEVELOPMENT AND MODIFICATION COST.

		C/(No ± I) (dB Hz)	
MODULATION	BANDWIDTH OR DATA RATE	MTS	MRS
NBFM (12)	30 KHz	53	53
NBFM (5)	12.5 KHz	52	52
ACSSB	5 KHz	48	48
RELP	4.8 KBPS	---	50
LPC 10	2.4 KBPS		47

DESIGN OBJECTIVES FOR C(No + I)

ANT.SIZE(FT.)	30		50		83	
EOC GAIN(dB)	33		36.5		39	
SERVICE	MTS	MRS	MTS	MRS	MTS	MRS
NBFM(12)	15.4	15.4	11.9	11.9	9.4	9.4
NBFM(5)	14.4	14.4	10.9	10.9	8.4	8.4
ACSSB (AVERAGE POWER)	10.4	10.4	6.9	6.9	4.4	4.4
RELP	----	12.4	----	8.9	---	7.4
LPC	----	9.4	----	5.9	---	3.4

DESIGN OBJECTIVES MOBILE POWER OUTPUT

adga

SUMMARY OF PERFORMANCE REQUIREMENTS NBFM (MTS)

	TERRESTRIAL (CELLULAR)	MSAT ONLY	MSAT + TERRESTRIAL
POWER OUTPUT	12 (3) WATTS	50 WATTS	50 (3) WATTS
Rx NOISE FIGURE	9 dB	2.2 dB	2.2 (A) dB
RF BANDWIDTH	20 + 20 MHZ	5 + 5 MHZ	25 + 25 MHZ
CHANNEL BANDWIDTH	30 KHZ	30 KHZ	30 KHZ
DYNAMIN RANGE	80 dB	37 dB	37 (80) dB
FREQ STABILITY	±2.5 PPM	±2.0 PPM	±2.0 PPM
SIGNALLING	10 KBITS/SECOND	10 KBITS/SECOND	10 KBITS/SECOND
MODE	FULL DUPLEX	VOICE ACTIVATED DUPLEX	VOICE ACTIVATED DUPLEX
IM INTERCEPT	-30 dBM	-83dBM	-83 (-30) dBM

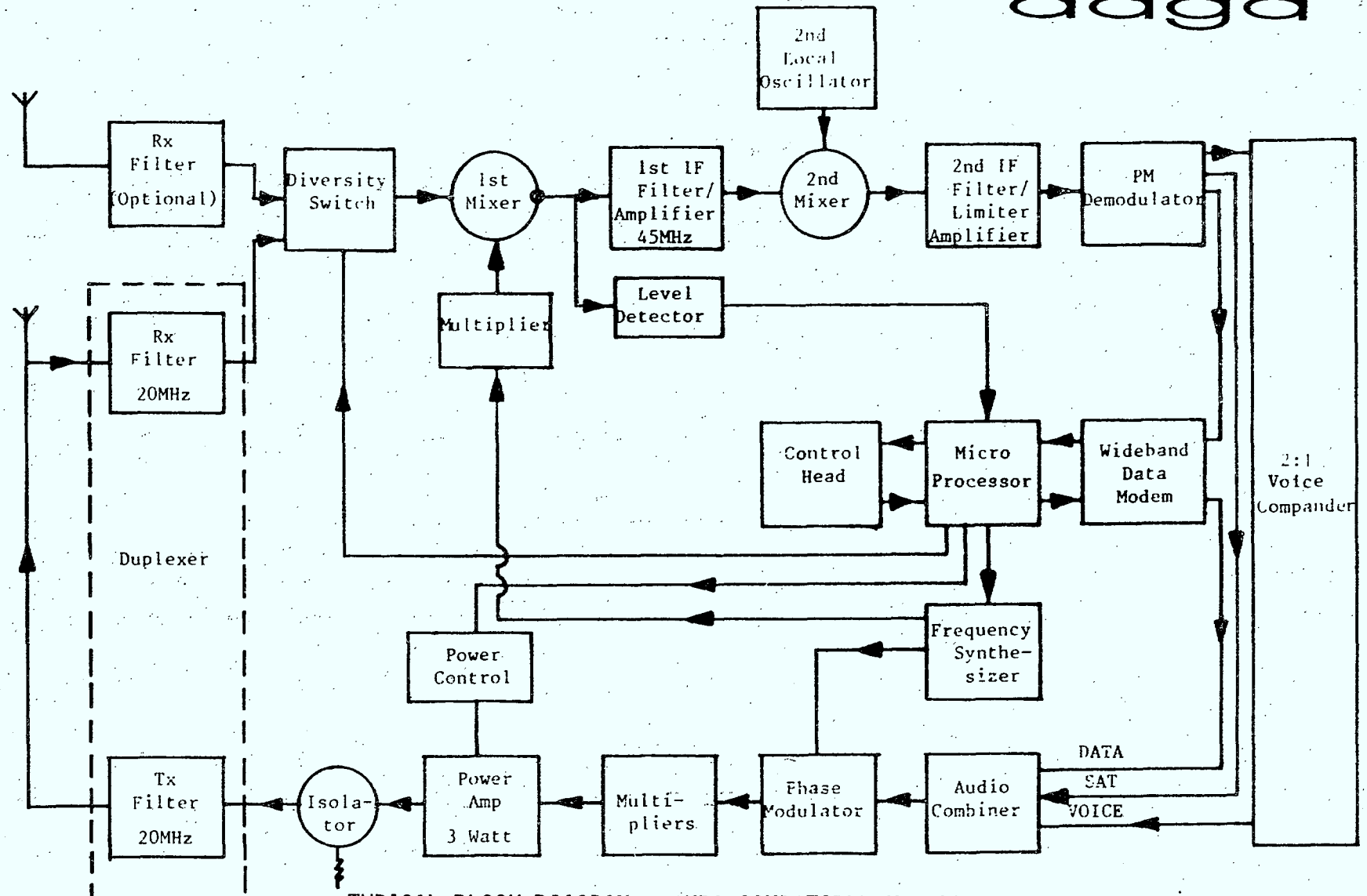
SUMMARY OF PERFORMANCE REQUIREMENTS ACSB (MRS)

	TERRESTRIAL	MSAT	MSAT + TERRESTRIAL
POWER OUTPUT	12 WATT PEAK	50 WATT PEAK	50 (12) WATT PEAK
Rx NOISE FIGURE	9 dB	2.2 dB	2.2 (9dB)
RF BANDWIDTH	5 + 5 MHZ	5 + 5 MHZ	10 + 10 MHZ
CHANNEL BANDWIDTH	5 KHZ	5 KHZ	5 KHZ
DYNAMIC RANGE	80 dB	37 dB	37 (80) dB
FREQ STABILITY	±0.5 PPM ± AFC	±0.5 PPM ± AFC	±0.5 PPM + AFC
SIGNALLING	2.4 KBITS/SECOND	2.4KBITS	2.4KBITS
MODE	HALF DUPLEX PTT	HALF DUPLEX PTT	HALF DUPLEX PTT
IM INTERCEPT	-30 dBM	-83 dBM	-83 (-30) dBM

CELLULAR FEATURES REQUIRED BY MSAT

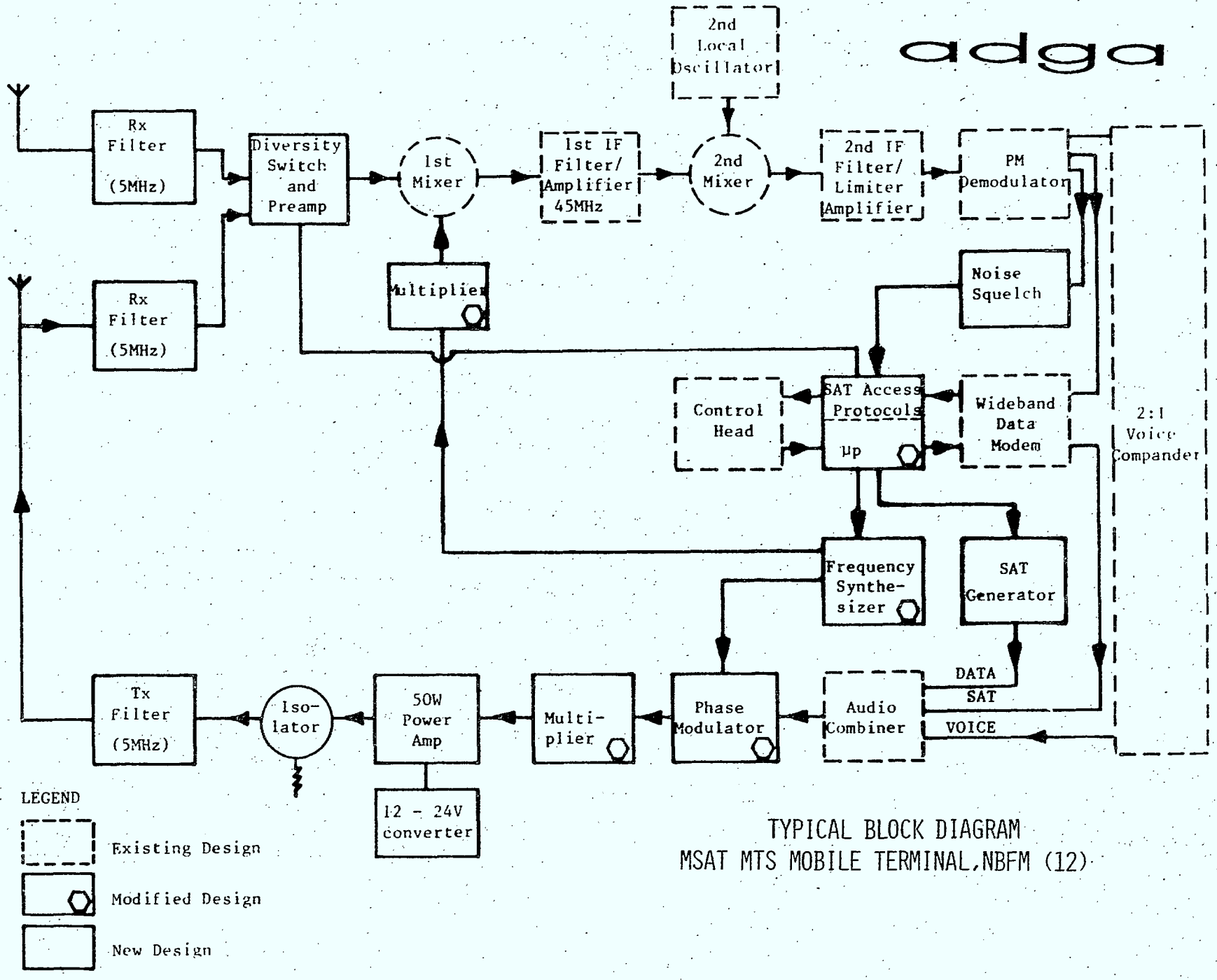
- DEMAND ASSIGNMENT MULTIPLE ACCESS (DAMA) OF VOICE CHANNELS FROM A CENTRAL CONTROLLER;
- AUTOMATIC VEHICLE INDENTIFICATION CODE TRANSMITTED FOR PURPOSES OF DAMA AND CALL DATA RECORDING (BILLING);
- DEDICATED PAGING AND ACCESS CHANNELS;
- AUTOMATIC REGISTRATION IN A FOREIGN CELL OR BEAM;
- HOME CELL (OR BEAM) DESIGNATION;
- REGULATED SCANNING OF PAGING CHANNELS;
- AUTOMATIC CALL TERMINATION IN THE EVENT OF SIGNAL LOSS.

adga



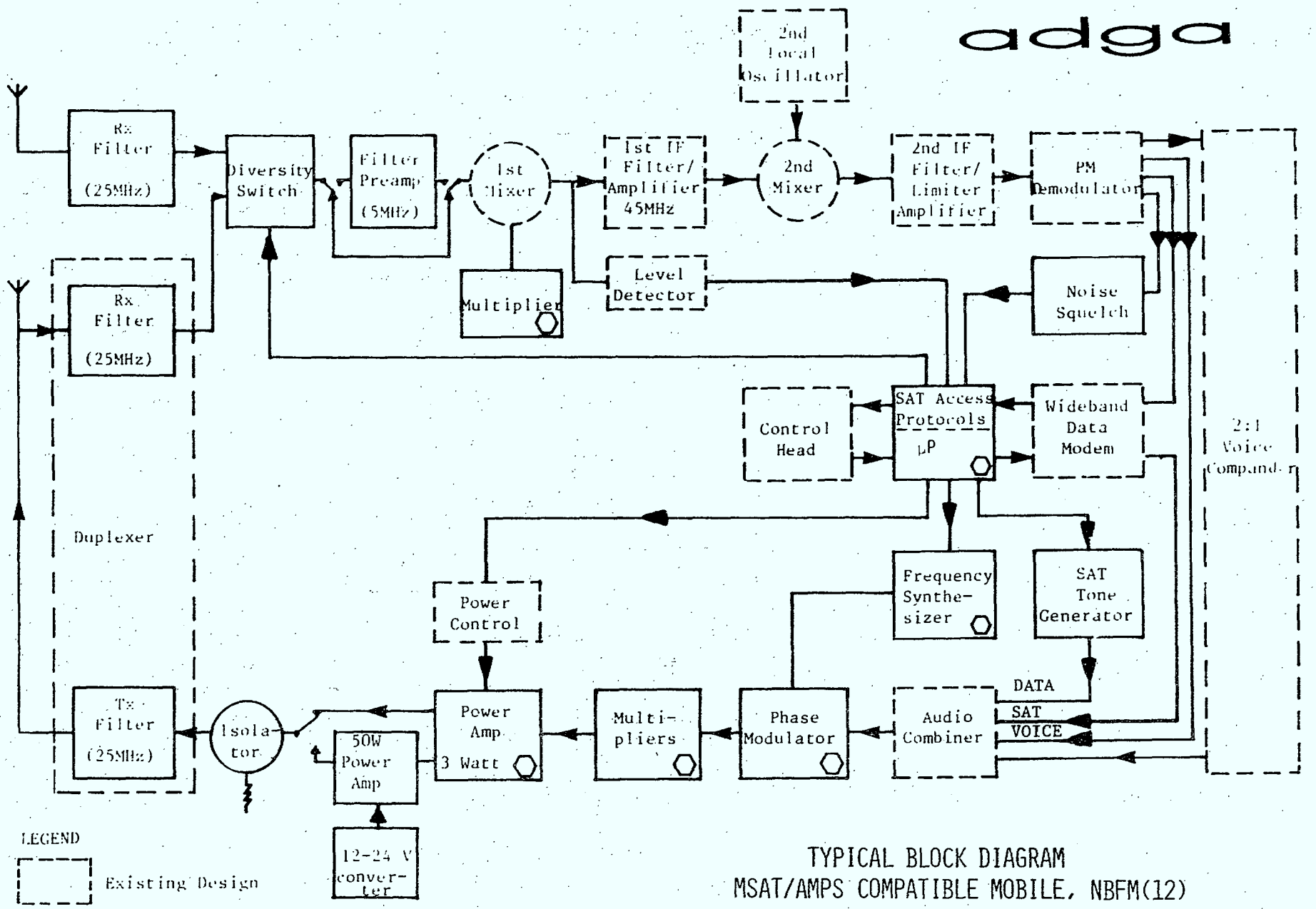
TYPICAL BLOCK DIAGRAM - AMPS COMPATIBLE MOBILE TERMINAL, NBFM(12)

adga



TYPICAL BLOCK DIAGRAM
MSAT MTS MOBILE TERMINAL,NBFM (12)

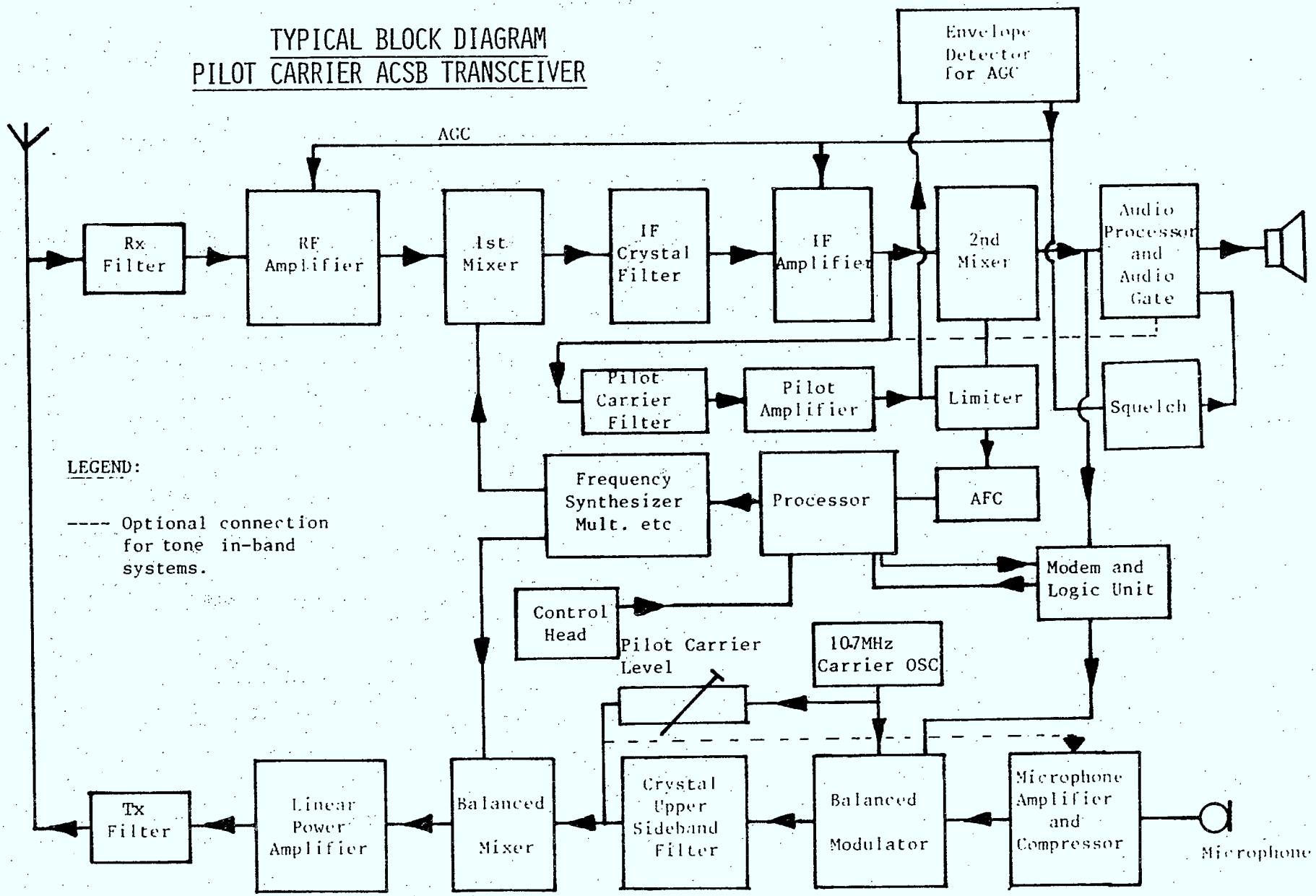
adga

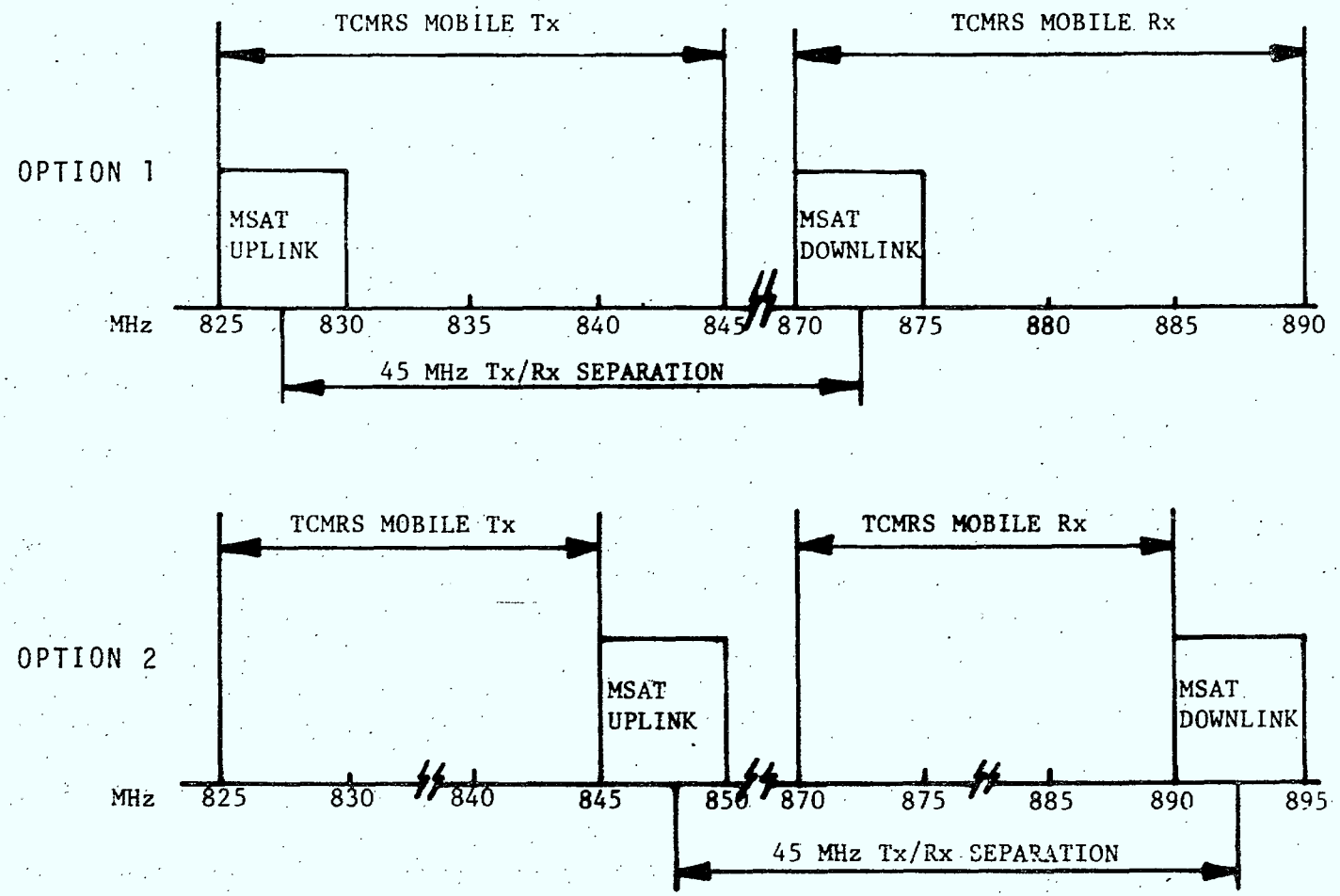


TYPICAL BLOCK DIAGRAM
MSAT/AMPS COMPATIBLE MOBILE, NBFM(12)

adga

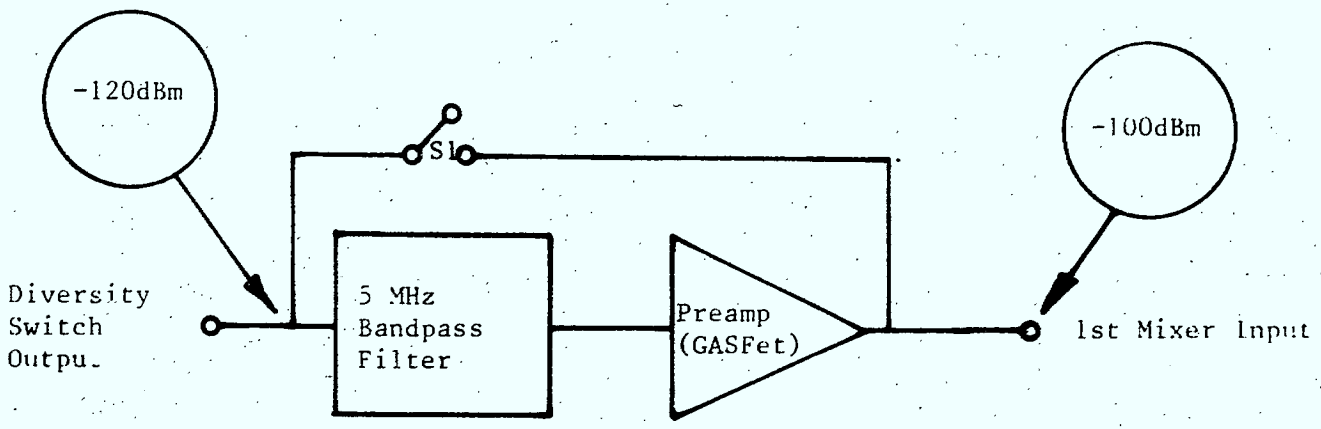
TYPICAL BLOCK DIAGRAM
PILOT CARRIER ACSB TRANSCEIVER



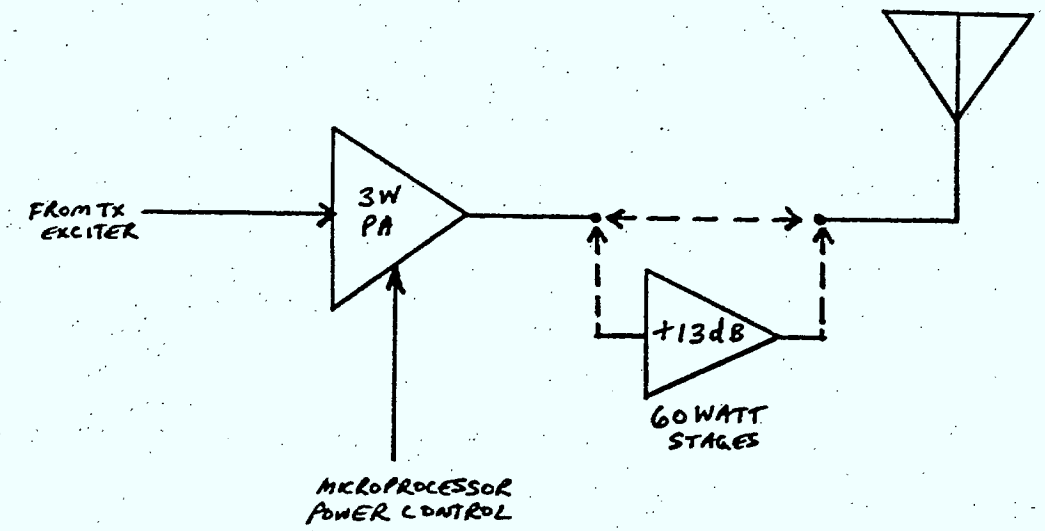


CANDIDATE MSAT FREQUENCY ALLOCATIONS

NOTE: S1 CLOSED FOR TERRESTRIAL SYSTEM



IMPLEMENTATION OF MSAT PROGRAM



POWER AMPLIFIER

TYPE OF MOBILE SERVICE	COST$C
MRS MOBILE SATELLITE ONLY SERVICE	3595.00
MRS MOBILE JOINT TERRESTRIAL/SATELLITE SERVICE	3705.00
MTS MOBILE SATELLITE ONLY SERVICE	3095.00
MTS MOBILE JOINT TERRESTRIAL/SATELLITE SERVICE	3230.00

PROJECTED MOBILE TERMINAL COST DURING LIFE OF OPERATIONAL SYSTEM ($1981 CANADIAN).

MSAT PHASE B INDUSTRY BRIEFING.