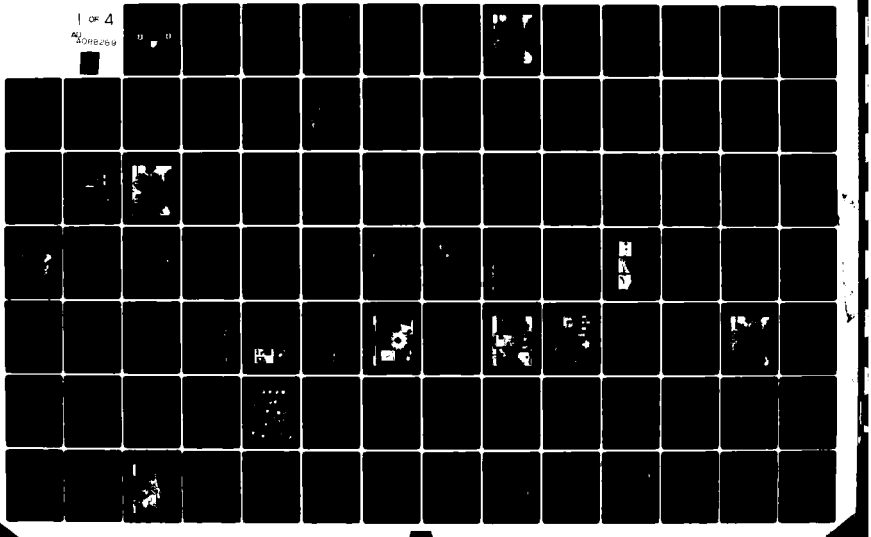
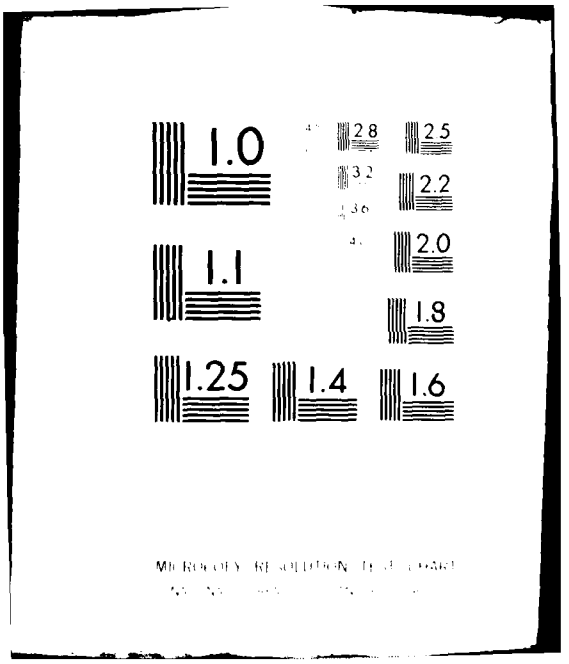
AD-A088 289 ROME AIR DEVELOPMENT CENTER GRIFFISS AFB NY F/G 5/1
INDUSTRY LOOKS AT RADC - 1980. VOLUME I.(U)
1980
UNCLASSIFIED RADC-TR-80-195-VOL-1 NL

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RADC-TR-80-195, Vol I (of three)
In-House Report
3-4 June 1980

LEVEL II

# ROME AIR DEVELOPMENT CENTER
# (RADC)

# INDUSTRY LOOKS AT RADC - 1980








**ROME AIR DEVELOPMENT CENTER**
**Air Force Systems Command**
**Griffiss Air Force Base, New York 13441**

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Because of the size of this document, it has been divided into three volumes. Volume I contains pages 1 - 303, Volume II contains pages 305 - 541, and Volume III contains pages 543 - 791.

RADC-TR-80-195, Volume I (of three) has been reviewed and is approved for publication.

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RADC Program Industry $C^3I$ Planning

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This report is a compilation of presentation materials used during the 2-day 'Industry Looks at RADC' briefings given on 3 - 4 June 1980. Projected RADC areas of contractual opportunity for FY 81 - 82 are given.

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**DEPARTMENT OF THE AIR FORCE**
HEADQUARTERS ROME AIR DEVELOPMENT CENTER (AFSC)
GRIFFISS AIR FORCE BASE, NEW YORK 13441

## RADC COMMANDER'S MESSAGE

THIS SET OF PROCEEDINGS REPRESENTS A SIGNIFICANT EXPANSION OVER OUR PREVIOUS PRESENTATIONS TO INDUSTRY. THE CHANGE TO A TWO DAY FORMAT AND PARALLEL AFTERNOON SESSIONS HAS ENABLED US TO PRESENT MORE DETAIL ON PARTICULAR PROGRAMS WITHOUT NEGLECTING THE LONG TERM DIRECTIONS OF RADC.

IF YOU HAVE SUGGESTIONS OR COMMENTS ON HOW WE CAN IMPROVE THIS UNDERSTANDING WITH INDUSTRY, PLEASE CONTACT US DIRECTLY, OR THROUGH THE QUESTIONNAIRE ENCLOSED WITH THIS COPY.

Donald J. Stukel

DONALD J. STUKEL
Colonel, USAF
Commander

3 June 1980

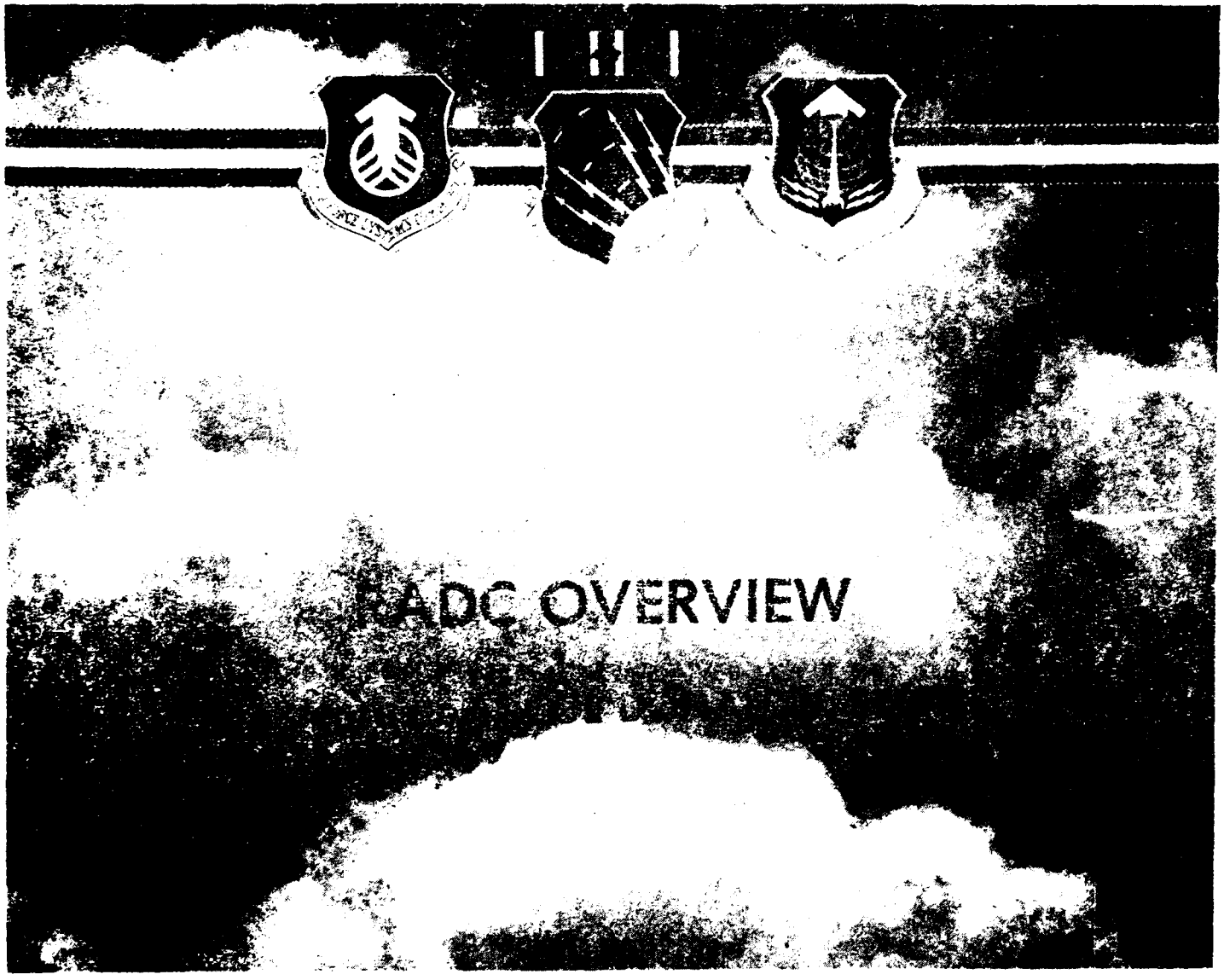
# INDUSTRY LOOKS AT RADC

| | |
|---|---|
| 0715 | Registration |
| 0800 | Welcome - |
| 0805 | RADC Overview - Col D. Stukel |
| 0830 | Film: AFSC Acquisition Initiative Update - General A. Slay |
| 0900 | Surveillance - Lt Col M. Haugen |
| 0945 | Communications - Dr. F. Diamond |
| 1030 | Break |
| 1045 | Electromagnetics - Lt Col W. Baschnagel |
| 1130 | Solid State Devices - Mr. B. Buchanan |
| 1215 | Lunch |
| 1345 - 1445 | Parallel Mini-Sessions |
| Bldg. 106 Auditorium | Host: OC - Surveillance ECCM - Shields<br>- Aircraft Identification - Wolf |
| Base Theater | Host: DC - Switching and Routing - Marples<br>- System Control - Spector<br>- Distributed $C^3$ - Schmitt |
| Silver Wings | Host: EE - Antennas - McIlvenna |
| Chapel | Host: ES - System Timing Components - Yannoni |
| 1515 - 1615 | Parallel Mini-Sessions |
| Bldg. 106 Auditorium | Host: OC - Space Based Radar - Simons<br>- Cruise Missile Surveillance - Ogrodnik |
| Base Theater | Host: DC - Satellite Communications - Lee<br>- Optical Communications - Hendrickson<br>- Sub-UHF Communications - Talty |
| Silver Wings | Host: EE - RF Components - Carr |
| Chapel | Host: ES - Electro-Optic Devices - Yang |
| 1900 | No Host Social Hour - Beeches Restaurant |
| 2000 | AFCEA Dinner |
| 2100 | Major General James W. Stansberry<br>DCS, Contracting and Manufacturing<br>AFSC |

4 June 1980

INDUSTRY LOOKS AT RADC

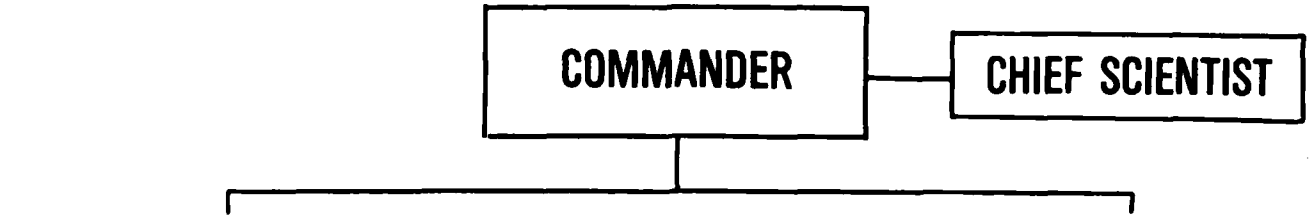
| | |
|---|---|
| 0800 | RECCE/Intel - Col O. Lawter |
| 0845 | Reliability/Maintainability/Compatibility - Mr. J. Bart |
| 0930 | Information Processing - Mr. A. Barnum |
| 1015 | Break |
| 1030 | Contracting Procedures - Lt Col J. Faulkner |
| 1115 | Questions & Answers for CC/CV/PK |
| 1145 | Lunch |
| 1330 - 1430 | Parallel Mini-Sessions |
| Base Theater | Host: IR - Direct Digital Targeting - Crane<br>- Precision Guidance & Strike Products - Palermo |
| Chapel | Host: RB - Solid State Device Reliability - Bart |
| Silver Wings | Host: IS - Information Processing Structures - Metzger<br>- Information Processing Databases - Metzger |
| Bldg. 106 Auditorium | Host: IS - $C^2I$ Decision Aids - Atkinson<br>- Higher Order Languages - DiNitto |
| 1500 - 1600 | Parallel Mini-Sessions |
| Base Theater | Host: IR - Wideband Recording - Jamberdino<br>- Speech Processing - Beek |
| Silver Wings | Host: RB - Equipment/System Reliability and Maintainability - Coppola |
| Bldg. 106 Auditorium | Host: IS - Software Engineering - Bergstrom |
| Chapel | Host: RB - Electromagnetic Compatibility Analysis and Controls - Capraro/Baustert/Stegmaier |


RADC OVERVIEW

# RADC MISSION

- PLANS & EXECUTES RESEARCH, EXPLORATORY & ADVANCED DEVELOPMENT IN $C^3I$ ACTIVITIES:
  - COMMUNICATIONS
  - SURVEILLANCE OF GROUND & AEROSPACE OBJECTS
  - INTELLIGENCE DATA COLLECTION & HANDLING
  - INFORMATION SYSTEM TECHNOLOGY
  - ELECTROMAGNETIC PROPAGATION
  - SOLID STATE PHYSICS
  - ELECTRONIC RELIABILITY, MAINTAINABILITY & COMPATIBILITY
- CONDUCTS ASSIGNED ENGINEERING DEVELOPMENTS
- PROVIDES SUPPORT TO TECHNOLOGY INTENSIVE ACQUISITION PROGRAMS
- CONDUCTS SELECTED ACQUISITIONS IN THE INTELLIGENCE AREA

# RADC ORGANIZATION




## STAFF & SUPPORT

- CONTRACTING
- COMPTROLLER
- SUPPORT SERVICES
- INTEGRATED LOGISTICS SUPPORT
- JUDGE ADVOCATE
- STAFF METEOROLOGIST
- SAFETY
- SMALL BUSINESS
- INTELLIGENCE
- OPERATIONS
- PLANS
- SECURITY

## MISSION DIVISIONS

- SURVEILLANCE
- COMMUNICATIONS & CONTROL
- INFORMATION SCIENCES
- RELIABILITY & COMPATIBILITY
- INTELLIGENCE & RECONNAISSANC
- SOLID STATE SCIENCES
- ELECTROMAGNETIC SCIENCES

# RADC RESOURCES

PEOPLE (AUTHORIZED):

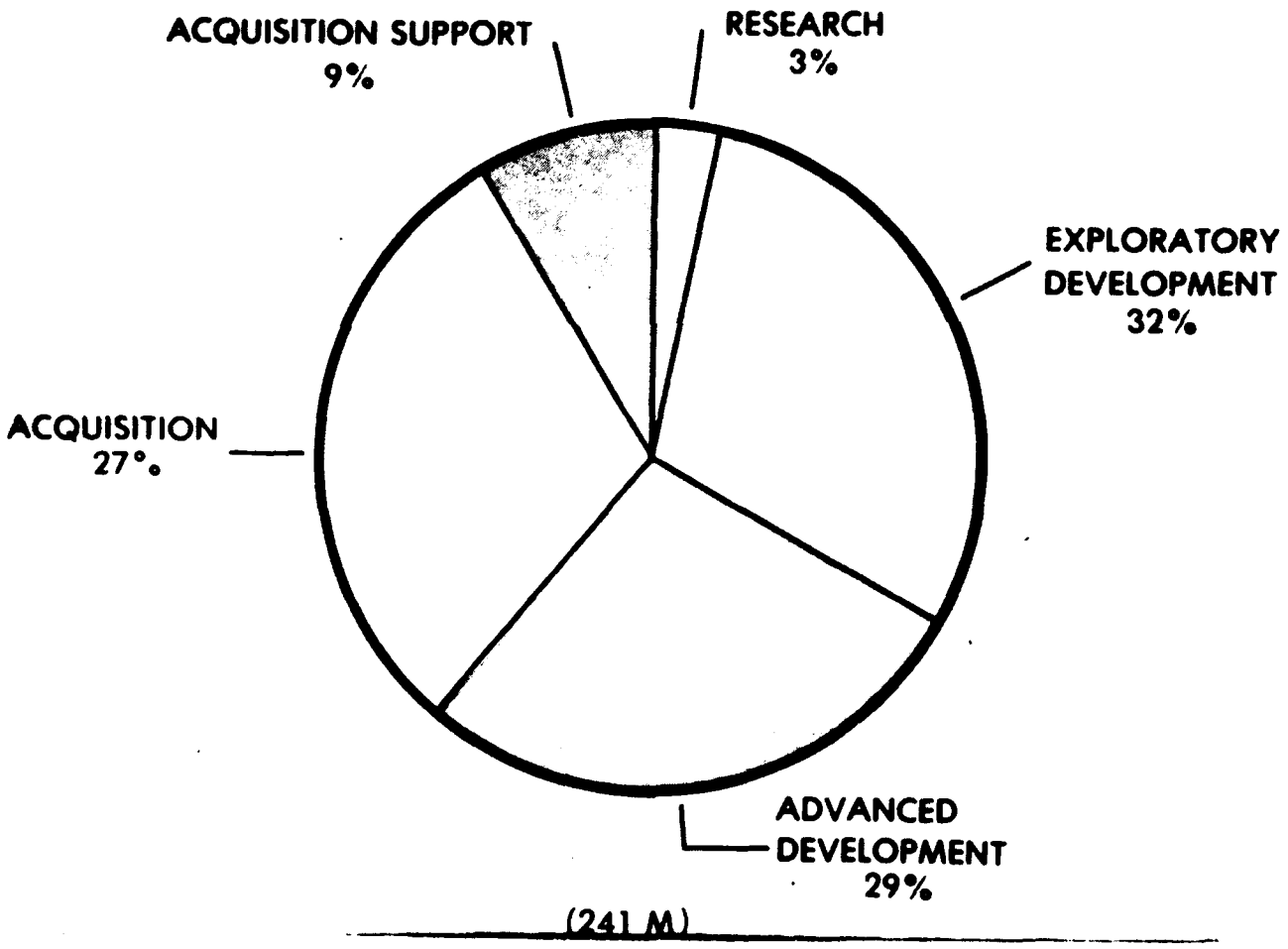
| | S&E | TECH | OTHER | TOTAL |
|---|---|---|---|---|
| OFFICERS | 118 | | 24 | 142 |
| AIRMEN | | 24 | 54 | 78 |
| CIVILIANS | 598 | 163 | 335 | 1096 |
| | 716 | 187 | 413 | 1316 |

MONEY:

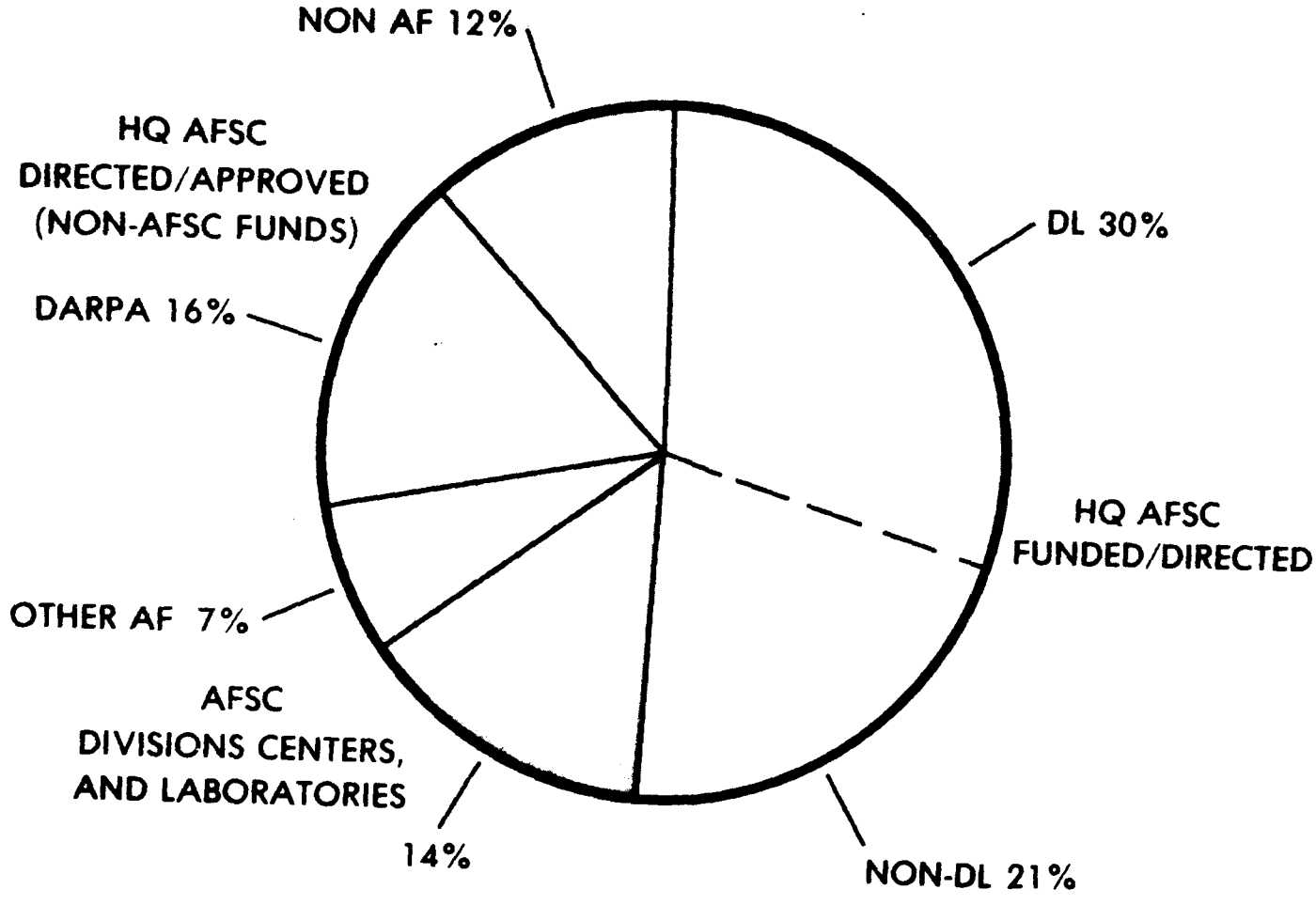
FY 80 241 MILLION

AS OF: 1 MAY 80

# FY-80
# RADC PROGRAM SPECTRUM
## FUNDS BY TYPE OF WORK



# FY-80
# SOURCES OF FUNDS



# SOURCES OF C³I TECHNOLOGY

- CONTRACT
  - $60M
  - RADC INITIATED
- INDEPENDENT RESEARCH & DEVELOPMENT
  - $400M
  - INDUSTRY INITIATED (55 CORPORATIONS)

# PROJECT VANGUARD

- A MAJOR AFSC PLANNING ACTIVITY

# RADC USAGE OF VANGUARD

- PROGRAM DIRECTION
- PROGRAM TIMING
- PROGRAM RELATIONSHIPS
- PROGRAM VISIBILITY

# TECHNOLOGY PLANNING OBJECTIVES

1. INDICATIONS & WARNING
   - TECHNICAL INTELLIGENCE
   - SIGNAL INTELLIGENCE
   - SURVEILLANCE SENSOR TECH
   - STRATEGIC TARGET SIGNATURES
   - INTEGRATED INTELLIGENCE SYSTEMS

2. ALL WEATHER SURVEILLANCE & TARGETING
   - EMITTER LOCATION, IDENT & STRIKE
   - ACTIVE TARGET IDENT & LOCATION
   - GROUND TARGET DETECT & IDENT
   - PRECISION TARGETING & CHARTING
   - AIRCRAFT IDENTIFICATION

3. COMM & INFORMATION PROCESSING FOR C$^{3}$
   - NETWORK MANAGEMENT & CONTROL
   - INFORMATION TRANSMISSION
   - DISTRIBUTED C$^{3}$
   - C$^{3}$ INFORMATION PROCESSING
   - C$^{3}$ SIMULATION & EXPER

4. C$^{3}$ SURVIVABILITY
   - COMMUNICATIONS ECCM
   - SURVEILLANCE ECCM
   - EM COMPATIBILITY
   - EM (DEVICE) RADIATION HARDENING
   - COMMUNICATIONS SECURITY

5. C$^{3}$ SYS AVAILABILITY (HARDWARE/SOFTWARE
   - SOFTWARE COST REDUCTION
   - SOLID STATE DEVICE RELIABILITY
   - EQUIPMENT SYSTEM R&M
   - ADV C$^{3}$ ELEC MATERIALS & DEVICES

6. OTHER
   - BISS
   - HAVE NOTE
   - C$^{3}$ PROTECTIVE SYS EVALUATION FAC

# RADC TECHNOLOGY PLANNING OBJECTIVES
# (TPO)

1. COMMND, CONTROL & COMMUNICATIONS
   - A. SUPPORT $C^3$
   - B. STRATEGIC $C^3$
   - C. TACTICAL $C^3$
   - D. $C^3CM$

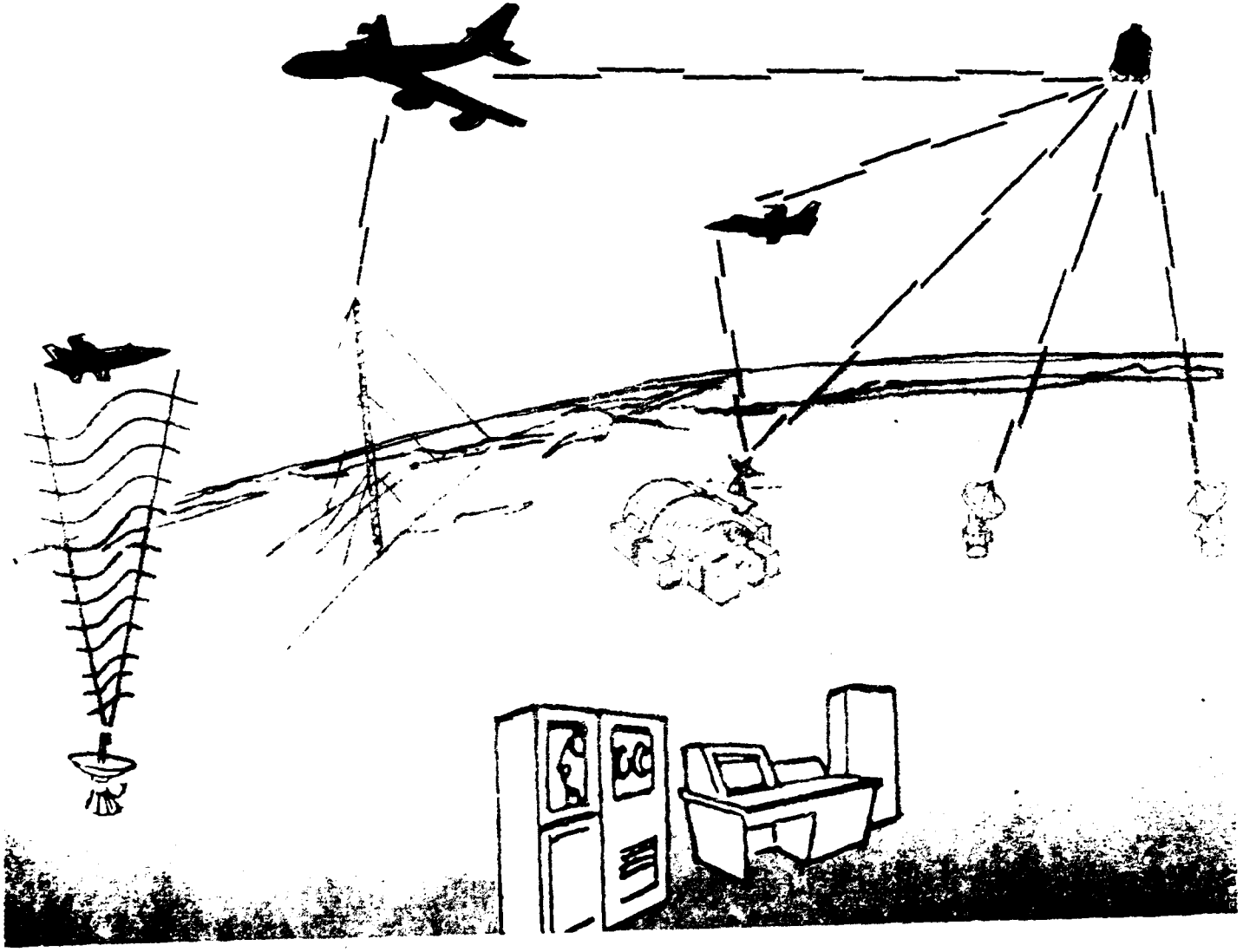
2. RECONNAISSANCE/INTELLIGENCE
   - A. SURVEILLANCE
   - B. CORRELATION/FUSION

3. STRATEGIC SYSTEMS
   - A. ATMOS SURV & WARNING
   - B. SPACE SURV & WARNING

4. TECHNOLOGY
   - A. SURVEILLANCE
   - B. COMMUNICATIONS
   - C. ELECTROMAGNETICS
   - D. SOLID STATE DEVICES
   - E. RECONNAISSANCE/INTELLIGENCE
   - F. RELIABILITY/COMPATIBILITY
   - G. INFORMATION PROCESSING

5. SPECIAL PROJECTS
   - A. SYSTEMS/EQUIPMENT EVALUATION
   - B. BISS
   - C. COMPUTER FACILITY
   - D. HAVE NAME

# TPO-1 COMMAND, CONTROL & COMMUNICATIONS



# TPO 1-COMMAND CONTROL & COMMUNICATIONS

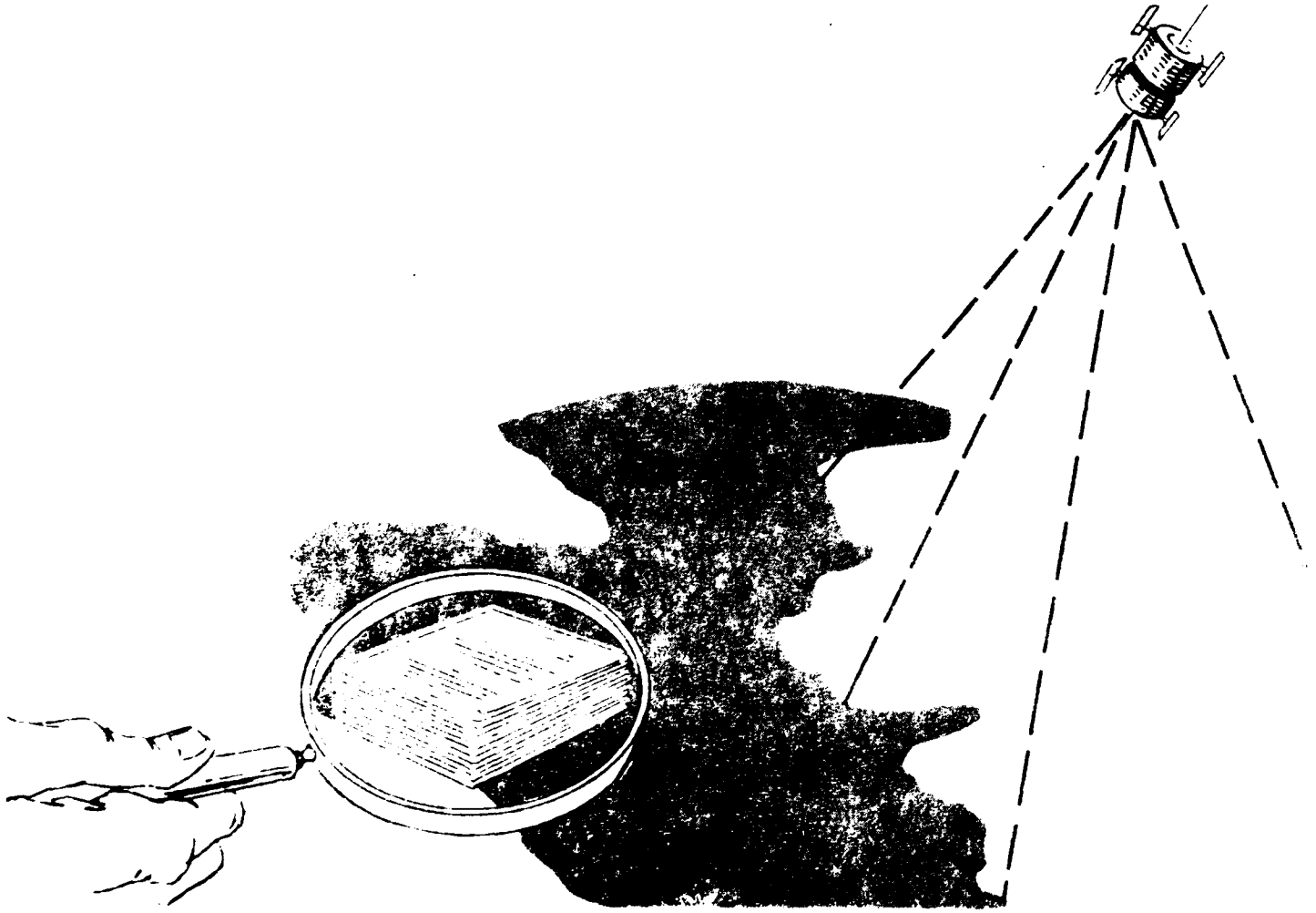
OBJECTIVE:

PROVIDE MEANS FOR COMMANDERS TO PLAN, DIRECT & CONTROL OPERATIONS OF ASSIGNED FORCES

MAJOR TECHNOLOGY THRUSTS:

- SURVIVABLE COMMUNICATION NETWORKS
- JAM RESISTANT COMMUNICATIONS
- REAL TIME AIRCRAFT IDENTIFICATION
- DISTRIBUTED, NETTED SENSORS
- AUTOMATED DECISION AIDS
- PRECISION TARGETING
- INTELLIGENCE PROCESSING & EXPLOITATION
- COMMAND & CONTROL COUNTERMEASURES

# TPO 2 - RECONNAISSANCE / INTELLIGENCE



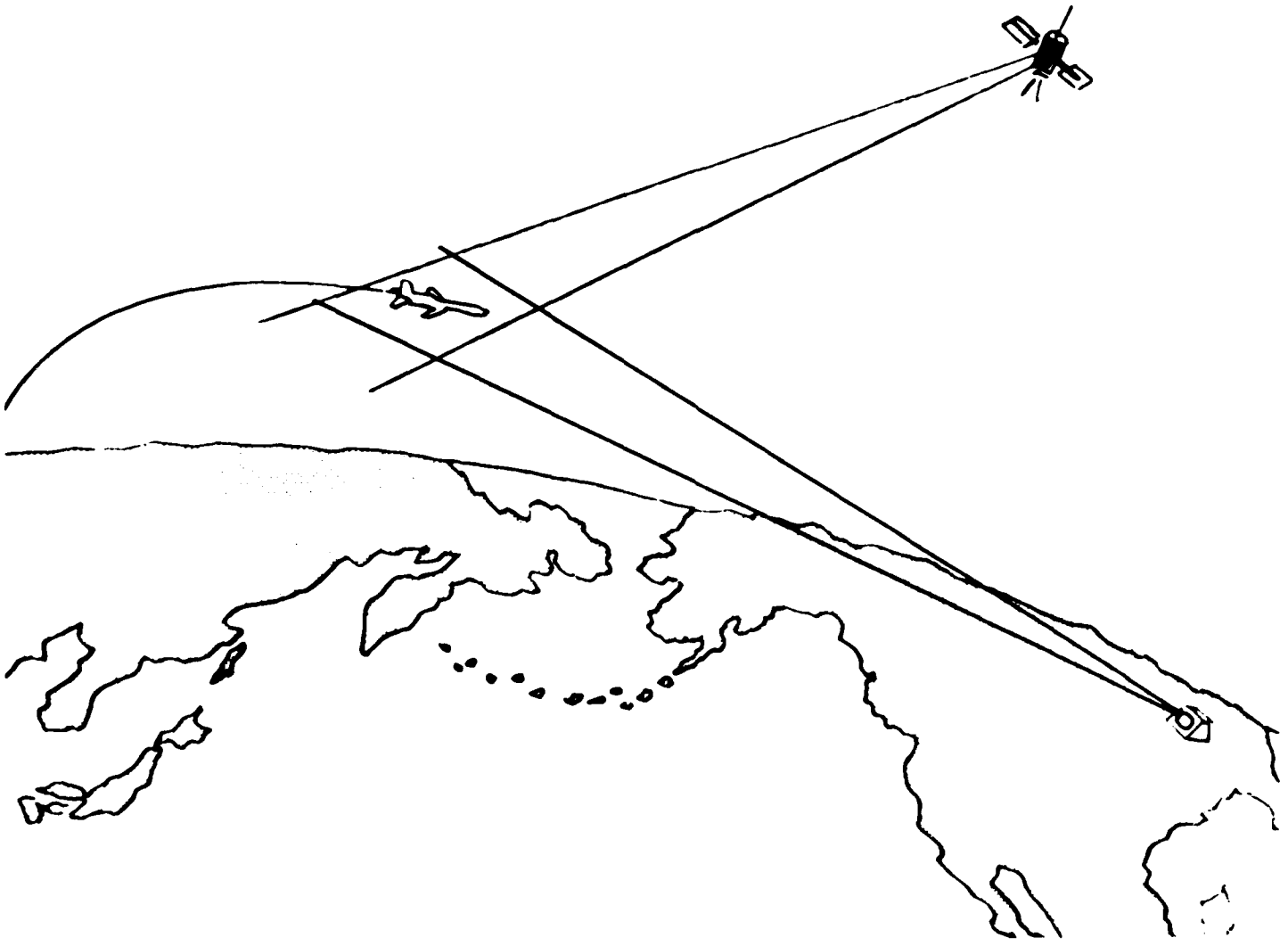
# TPO 2 - RECONNAISSANCE/INTELLIGENCE

INTEGRATED INTELLIGENCE PRODUCTS AND PRECISION LOCATION INFORMATION TO SUPPORT A.F. COMMAND, CONTROL AND STRIKE

MAJOR TECHNOLOGY THRUSTS:

- ACTIVE TARGET LOCATION
- INTELLIGENCE DATA CORRELATION/FUSION
- GUIDANCE & STRIKE PRODUCTS FROM IMAGERY EXPLOITATION

# TPO 3 - STRATEGIC SYSTEMS



# TPO 3-STRATEGIC SYSTEMS

OBJECTIVE:

PROVIDE SURVEILLANCE & WARNING OF BOMBER/MISSILE ATTACK THROUGH SPACE BASED AND ATMOSPHERIC SURVEILLANCE TO ENHANCE EXECUTION CAPABILITY OF U.S. STRATEGIC OFFENSIVE FORCES

MAJOR TECHNOLOGY THRUSTS:

- SPACE BASED RADAR/CRUISE MISSILE SURVEILLANCE
- INTELLIGENCE /SPECIAL RADARS
- ELECTRO-OPTICAL SURVEILLANCE
- DUCTED IONOSPHERIC PROPAGATION

# TPO 4-TECHNOLOGY

INFORMATION PROCESSING

SURVEILLANCE

SOLID STATE DEVICES

TECH
BASE

COMMUNICATIONS

RECONNAISSANCE /
INTELLIGENCE

ELECTROMAGNETICS

RELIABILITY,

MAINTAINABILITY, & COMPATIBILITY

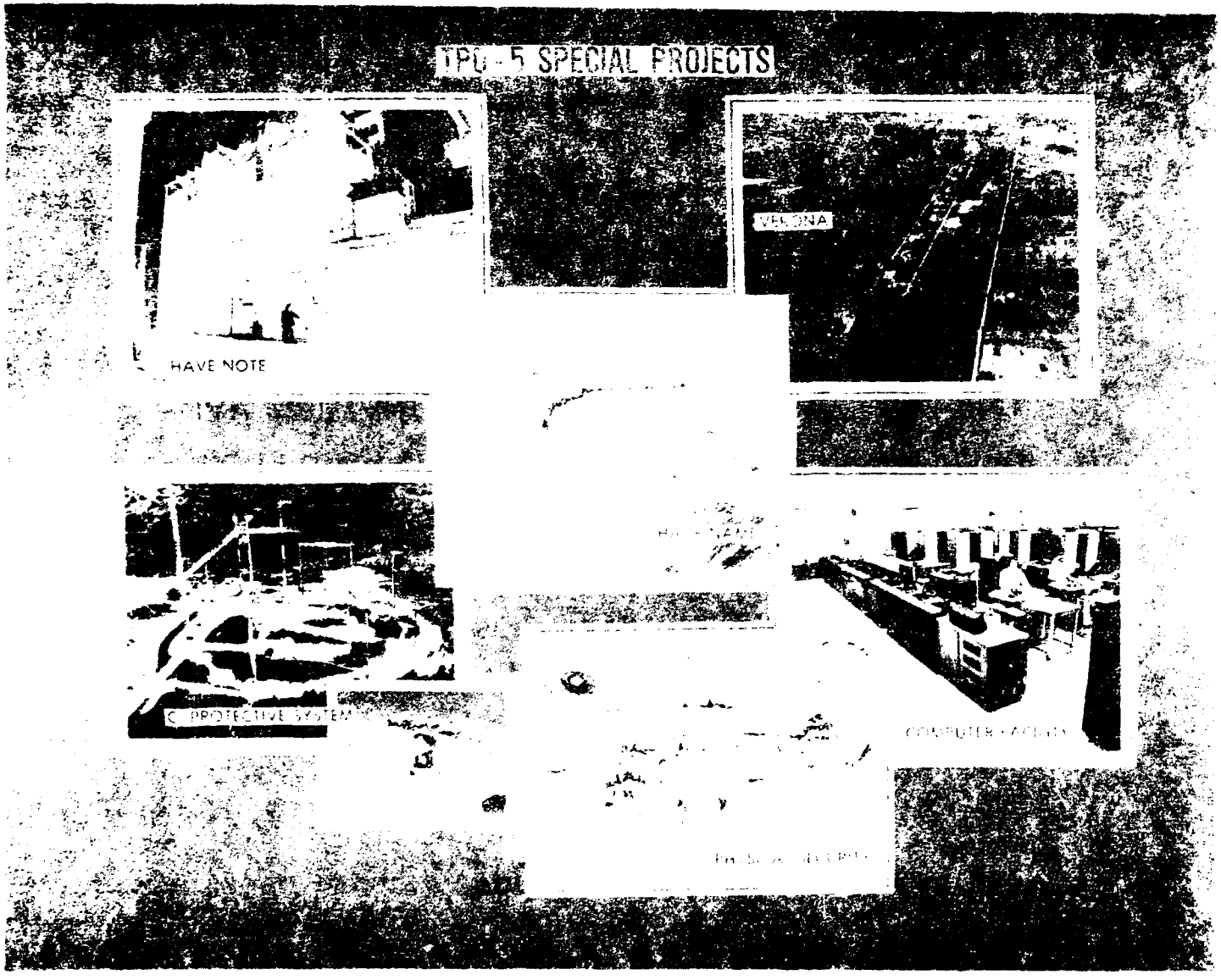
# TPO 4-TECHNOLOGY

OBJECTIVE:

TO PROVIDE A BROAD SCIENTIFIC & ENGINEERING FOUNDATION FOR THE DEVELOPMENT OF AIR FORCE $C^3I$ SYSTEMS

MAJOR TECHNOLOGY THRUSTS:

- HIGH POWER MICROWAVE AMPLIFIERS & TRANSMITTERS
- JAM RESISTANT DATA LINKS
- CONFORMAL ANTENNA ARRAYS
- SURVIVABLE SOLID STATE DEVICES
- HIGH DATA RATE DIGITAL RECORDERS
- RELIABILITY, MAINTAINABILITY & COMPATIBILITY ANALYSIS & PREDICTION
- SURVIVABLE & INTEROPERABLE DATA PROCESSING


TPQ-5 SPECIAL PROJECTS
HAVE NOTE
VELCRO

# TPO 5-SPECIAL PROJECTS

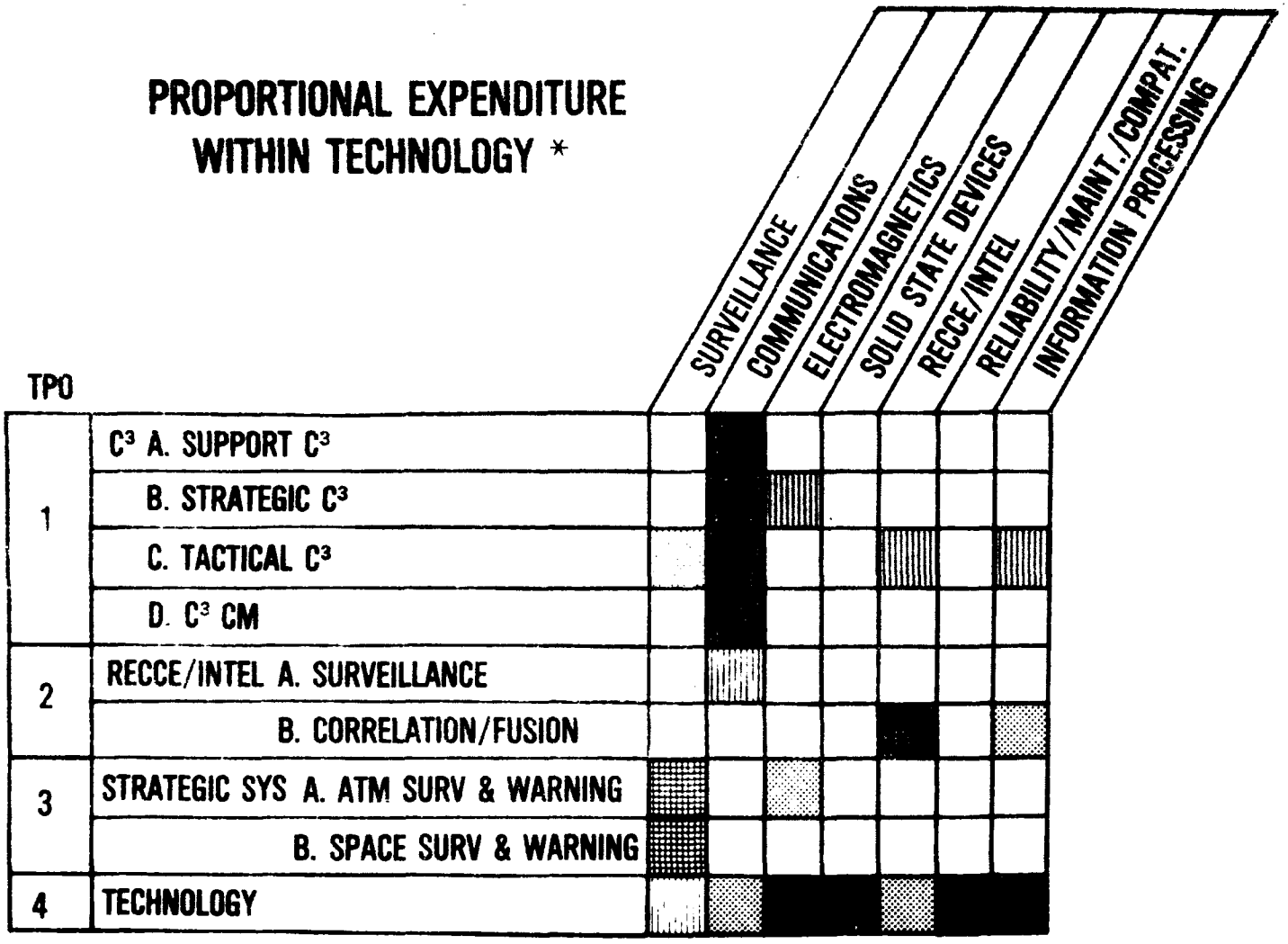
OBJECTIVES:

- DEVELOP METHODOLOGY & DATA ACQUISITION/ANALYSIS FACILITIES ESSENTIAL FOR EVALUATION OF $C^3$ AND PROTECTIVE SYSTEMS/EQUIPMENT
- PROVIDE SUPPORT TO PROJECTS UNIQUE TO RADC AREAS OF EXPERTISE

MAJOR TECHNOLOGY THRUSTS:

- TECHNIQUES & SYSTEMS EVALUATION FACILITIES
- PHYSICAL SECURITY
- HAVE NAME

# PROPORTIONAL EXPENDITURE WITHIN TECHNOLOGY *

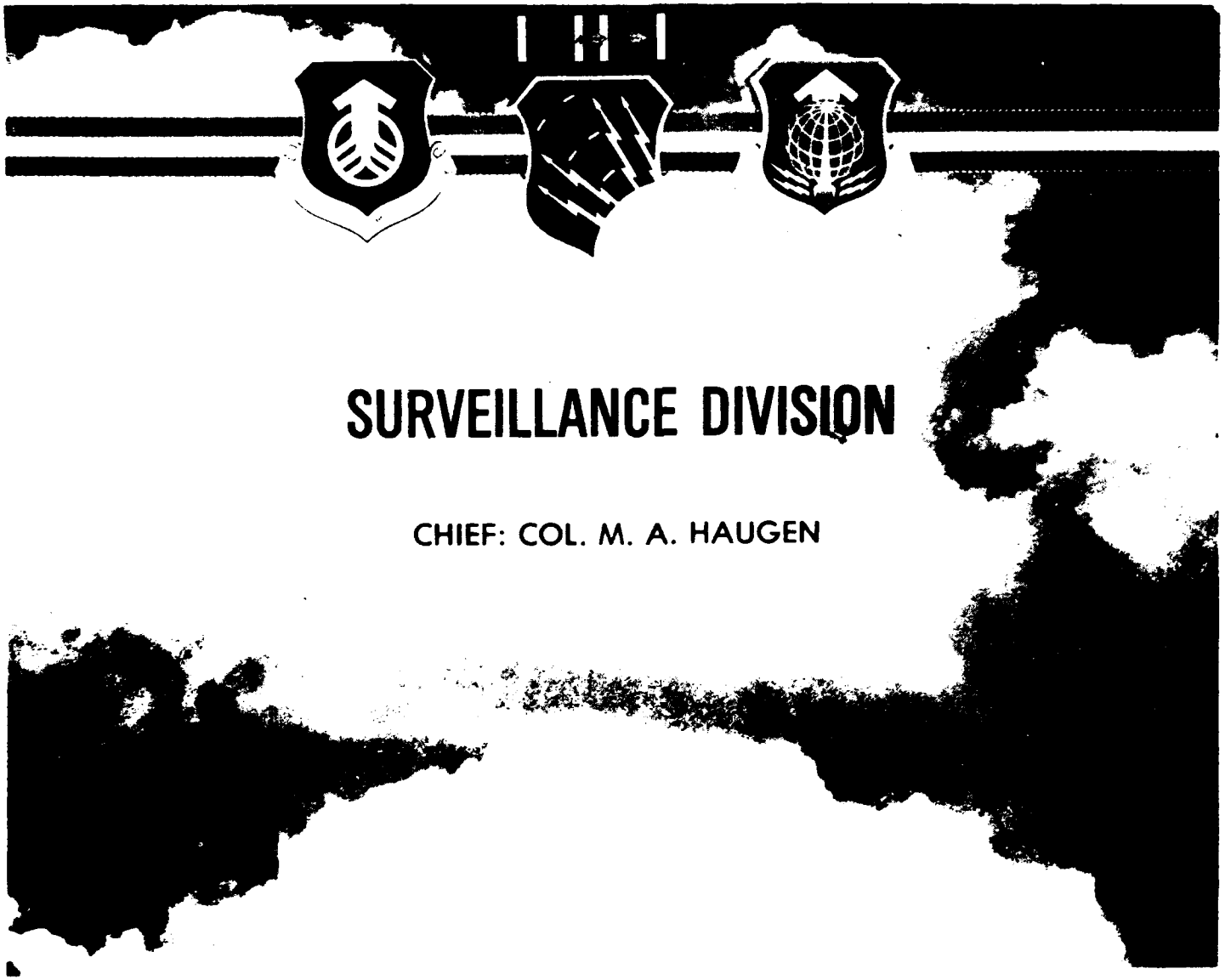



* BASED ON $ SPENT

LARGE EXPENDITURE

MODERATE

SMALL



# SURVEILLANCE DIVISION

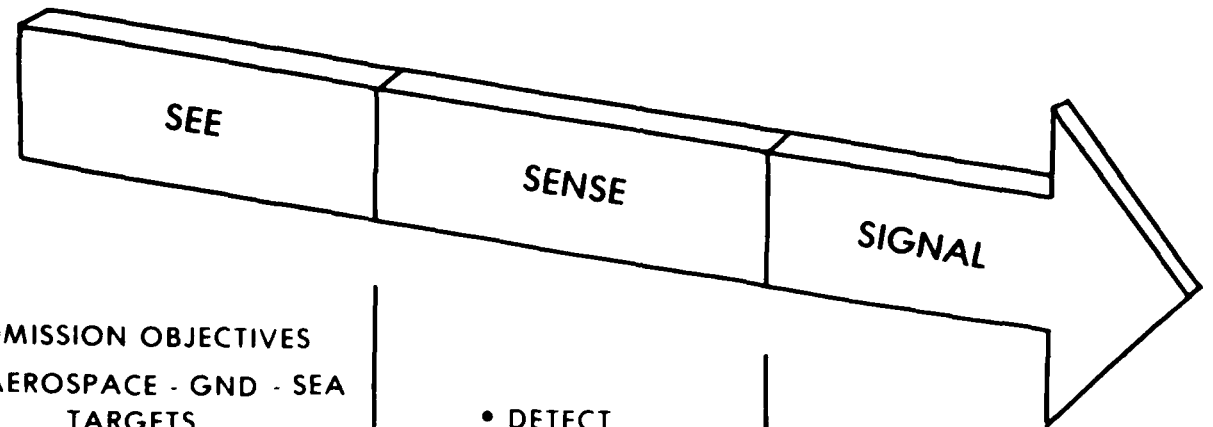
CHIEF: COL. M. A. HAUGEN

# DIVISION MISSION

PLAN & CONDUCT RESEARCH, EXPLORATORY & ADVANCED DEVELOPMENT PROGRAMS IN $C^3$ TECHNICAL FIELDS CONSISTENT WITH OVERALL $C^3$ TECHNOLOGY NEEDS OF AIR FORCE.

CONDUCT SPECIAL STUDIES & ANALYSIS FOR TACTICAL SURVEILLANCE, STRATEGIC SURVEILLANCE & SURVEILLANCE TECHNOLOGY.

# SURVEILLANCE /sər-'vā-lən(t)s/ n. [F] to watch over




- MULTIMISSION OBJECTIVES
  - AEROSPACE - GND - SEA TARGETS
- PLATFORM VARIETY
  - GROUND - AIR - SPACE
- MULTIPLE SENSOR TYPES
  - FULL SPECTRUM

- DETECT
- TRACK
- DISCRIMINATE
- IDENTIFY

PROVIDE TIMELY:

- WARNING
  STRATEGIC/TACTICAL
- FORCE MANAGEMENT INFO
  - ALLOCATION
  - ENGAGEMENT

# SURVEILLANCE DIVISION ACTIVITIES

OUTLINE:

- ADVANCED TACTICAL SURVEILLANCE
  - DETECTION - DISCRIMINATION - BATTLE MGT
- STRATEGIC SURVEILLANCE
  - DETECTION - WARNING
- SURVEILLANCE TECHNOLOGY
  - PROCESSES - THERMIONICS

# ADVANCED TACTICAL SURVEILLANCE

KEY/RELATED ELEMENTS

- RADAR INTERNETTING
- ADVANCED AIRBORNE SURVEILLANCE RADAR
- ADVANCED TACTICAL RADAR
- AIRCRAFT IDENTIFICATION

# RADAR INTERNETTING

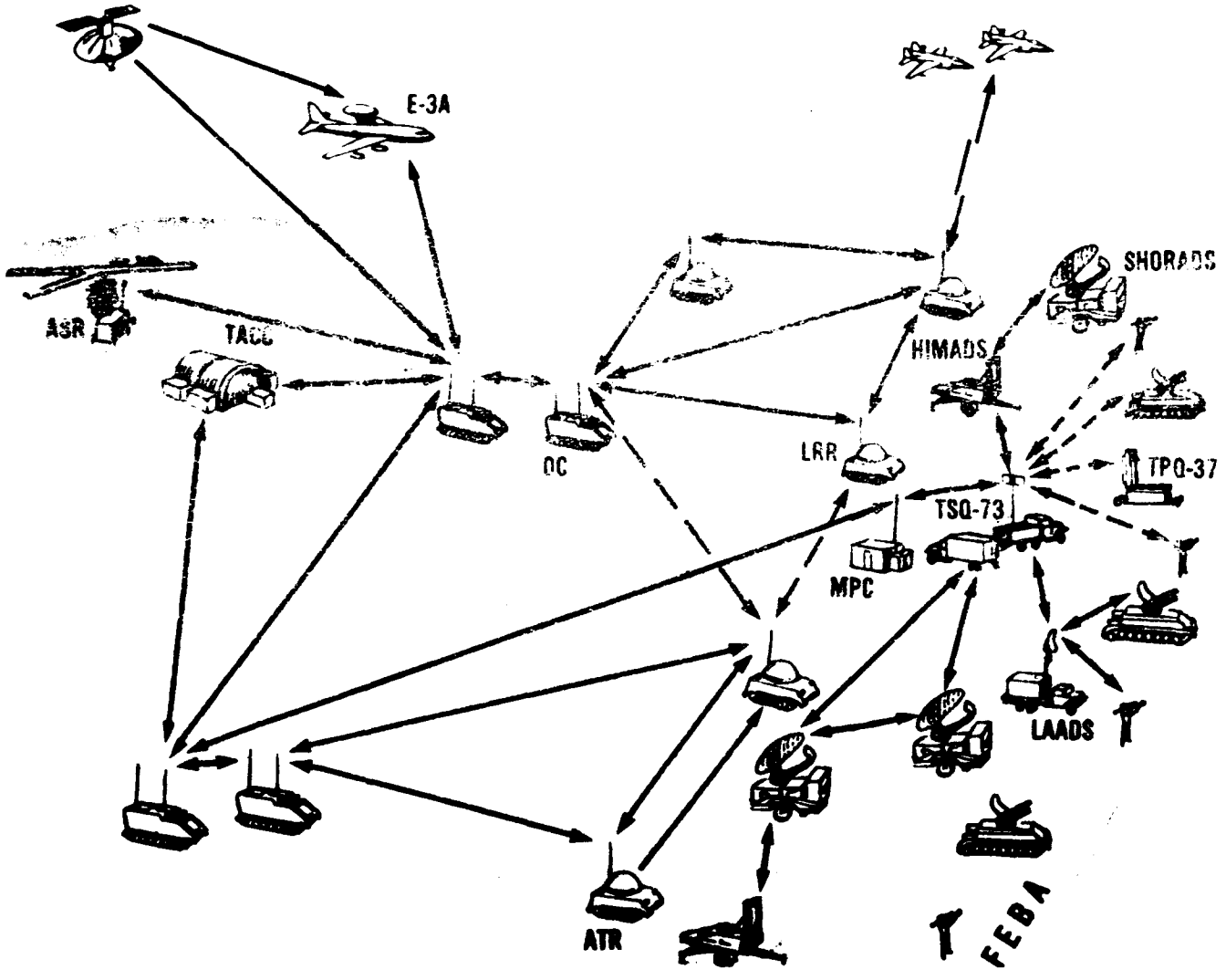
OBJECTIVE: IMPROVED TACTICAL SURVEILLANCE SYSTEM, LOW LEVEL COVERAGE, TARGET HANDLING & SURVIVABILITY

APPROACH: SIMULTANEOUS TRACK OF 1,000 TARGETS
COVERAGE TO 200 FEET AGL
ECCM, ANTI-ARM IMPROVEMENT
6.3 FY 82 - TRANSFER TO SPO FY 88

START DATE/DURATION: FY 82 7 YEARS

FUNDS (TOTAL 6.3): $10M

# SURVEILLANCE SYSTEM INTERNETTING



# RADAR INTERNETTING

OPTIMIZE SENSOR DATA UTILIZATION

- SIMULATION/EMULATION
- ADAPTIVE PROCESSING
- ADVANCED TRACKING VIA ARRAY PROCESSING
- DATA EXTRACTION

EXPLOIT IMPROVED ID TECHNIQUES

- MULTI-SENSOR TECHNIQUES
- PASSIVE
- ACTIVE

DEVELOP QUADRAPHASE MODEMS

- IMPROVED MESSAGE STANDARDS/ERROR CORRECTION
- DATA HANDLING & TRANSFER TECHNIQUES

IMPROVE SURVIVABILITY

- MODULARITY
- ENERGY MANAGEMENT

# ADVANCED AIRBORNE SURVEILLANCE RADAR

OBJECTIVE: ENHANCED CAPABILITY FOR E-3A RADAR:

SURVIVABILITY FROM ARMs

UPGRADED AIRCRAFT TRACKING

APPROACH: INVESTIGATIONS IN CRITICAL AREAS FY 82

FABRICATION OF CRITICAL EQUIPMENT FY 83

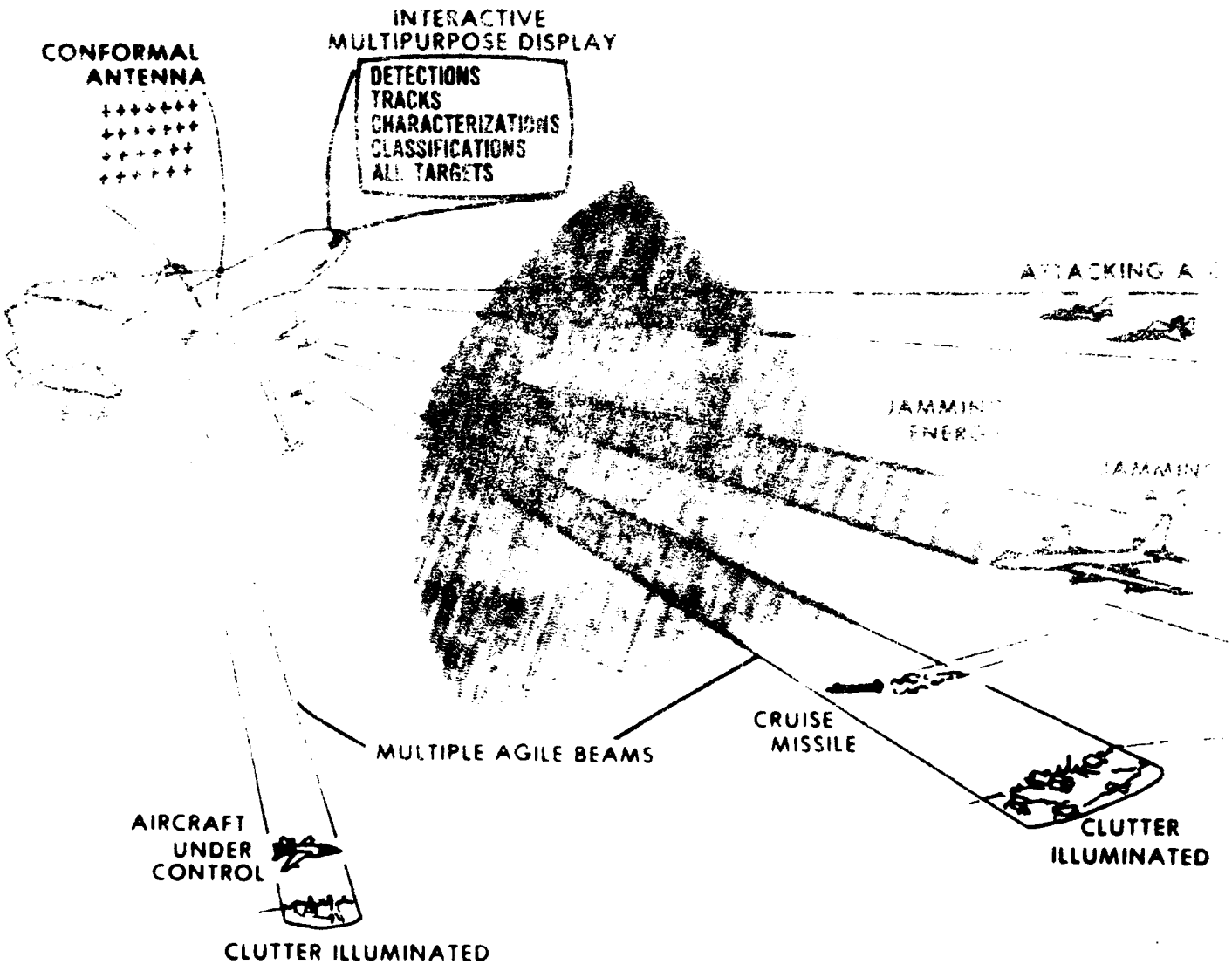
FABRICATION OF LABORATORY MOCKUP & TESTING FY 85

TRANSITION TO SPO FOR ADVANCED MODEL & AIRBORNE TESTS FY 87

START DATE/DURATION: FY 82 5 YEARS

FUNDS (TOTAL 6.3): $4.6M

# ADVANCED AIRBORNE SURVEILLANCE RADAR



# ADVANCED E3A RADAR TECHNOLOGY

APPROACH:

ESTABLISH POST- 1990 THREAT

EXPLOIT NEW TECHNOLOGY

- ADAPTIVE, AGILE, MULTIPLE BEAMS
- SOLID STATE TRANSMIT-RECEIVE MODULES
- VHSI TECHNIQUES FOR:
  - OVERALL SENSOR CONTROL
  - ADAPTIVE PROCESSING
  - WAVEFORM CONTROL
- MULTISTATIC & ESM - SURVIVABILITY

SENSOR CANDIDATE DECISIONS

DESIGN, FABRICATION & TEST OF CRITICAL SUBSYSTEMS

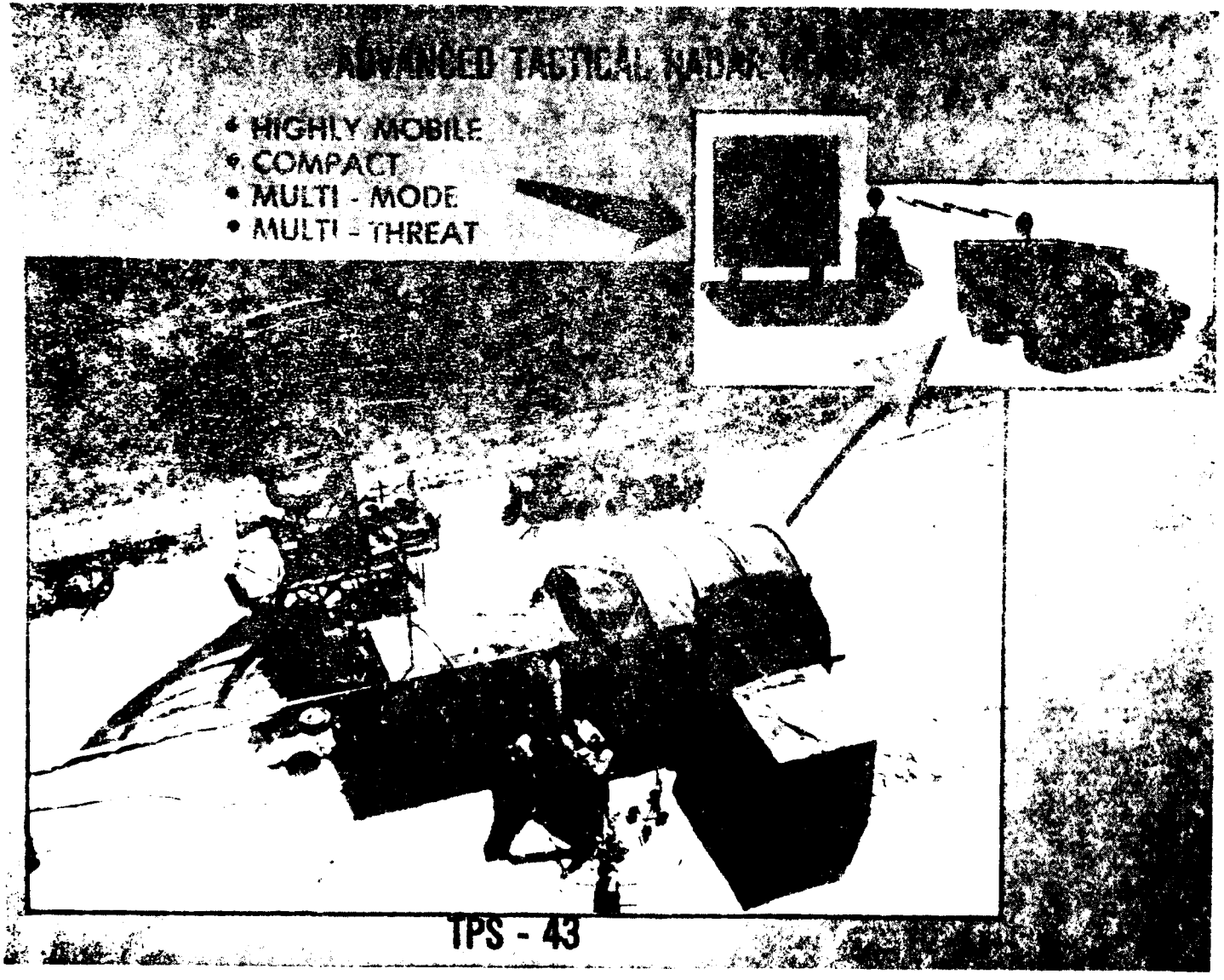
# ADVANCED TACTICAL RADAR

OBJECTIVE — DEVELOP ADVANCED TACTICAL RADAR TO MEET THE MULTI THREAT ENVIRONMENT OF 1990's

APPROACH — DESIGN, FABRICATE AND FULLY TEST TWO ADVANCED TACTICAL RADAR DIVERGENT DESIGN (S-BAND, C-BAND) RADAR MODELS

START DATE/DURATION: FY82 - 86

FUNDS (TOTAL FY82 - 86) 15.2M


ADVANCED TACTICAL RADAR
• HIGHLY MOBILE
• COMPACT
• MULTI - MODE
• MULTI - THREAT
TPS - 43

# AIRCRAFT IDENTIFICATION

AF PROBLEMS BEING ADDRESSED:

- TIMELY AND OPTIMUM ALLOCATION OF AIR WEAPON RESOURCES FOR AIR COMMAND AND CONTROL FUNCTIONS

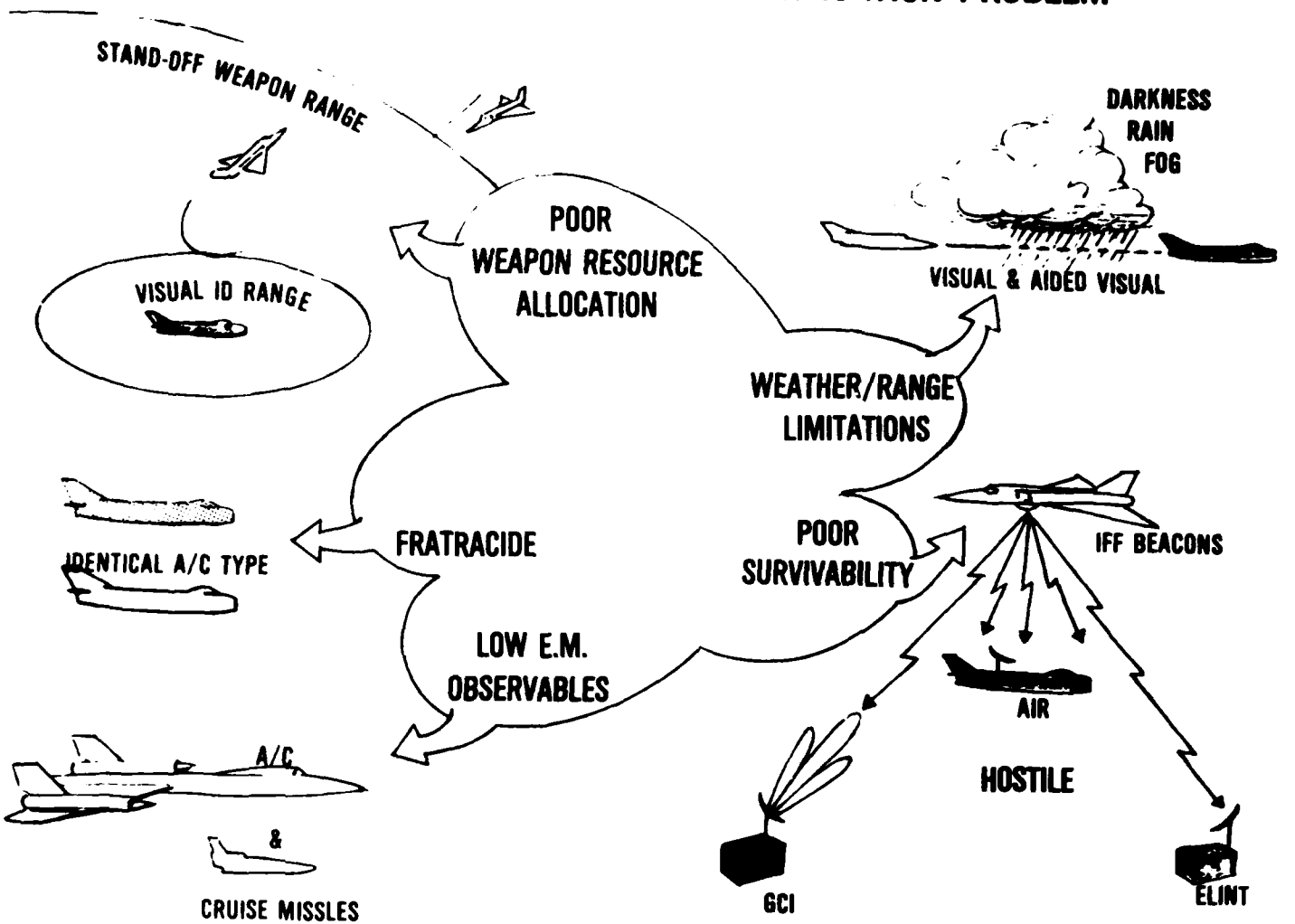
SPECIFIC OBJECTIVE:

- PROVIDE REAL TIME, ALL WEATHER, DAY/NIGHT, LONG RANGE IDENTIFICATION & CLASSIFICATION OF HOSTILE AND FRIENDLY AIRCRAFT

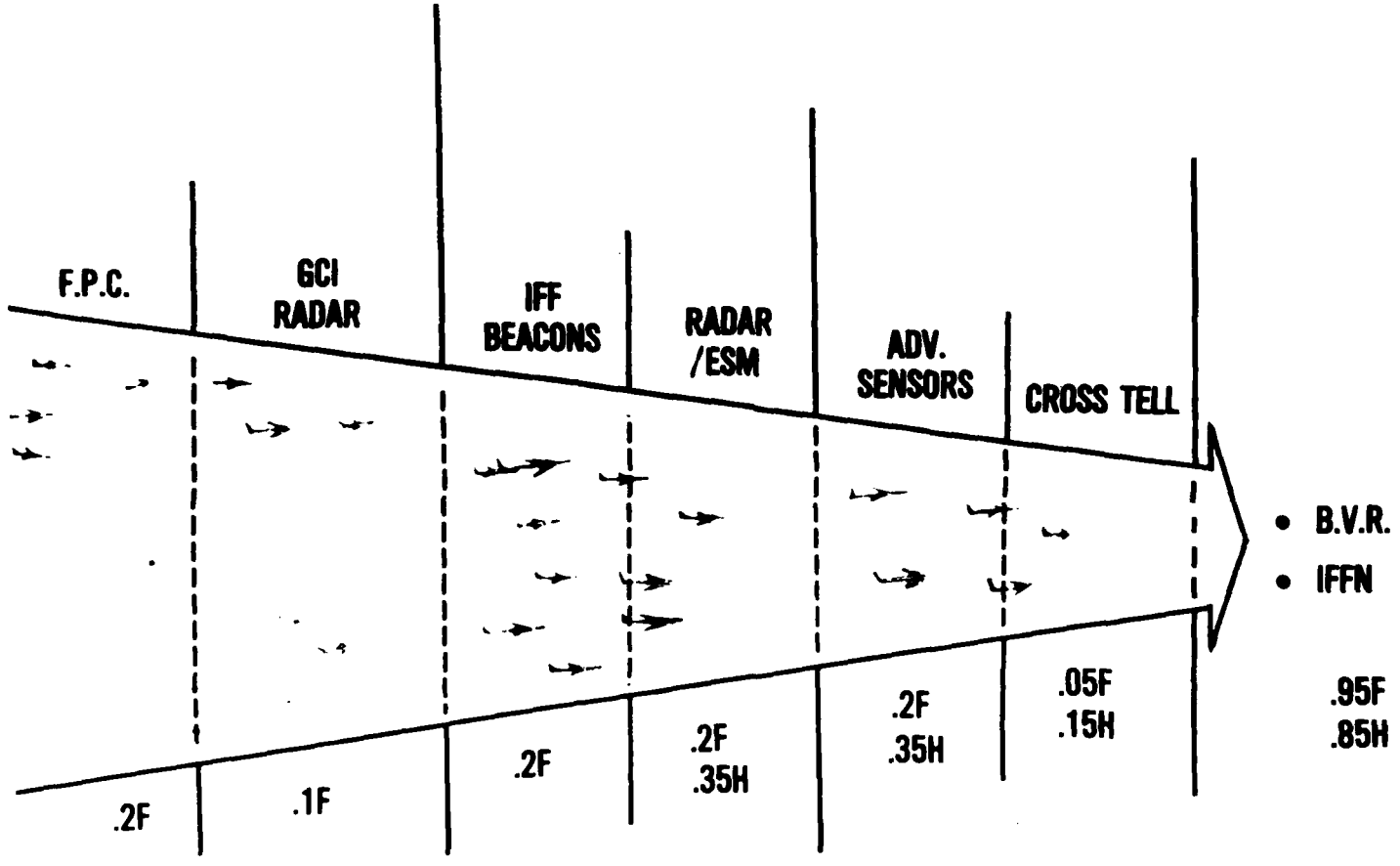
APPROACH:

- UTILIZATION OF COHERENT WIDEBAND RADAR DATA FOR SIZE & SHAPE
- OPTIMUM QUIET IDENTIFICATION CONCEPT FOR OWNERSHIP
- REAL TIME INTERACTIVE PROCESSING
- MULTI FUNCTION RADAR CONCEPTS
- MULTIPLE SENSOR SYNERGISM

# ASSESSMENT OF AIRCRAFT IDENTIFICATION PROBLEM



# RATIONALE FOR MULTI-SENSOR APPROACH



# STRATEGIC SURVEILLANCE

HIGH PRIORITY ACTIVITIES:

- SPACE BASED RADAR
  - GLOBAL, ALL WEATHER COVERAGE
  - MULTI- MISSION
- CRUISE MISSILE SURVEILLANCE
  - STRESSING THREAT
    - LOW - SLOW- SMALL
  - MULTI- SPECTRAL, MULTI-SENSOR

# SPACE BASED RADAR

**OBJECTIVE:** INVESTIGATE CRITICAL TECHNOLOGIES & SYSTEM CONCEPTS FOR GLOBAL, MULTI-MISSION SPACE BASED RADAR

**APPROACH:** SYSTEM-SUBSYSTEM CONCEPTUAL/DESIGN ANALYSIS
- SIMULATION MODELING

LARGE APERTURE, PHASED ARRAY CONCEPTS

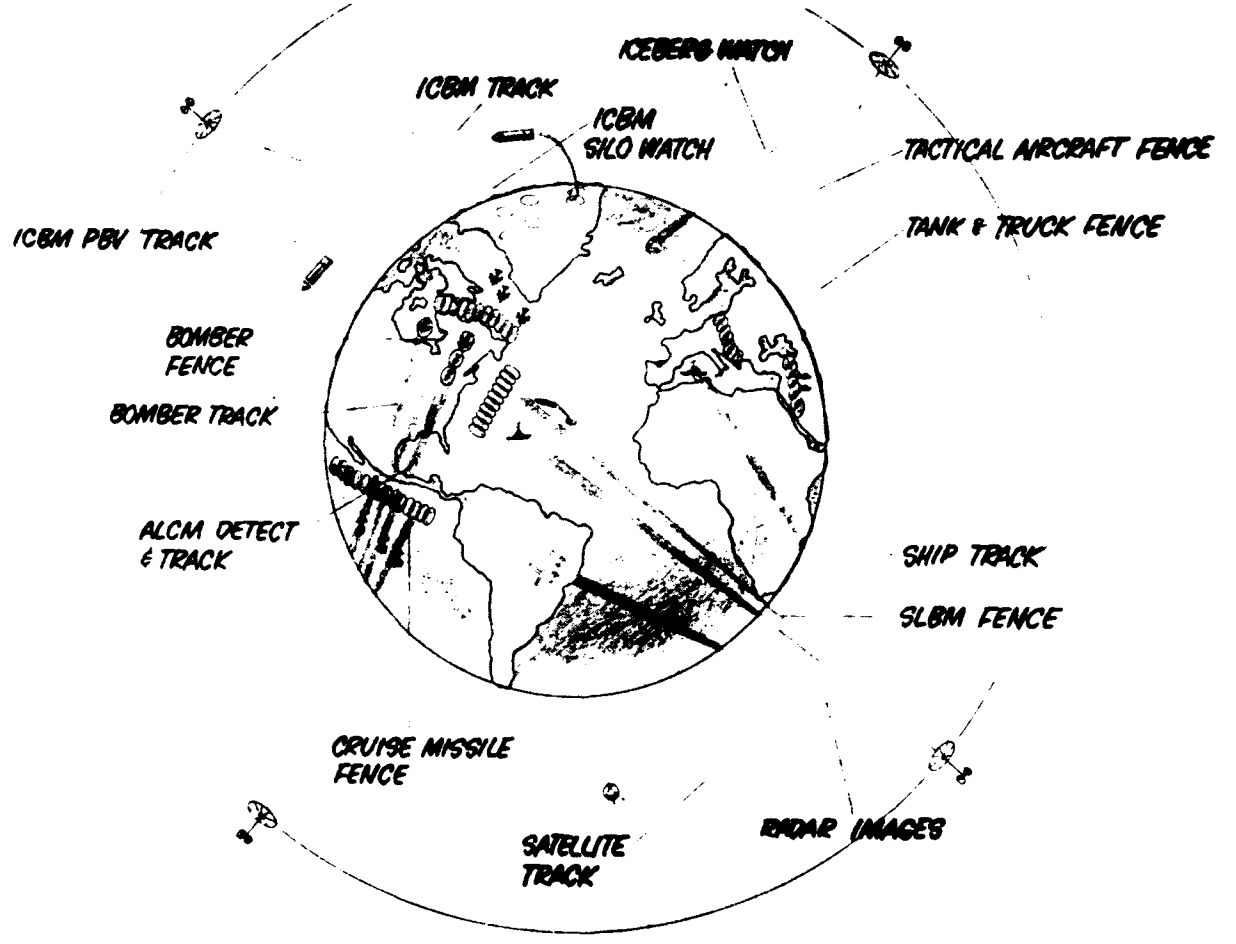
ADVANCED ON-BOARD SIGNAL PROCESSING

SOLID STATE TRANSMIT/RECEIVE MODULES

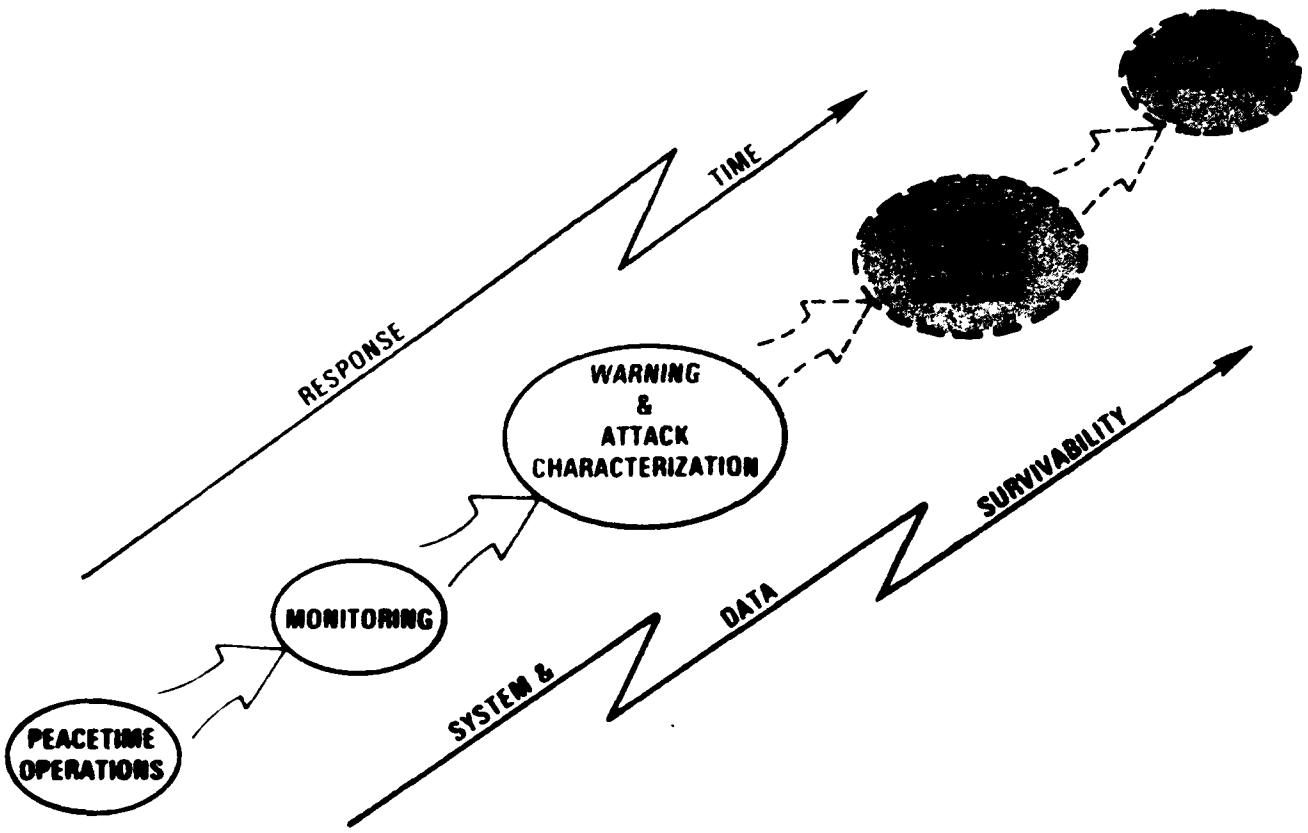
**TIMELINE:** ON-GOING

**TOTAL FUNDING** (FY81-83) **$38M**

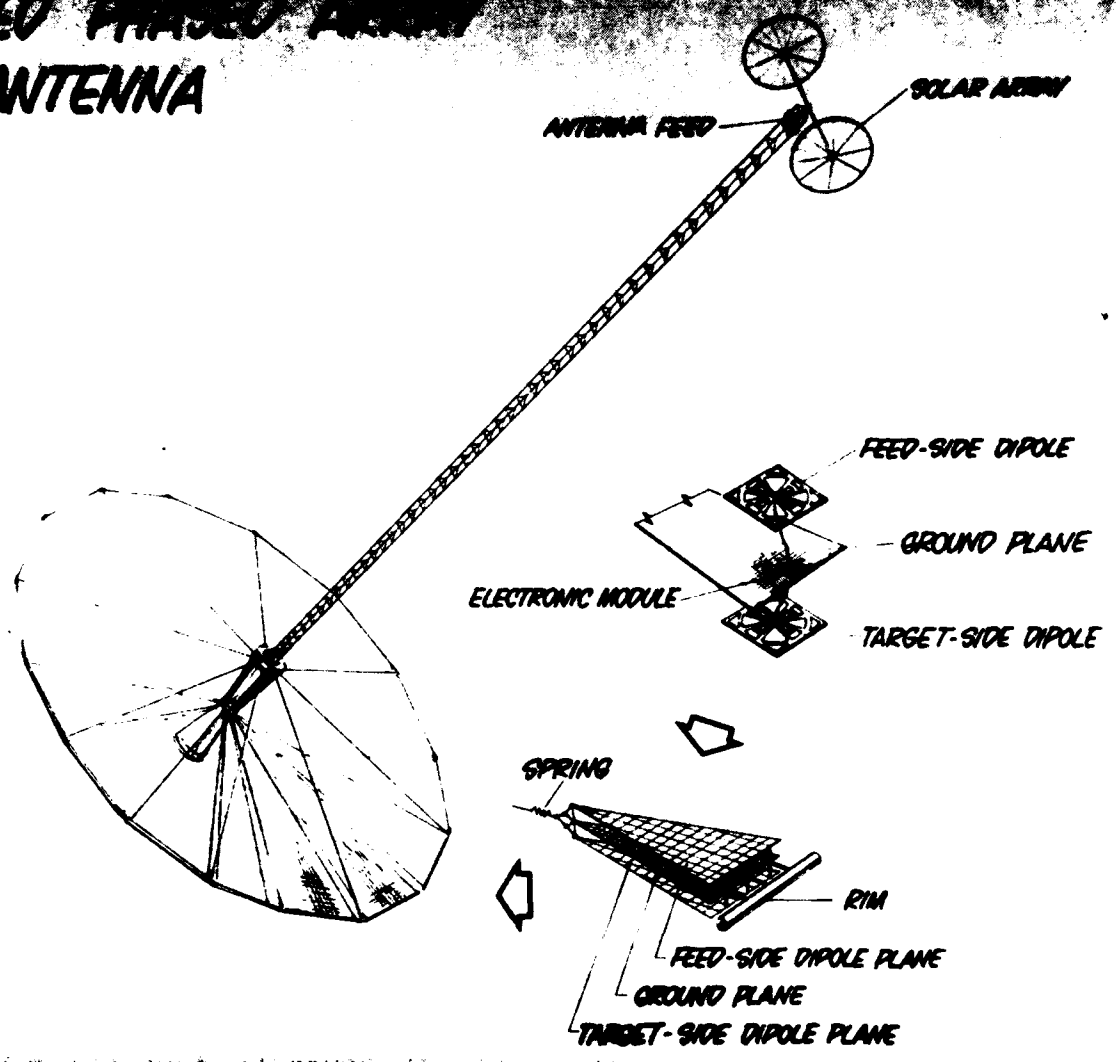
# SPACED - BASED RADAR MULTI-MISSION OPERATION



# SPACED-BASED RADAR MISSION AREAS



## SBR ANTENNA


SOLAR ARRAY
ANTENNA FEED
FEED-SIDE DIPOLE
GROUND PLANE
ELECTRONIC MODULE
TARGET-SIDE DIPOLE
SPRING
RIM
FEED-SIDE DIPOLE PLANE
GROUND PLANE
TARGET-SIDE DIPOLE PLANE

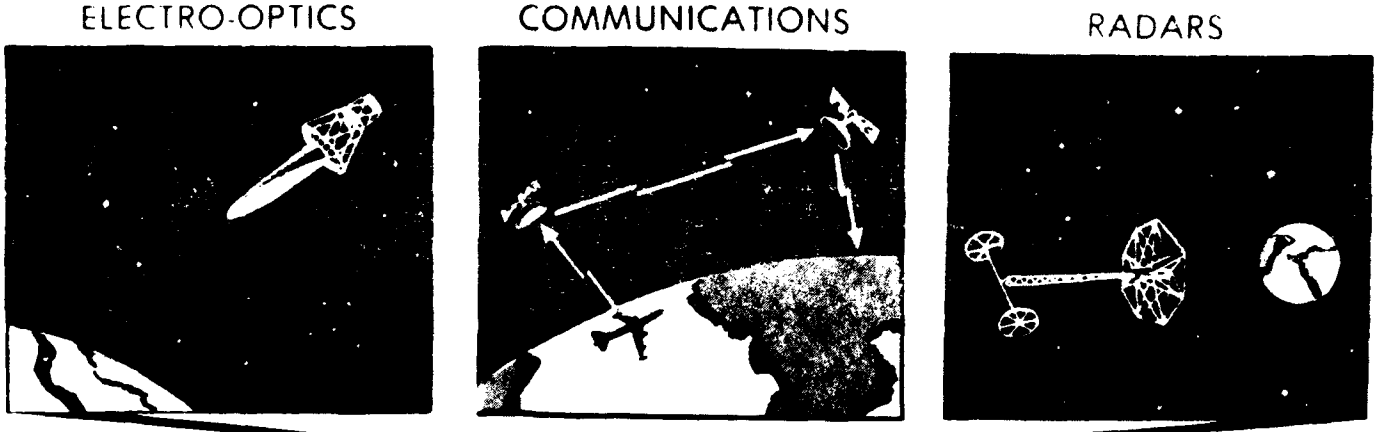
# RF SYSTEMS IN SPACE

OBJECTIVE: DEVELOP/IMPROVE SYSTEM/SUBSYSTEM ANALYTICAL CAPABILITIES
- ALTERNATIVE SPACE BASED RADAR CONCEPTS

APPROACH: MULTI-TASK
- RF SUBSYSTEM PERFORMANCE ANALYSES
  - LARGE APERTURE PHASED ARRAYS
  - CALIBRATION - COMPENSATION TECHNIQUES
- GROUND TEST PROCEDURES DESIGN
- SURVIVABILITY ANALYSIS

START/DURATION: JAN 81 / 18 MONTHS

# ADVANCED ONBOARD SIGNAL PROCESSOR (AOSP)




- VHSI TECH
- RADIATION
- SOFTWARE ENGINEERING
- FAULT TOLERANCE

**AOSP TECHNOLOGY PROGRAM**

- 100 W
- 5 YEAR LIFE

- MULTIMISSION
  - —ADAPTIVE PROGRAMMABLE
  - —HIGH PERFORMANCE
- SURVIVABLE SYSTEMS
  - —AUTONOMOUS OPERATION

# TRANSMIT/RECEIVE MODULE IMPACT

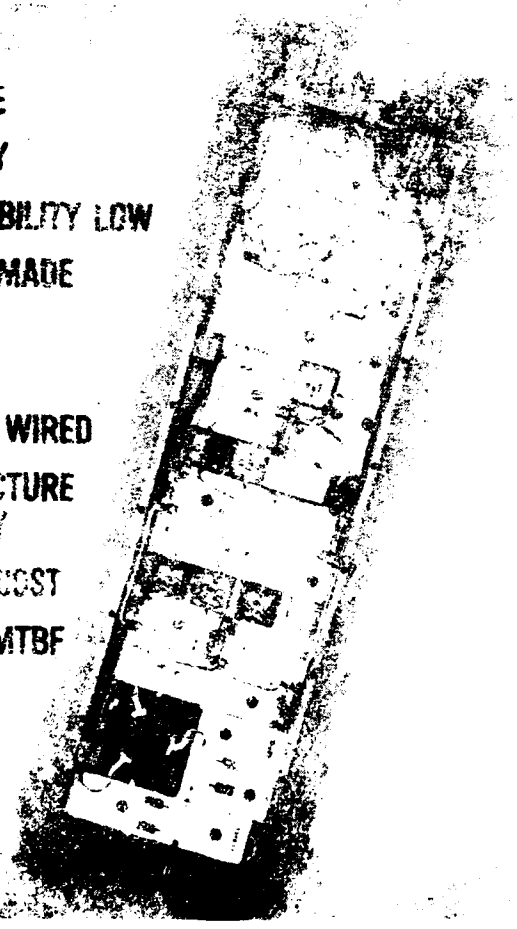
## 1979

MODULE

- LARGE
- HEAVY
- RELIABILITY LOW
- HANDMADE

SYSTEM

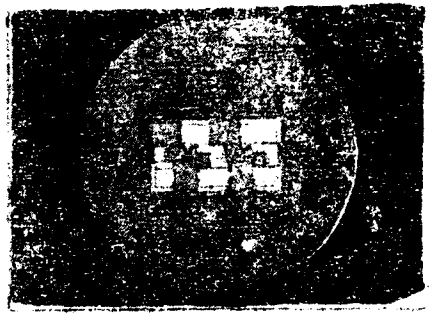
- HARD WIRED
- STRUCTURE HEAVY
- HIGH COST
- LOW MTBF



## 1985

MODULE

- LIGHT
- INTEGRATED LOGIC
- ADAPTIVE
- MASS PRODUCTION



SYSTEM

- FLEXIBLE
- LOW COST
- LIGHTWEIGHT
- HIGH MTBF

# CRUISE MISSILE (CM) SURVEILLANCE

OBJECTIVE: COST-EFFECTIVE WARNING SYSTEM OPTIONS FOR DETECTION, TRACKING & IDENTIFICATION OF PROJECTED CM THREATS

APPROACH: MULTISTATIC RADAR CONCEPTS
ESM/RADAR INTEGRATION
SENSOR CUEING
6.3 DEMONSTRATIONS & VALIDATION FY 83 - 85

START DATE/DURATION: FY 82 5 YEARS

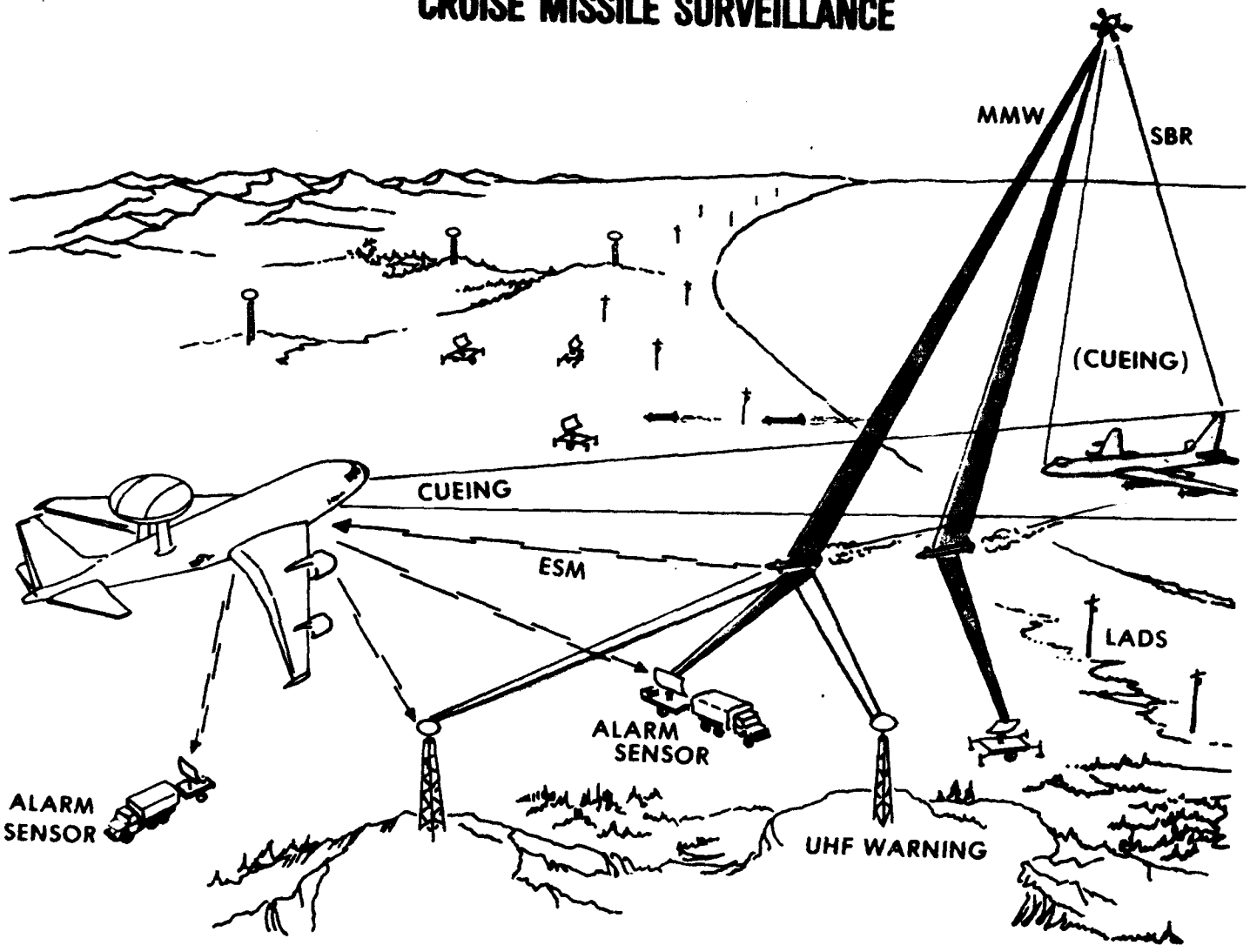
FUNDS (TOTAL): $7.4M

# CRUISE MISSILE SURVEILLANCE

OBJECTIVES:

- PROVIDE WARNING OPTIONS PRIOR TO USSR DEPLOYMENT OF ADP-IV, TOMAHAWK VARIANT
- PROVIDE THEATER WARNING CONSISTENT WITH ENGAGEMENT CAPABILITY
- ADDRESS STRATEGIC WARNING REQUIRED BY ADVANCED AIR DEFENSE CONCEPTS

# CRUISE MISSILE SURVEILLANCE



# CRUISE MISSILE SURVEILLANCE

APPROACH:

TOTAL EXPLOITATION OF ALL POSSIBLE E. M. OBSERVABLES TO NULLIFY PENETRATION

- VHF/UHF MULTISTATICS
- ALARM SENSOR
- ESM AUGMENTATION
- MMW

MULTIPLE SENSOR CONCEPTS EMPLOYING CUEING BASED ON ASM CARRIER TRACK INFORMATION

MISSION ANALYSIS

DEMONSTRATION & VALIDATION

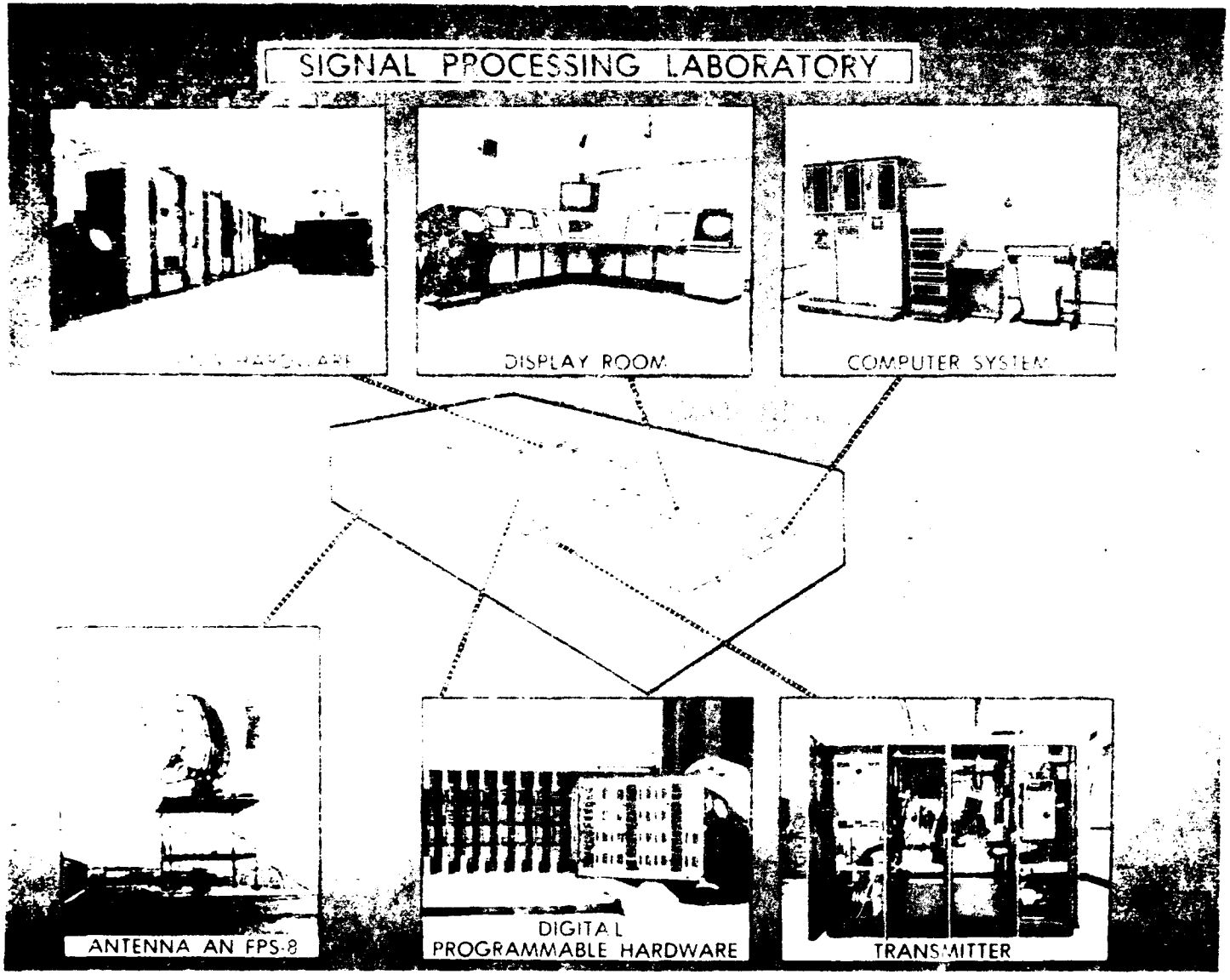
# SURVEILLANCE TECHNOLOGY

PROCESSES

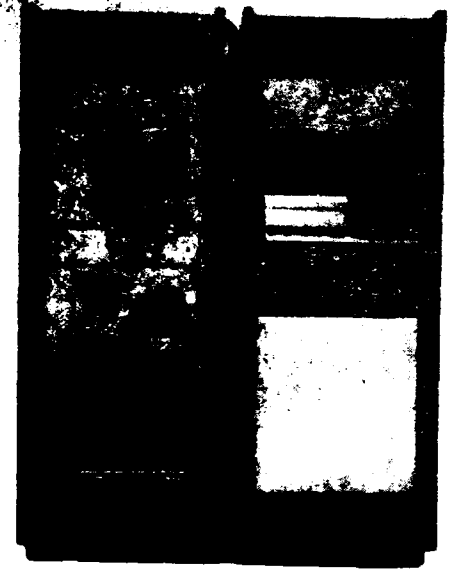
- SIGNAL PROCESSING TECHNIQUES
  - ARCHITECTURE/ALGORITHM DEVELOPMENT
  - PROCESSOR IMPROVEMENT

THERMIONICS

- RADAR/COMMUNICATIONS TUBES
  - ADAPTIVE TRANSMITTERS
    - TUBE
    - SOLID STATE


SIGNAL PROCESSING LABORATORY
DISPLAY ROOM
COMPUTER SYSTEM
ANTENNA AN FPS-8
DIGITAL
PROGRAMMABLE HARDWARE
TRANSMITTER

# SIGNAL PROCESSOR DESIGN CONSTRAINTS



1979

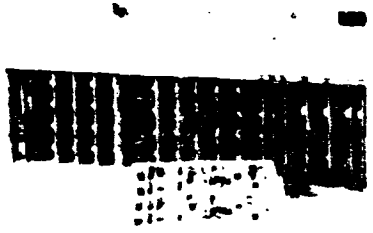
1985

- SIZE
- WEIGHT
- POWER CONSUMPTION
- MTBF
- COOLING
- COST

- SOFTWARE
- TECHNICAL OBSOLESCENCE
- FLEXIBILITY
- GROWTH POTENTIAL

# PROGRAMMABLE ANALOG PROCESSOR

1978

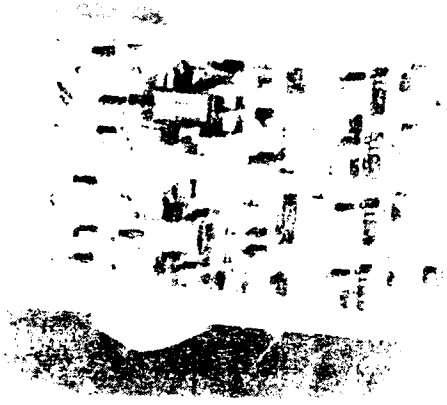


- 50 WATTS
- 1 MHZ SIGNAL BANDWIDTH
- 50dB DYNAMIC RANGE
- HARD-WIRED PROCESSOR

ARCHITECTURAL BREAKTHRUS

- SEQUENTIAL PUSH-PULL
- ADDITIVE REFRESH
- BIPOLAR MOS CIRCUITRY

1985



- <10 WATTS
- 20 MHZ SIGNAL BANDWIDTH
- 60dB DYNAMIC RANGE
- COMPUTER-CONTROLLED FUNCTION

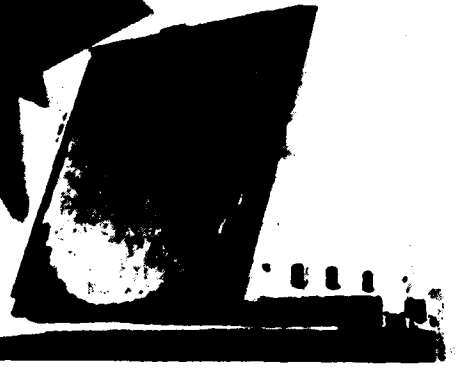
# THERMIONICS TECHNOLOGY PROBLEM

- ULTRA LONG LIFE

- WIDE BANDWIDTH
- LIGHT WEIGHT
- MULTI FUNCTION

R&D

- POWER
- SIGNAL FIDELITY
- BANDWIDTH



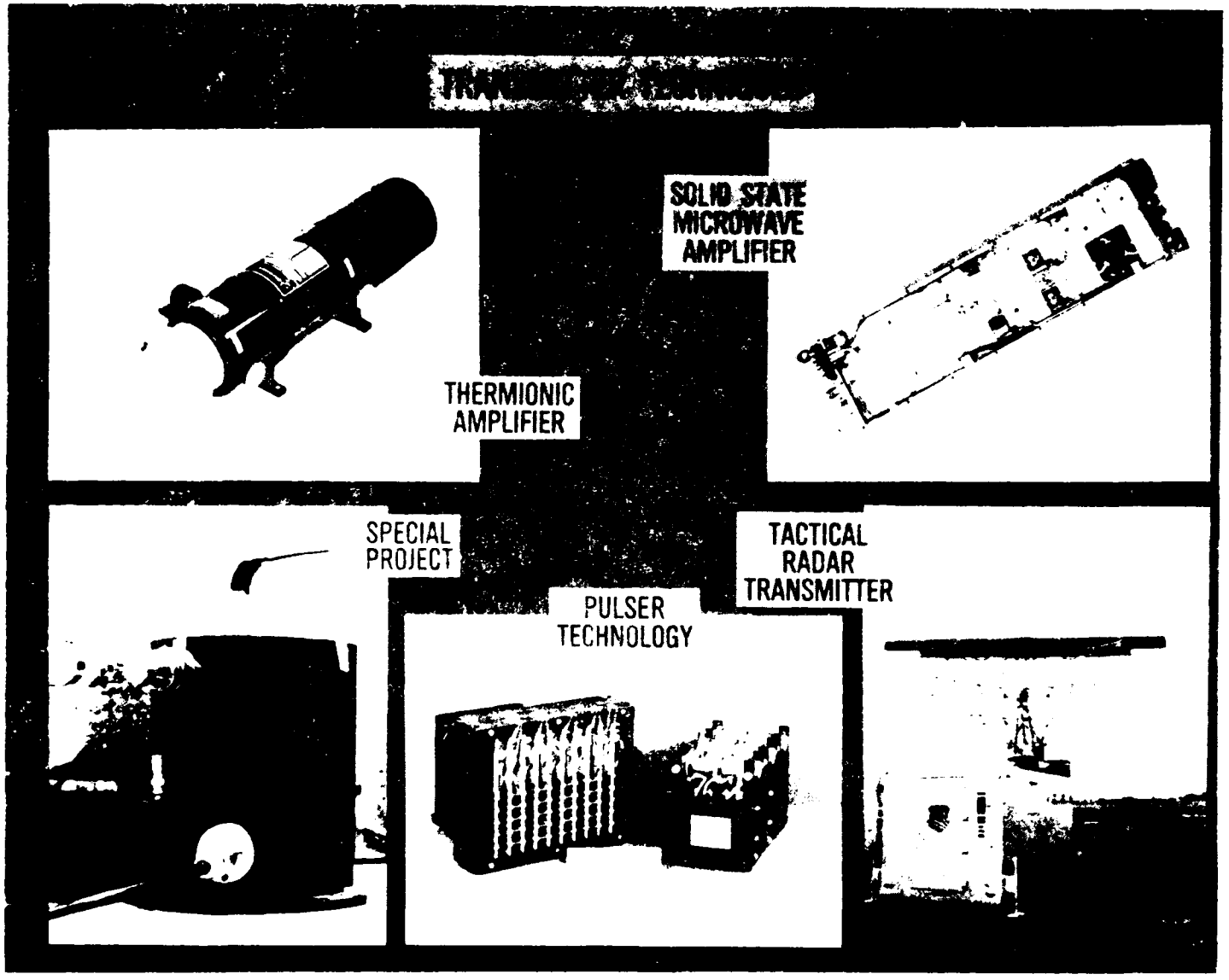
# LIGHTWEIGHT/HIGH EFFICIENCY

GOAL:

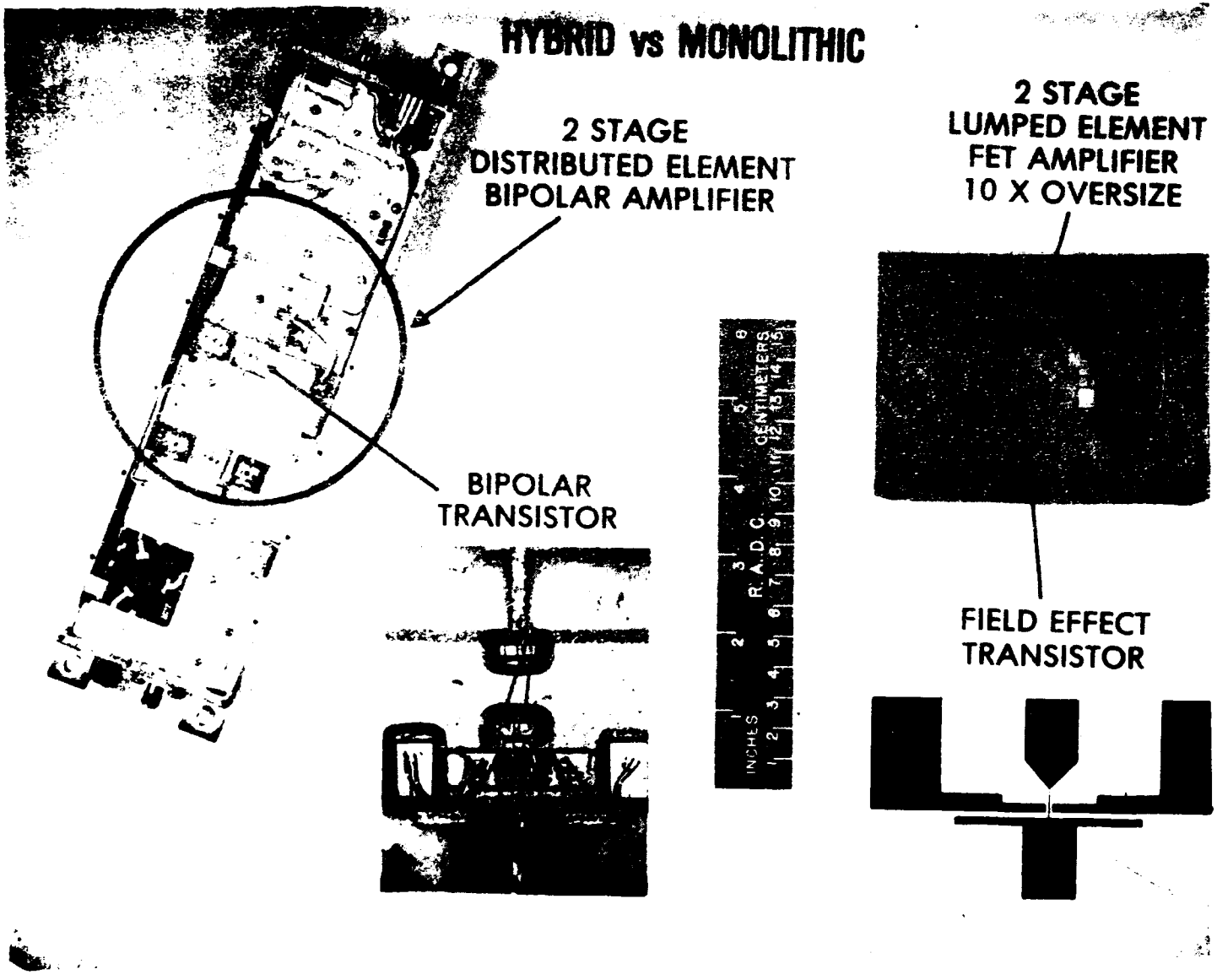
- DEVELOP HIGH POWER TUBE AMPLIFIERS/TRANSMITTERS THAT ARE 20% LIGHTER AND 15% MORE EFFICIENT
- DEVELOP SOLID STATE PHASED ARRAY MODULES WITH A 10:1 REDUCTION IN COST AND WEIGHT

PAYOFF:

- INCREASED SYSTEM SURVIVABILITY/PERFORMANCE VIA:
  - INCREASED MOBILITY
  - LESS FUEL CONSUMPTION
  - REDUCED PRIME POWER REQUIREMENT
  - MULTIFUNCTION OPERATION


SOLID STATE
MICROWAVE
AMPLIFIER
THERMIONIC
AMPLIFIER
SPECIAL
PROJECT
TACTICAL
RADAR
TRANSMITTER
PULSER
TECHNOLOGY

# HYBRID vs MONOLITHIC



SURVEILLANCE DIVISION

MINI-SESSION PRESENTATIONS

TUESDAY, 3 JUNE 1980

RADC - BLDG 106 - AUDITORIUM

1:45 PM SURVEILLANCE ECCM - MR. SHIELDS

AIR CRAFT IDENTIFICATION - MR. WOLF

3:15 PM SPACE BASED RADAR - MR. SIMONS

CRUISE MISSILE SURVEILLANCE - MR. OGRODNIK

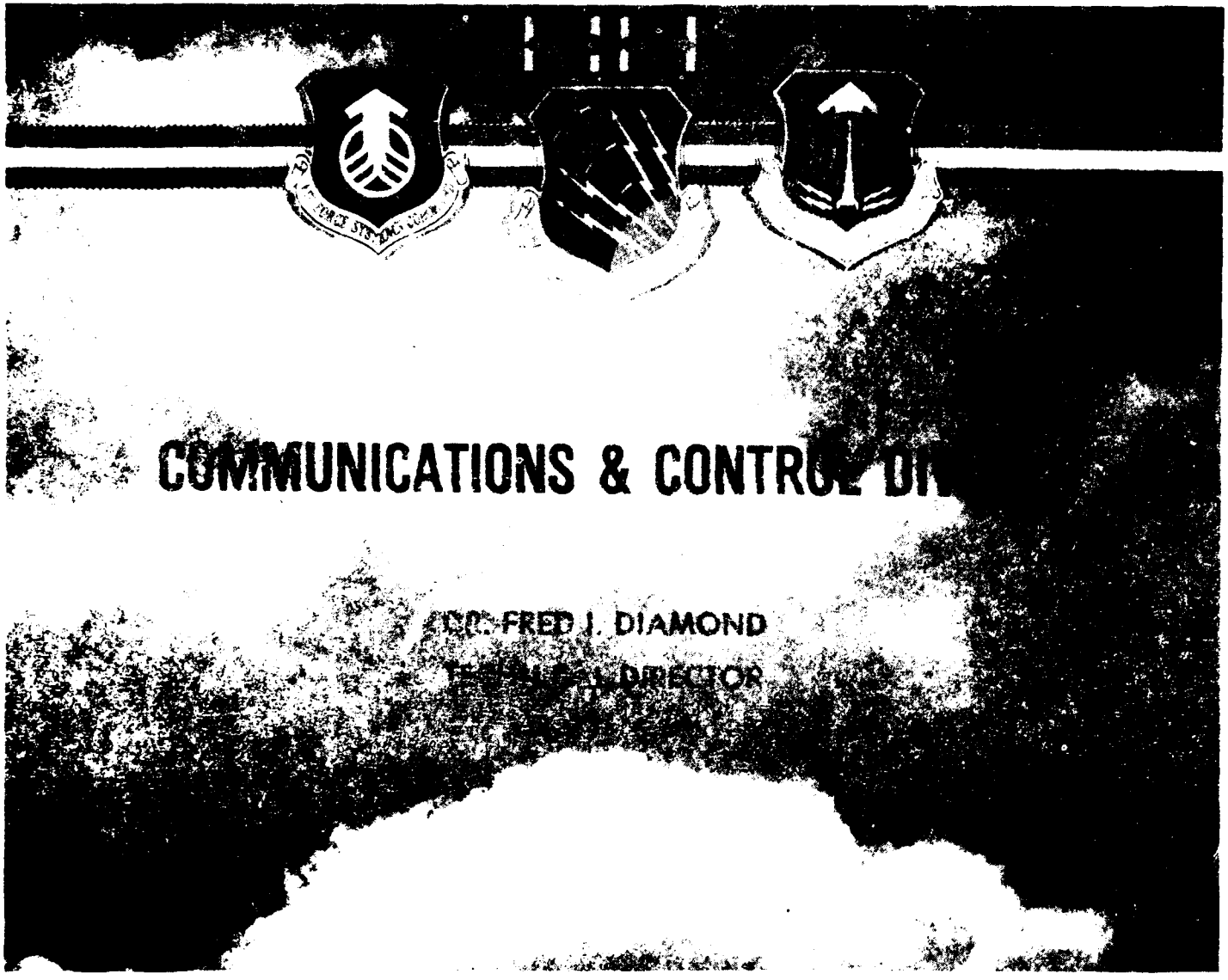
## SURVEILLANCE DIVISION
## POINTS OF CONTACT

SURVEILLANCE/ECCM (TACTICAL) - MR. T. SHIELDS
(315) 330-4496

AIRCRAFT IDENTIFICATION - MR. W. WOLF
(315) 330-4431

SPACE BASED RADAR - MR. J. SIMONS
(315) 330-3573

CRUISE MISSILE SURVEILLANCE - MR. R. OGRODNIK
(315) 330-4431


COMMUNICATIONS & CONTRO
COL FRED J. DIAMOND
DIRECTOR

# COMMUNICATIONS OVERVIEW

- INTRODUCTION
- LONG TERM OBJECTIVES
- NEW INITIATIVES
- MAJOR PROGRAM AREAS
- SUMMARY

# LONG TERM OBJECTIVES

- ECCM
- ADAPTIVE COMMUNICATIONS
- $C^3$ COUNTERMEASURES
- MODELING & SIMULATION

# NEW INITIATIVES

- SATELLITE COMMUNICATIONS
- HF COMMUNICATIONS
- FIBER OPTICS
- LOW COST DATA LINKS
- MILLIMETER AIR/AIR COMMUNICATIONS
- $C^3$ COUNTERMEASURES

# MAJOR PROGRAM AREAS

## SUPPORT $C^3$

- SWITCHING & ROUTING
- TERMINAL SIGNAL PROCESSING
- SYSTEM CONTROL
- SATELLITE COMMUNICATIONS
- LOS TROPO
- DCS TIMING & SYNCHRONIZATION

## STRATEGIC $C^3$

- SUB-UHF COMMUNICATIONS

## TACTICAL $C^3$

- OPTICAL COMMUNICATIONS
- UHF VOICE COMMUNICATIONS
- DISTRIBUTED C

## $C^3$ COUNTERMEASURES

## RECCE INTEL SURVEILLANCE

- ACTIVE TARGET LOCATION

## COMMUNICATIONS TECHNOLOGY

- ADAPTIVE PROCESSING FOR COMMUNICATIOI
- ADVANCED SURVIVABLE TECHNOLOGY
- C SYSTEM DESIGN & ANALYSIS

# SWITCHING & ROUTING

PROGRAM GOALS

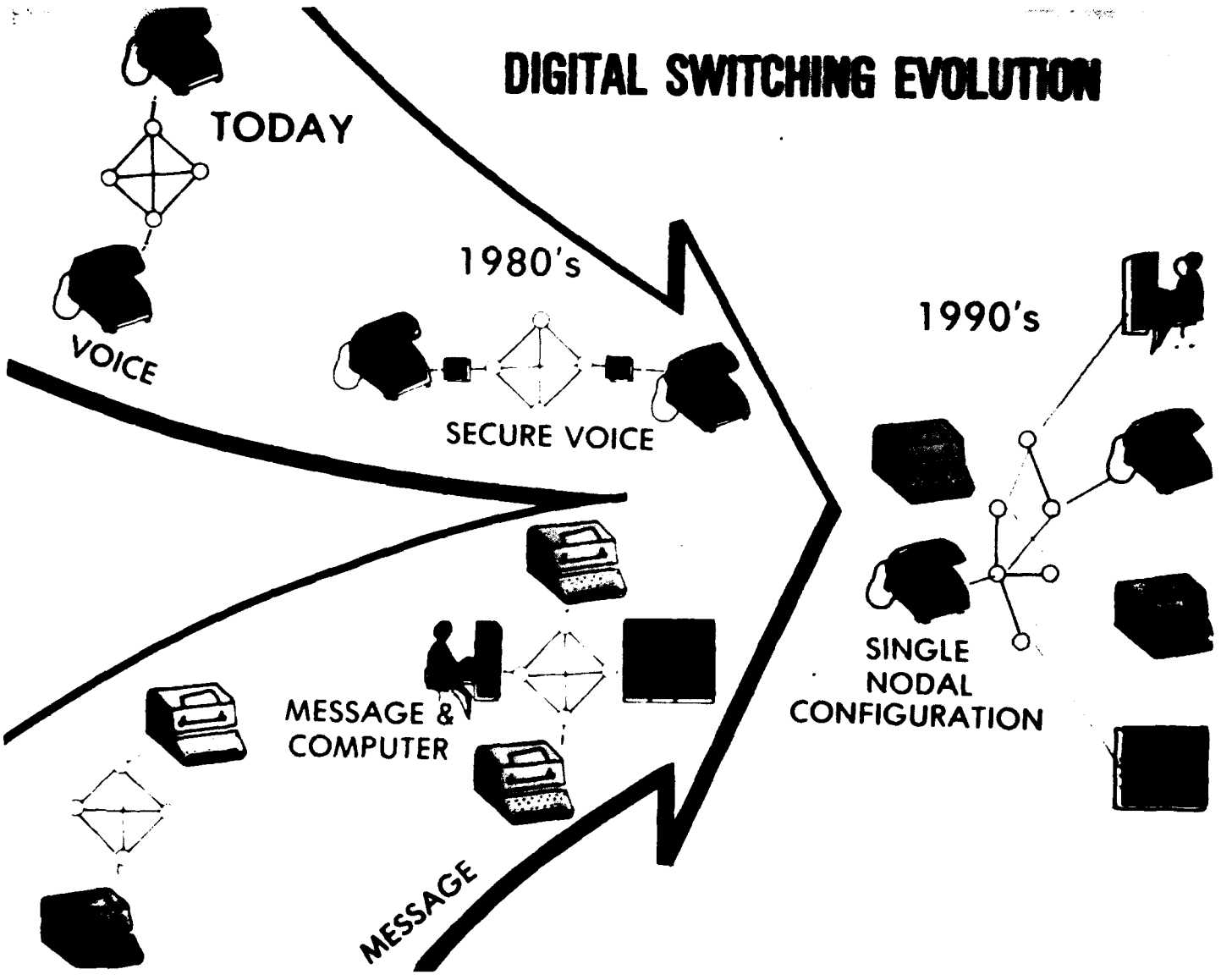
DEVELOP AN INTEGRATED SWITCHED SYSTEM
FOR DEFENSE COMMUNICATIONS SYSTEM (DCS III)

TECHNICAL AREAS

- NODAL ARCHITECTURES
- PACKET SWITCHED NETWORKS
- HIGHER ORDER LANGUAGES

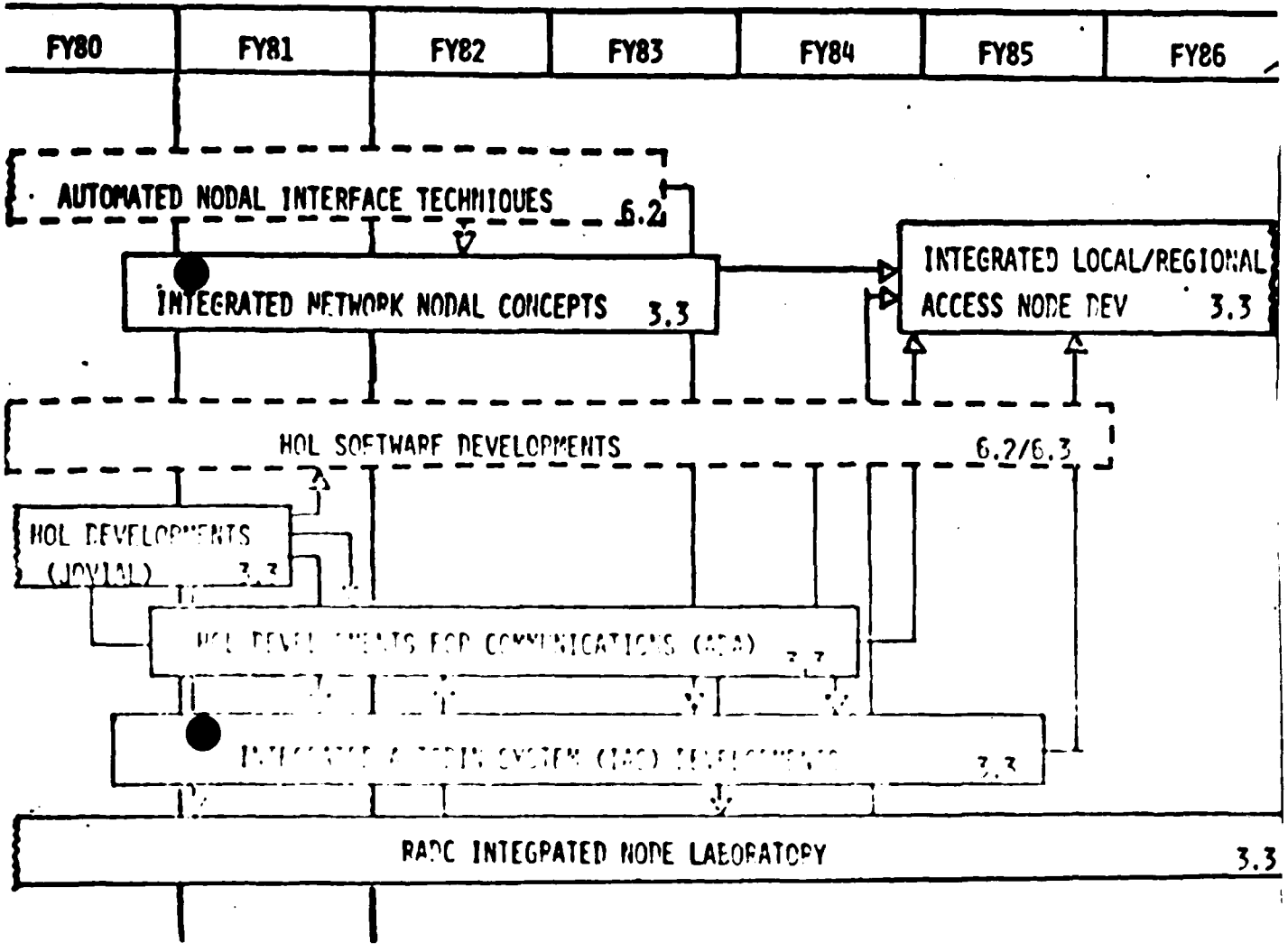
ESTIMATED FUNDING: FY 80-83 (IN THOUSANDS)

$12,517


DIGITAL SWITCHING EVOLUTION
TODAY
VOICE
1980's
SECURE VOICE
MESSAGE &
COMPUTER
MESSAGE
1990's
SINGLE
NODAL
CONFIGURATION

RADC DEV/THRUST: IA/SUPPORT C

SUB-SUB-THRUST: 1A. SWITCHING AND ROUTING



# SYSTEM CONTROL

PROGRAM GOALS

EXPAND EXISTING SYSCON SUBSYSTEMS TO PROVIDE

- ENHANCED PERFORMANCE ASSESSMENT
- COORDINATED RESTORAL & NETWORK RESOURCE ALLOCATION
- INTEROPERABILITY SURVIVABILITY OF SYSCON ELEMENTS

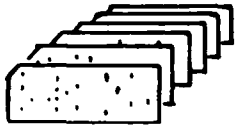
TECHNICAL AREAS

- NETWORK PARAMETER MEASUREMENT
- ECM SIGNAL DETECTION, ISOLATION, CHARACTERIZATION
- CHANNEL RECONFIGURATION
- INFORMATION PROCESSING & DISPLAYS

ESTIMATED FUNDING: FY80-83 (IN THOUSANDS)

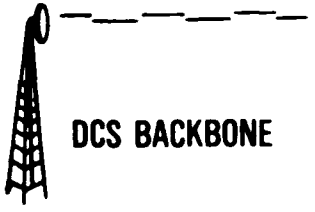
$10,274

# SYSTEM CONTROL



AUTODIN

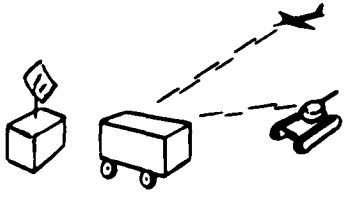
AUTOVON



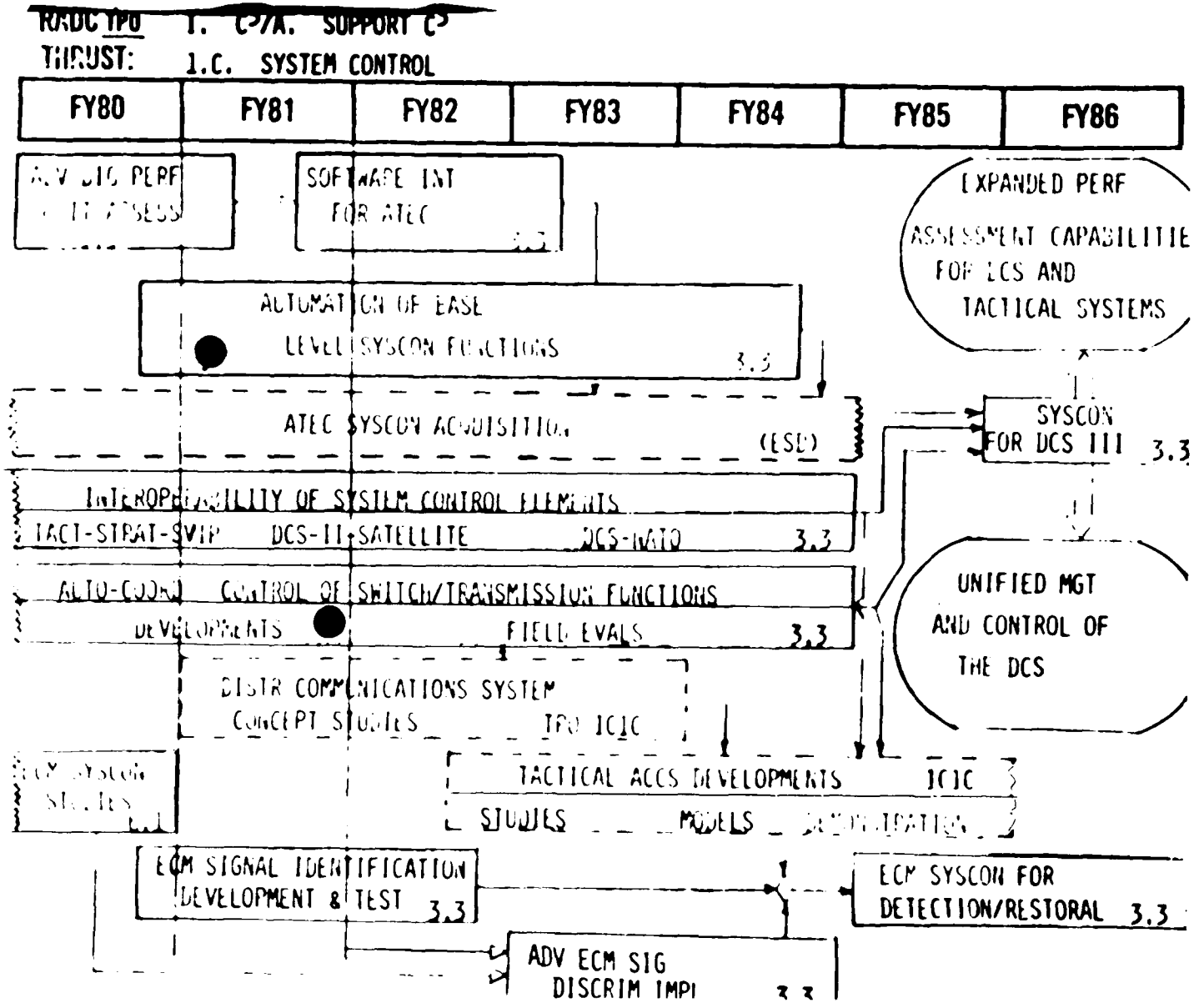
DCS BACKBONE

- PERFORMANCE ASSESSMENT
- NETWORK MANAGEMENT
- INTEROPERABILITY

SATELLITE
GROUND TERMINALS



TACTICAL NETS


PRODUCTS: I. C²/A. SUPPORT C³
THRUST: 1.C. SYSTEM CONTROL
FY80
FY81
FY82
FY83
FY84
FY85
FY86
ADV DIG PERF
IT ASSESS
SOFTWARE INT
FOR ATEC
3.3
EXPANDED PERF
ASSESSMENT CAPABILITIE
FOR ICS AND
TACTICAL SYSTEMS
AUTOMATION OF EASE
LEVEL SYSCON FUNCTIONS
3.3
ATEC SYSCON ACQUISITION
(ESD)
SYSCON
FOR DCS III
3.3
INTEROPERABILITY OF SYSTEM CONTROL ELEMENTS
TACT-STRAT-SVIP
DCS-II SATELLITE
DCS-NATO
3.3
AUTO-CODN
CONTROL OF SWITCH/TRANSMISSION FUNCTIONS
DEVELOPMENTS
FIELD EVALS
3.3
UNIFIED MGT
AND CONTROL OF
THE DCS
DISTR COMMUNICATIONS SYSTEM
CONCEPT STUDIES
FOR ICIC
ECM SYSCON
STUDIES
TACTICAL ACCS DEVELOPMENTS
ICIC
STUDIES
MODELS
ECM SIGNAL IDENTIFICATION
DEVELOPMENT & TEST
3.3
ECM SYSCON FOR
DETECTION/RESTORAL
3.3
ADV ECM SIG
DISCRIM IMPL
2 2

# SATELLITE COMMUNICATIONS

PROGRAM GOALS

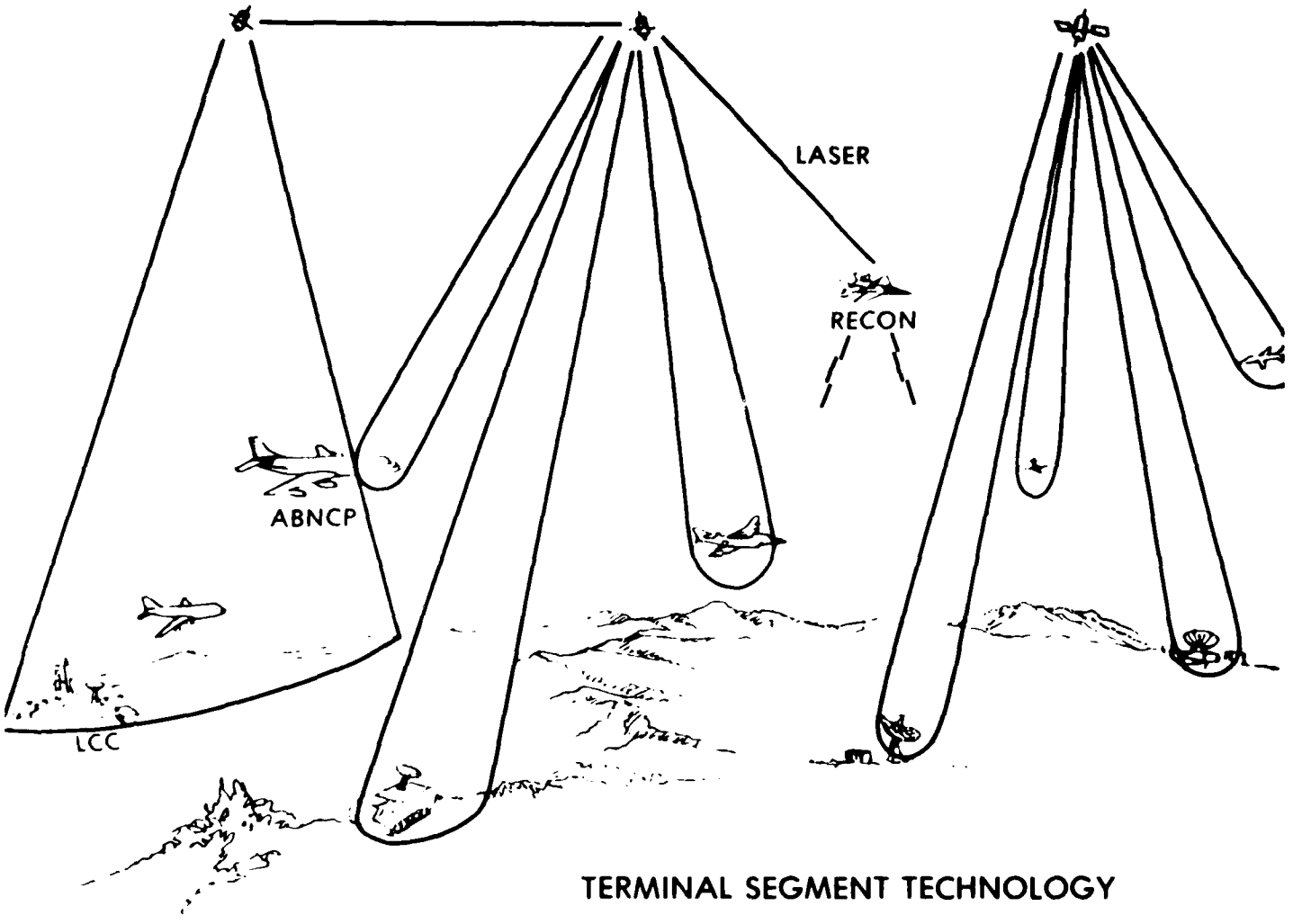
- IDENTIFY SATCOM REQUIREMENTS
- DEVELOP & DEMONSTRATE ADVANCED TERMINALS

TECHNICAL AREAS

- A/B TERMINALS
- SPACE SUBSYSTEMS
- ECCM/SURVIVABILITY

ESTIMATED FUNDING FY80-83 (IN THOUSANDS)
$54,934

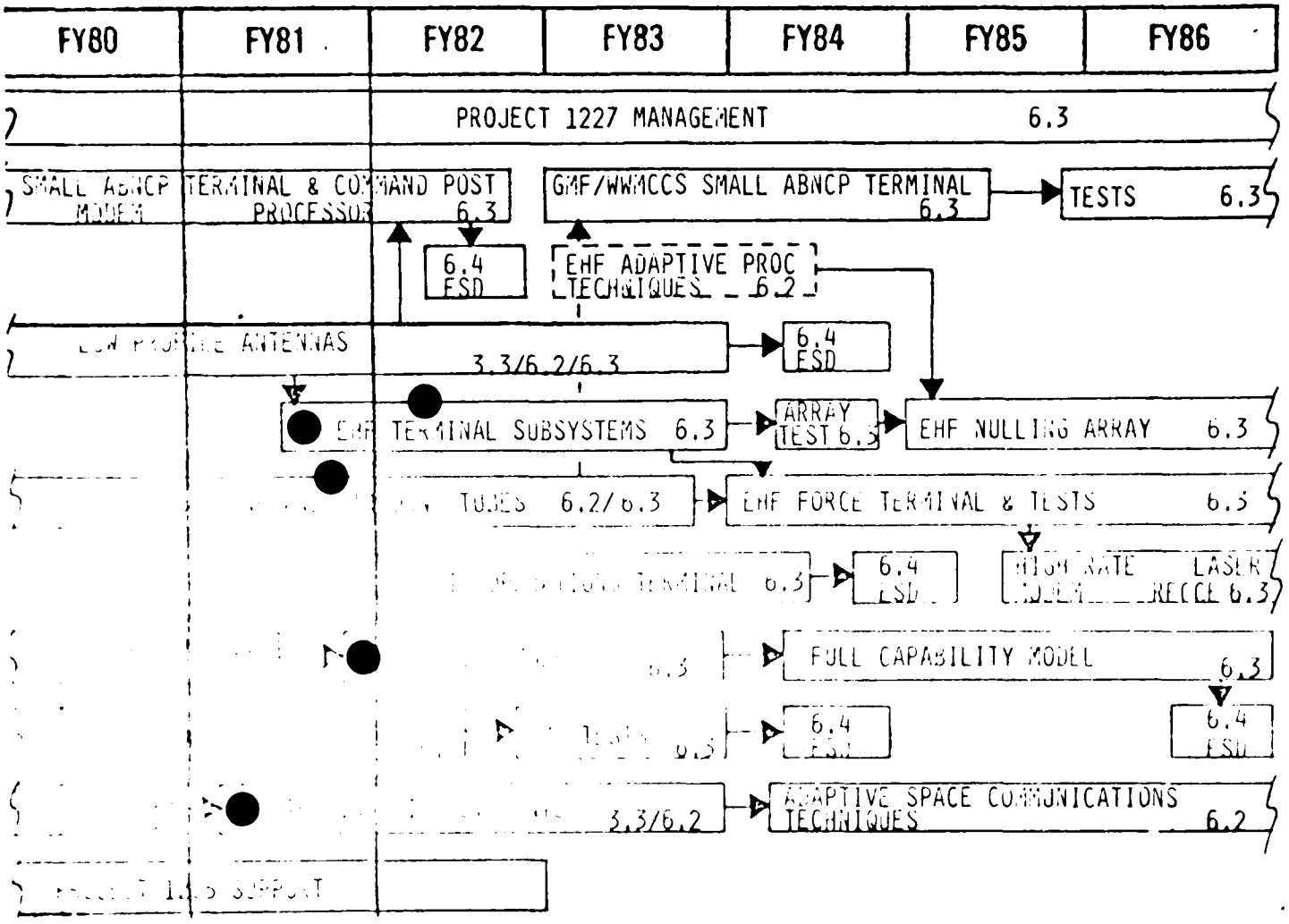
# SATCOM




TERMINAL SEGMENT TECHNOLOGY

**RADC TPO** 1 $C^3$

**THRUST:** A.1.D. SUPPORT $C^3$/COMM/SATELLITE COMMUNICATIONS



# LOS/TROPO

PROGRAM GOALS

TRANSMISSION OVER MILITARY LOS/TROPO CHANNELS WITH

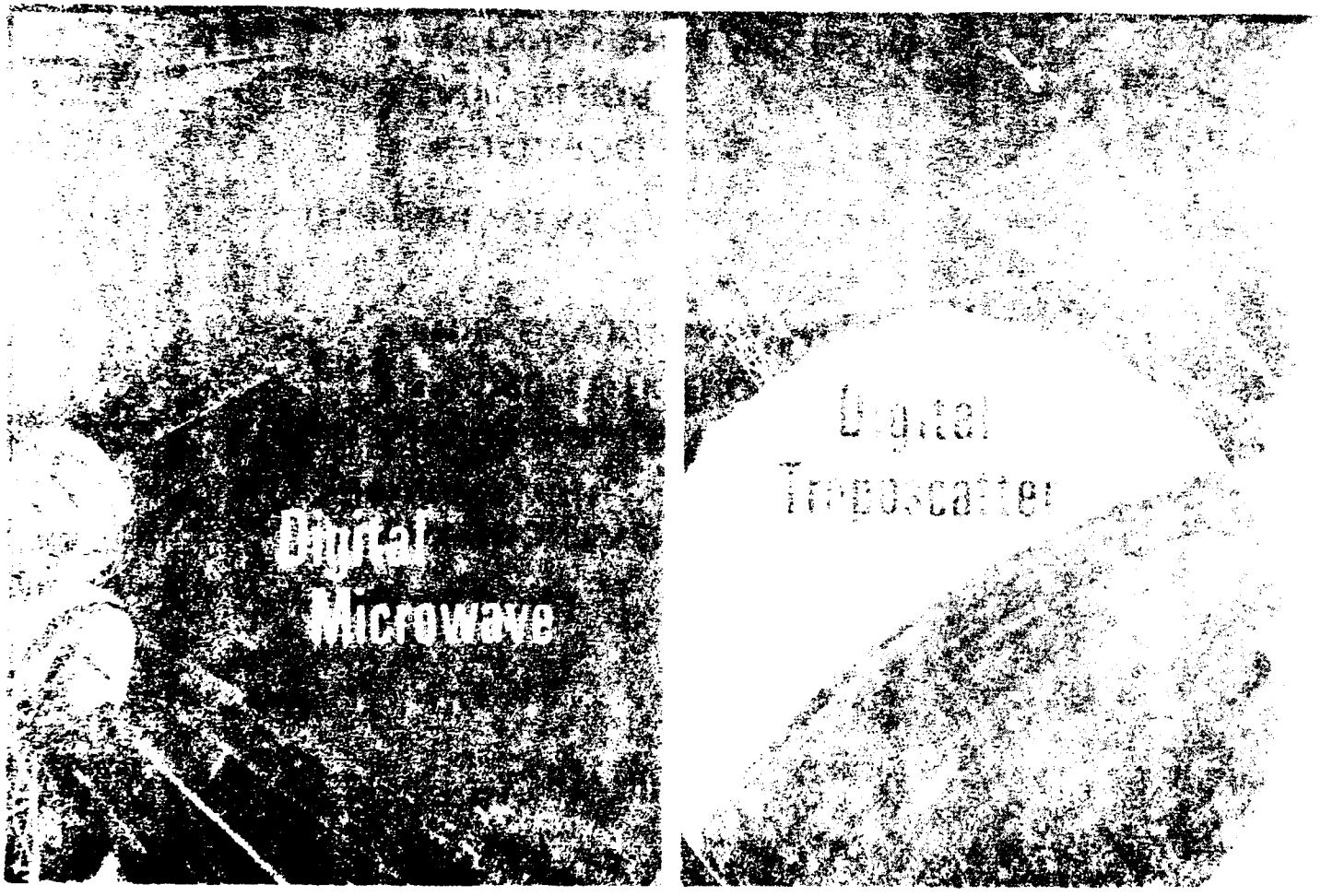
- HIGH AVAILABILITY (STRESSED & UNSTRESSED)
- SPECTRUM EFFICIENCY
- REDUCED VULNERABILITY

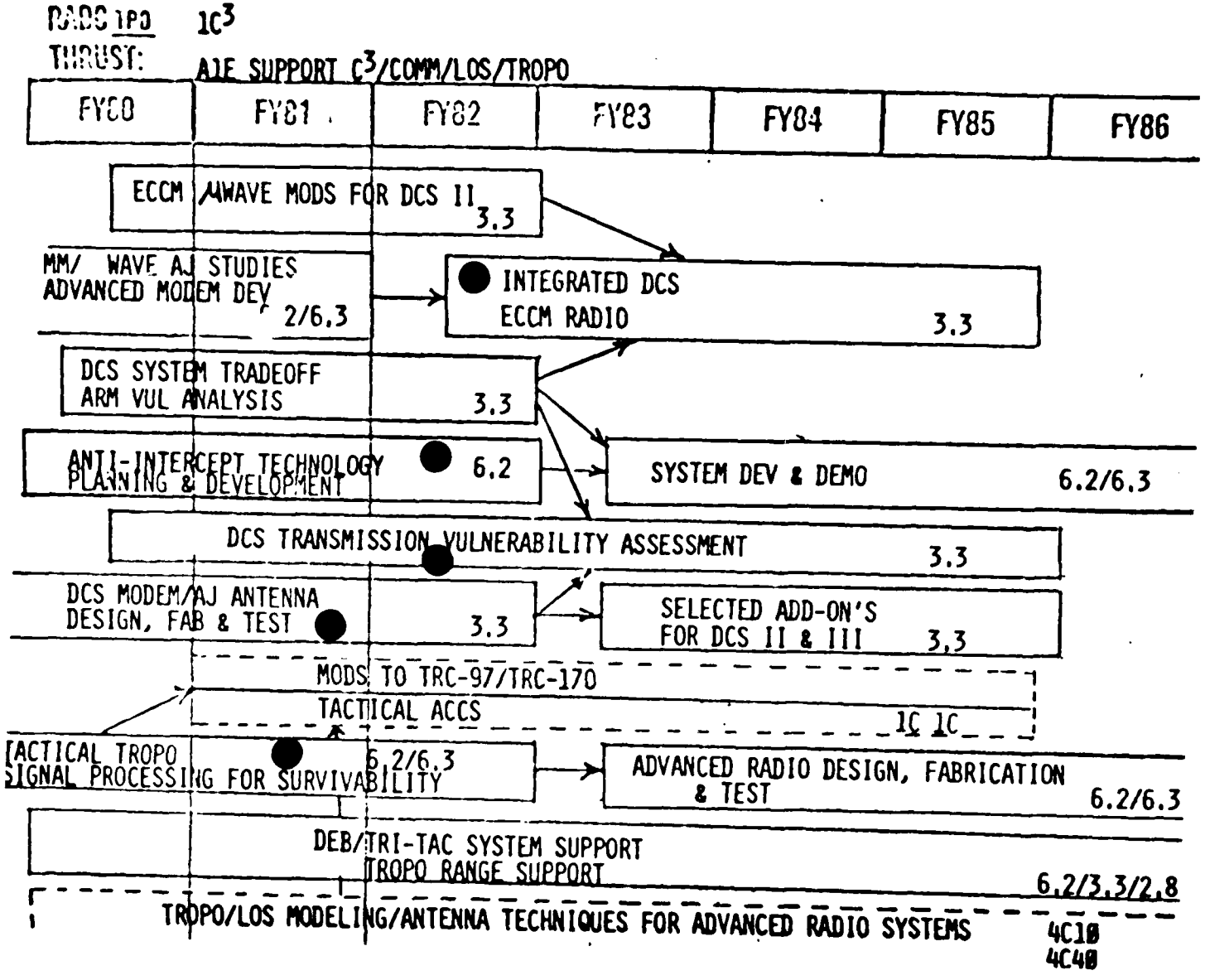
TECHNICAL AREAS

- SIGNAL PROCESSING
- RADIO DESIGN
- ANTENNA SIGNAL PROCESSING

ESTIMATED FUNDING: FY80-83 (IN THOUSANDS)
$11,616

# MICROWAVE & TROPOSCATTER TRANSMISSION




RADC IPD 1C3
THRUST: AIE SUPPORT C3/COMM/LOS/TROPO
FY80
FY81
FY82
FY83
FY84
FY85
FY86
ECCM MMWAVE MODS FOR DCS II 3.3
MM/ WAVE AJ STUDIES ADVANCED MODEM DEV 2/6.3
INTEGRATED DCS ECCM RADIO 3.3
DCS SYSTEM TRADEOFF ARM VUL ANALYSIS 3.3
ANTI-INTERCEPT TECHNOLOGY PLANNING & DEVELOPMENT 6.2
SYSTEM DEV & DEMO 6.2/6.3
DCS TRANSMISSION VULNERABILITY ASSESSMENT 3.3
DCS MODEM/AJ ANTENNA DESIGN, FAB & TEST 3.3
SELECTED ADD-ON'S FOR DCS II & III 3,3
MODS TO TRC-97/TRC-170
TACTICAL ACCS 1C 1C
TACTICAL TROPO SIGNAL PROCESSING FOR SURVIVABILITY 6.2/6.3
ADVANCED RADIO DESIGN, FABRICATION & TEST 6.2/6.3
DEB/TRI-TAC SYSTEM SUPPORT
TROPO RANGE SUPPORT 6.2/3.3/2.8
TROPO/LOS MODELING/ANTENNA TECHNIQUES FOR ADVANCED RADIO SYSTEMS 4C10 4C40

# SYSTEM TIMING & SYNCHRONIZATION

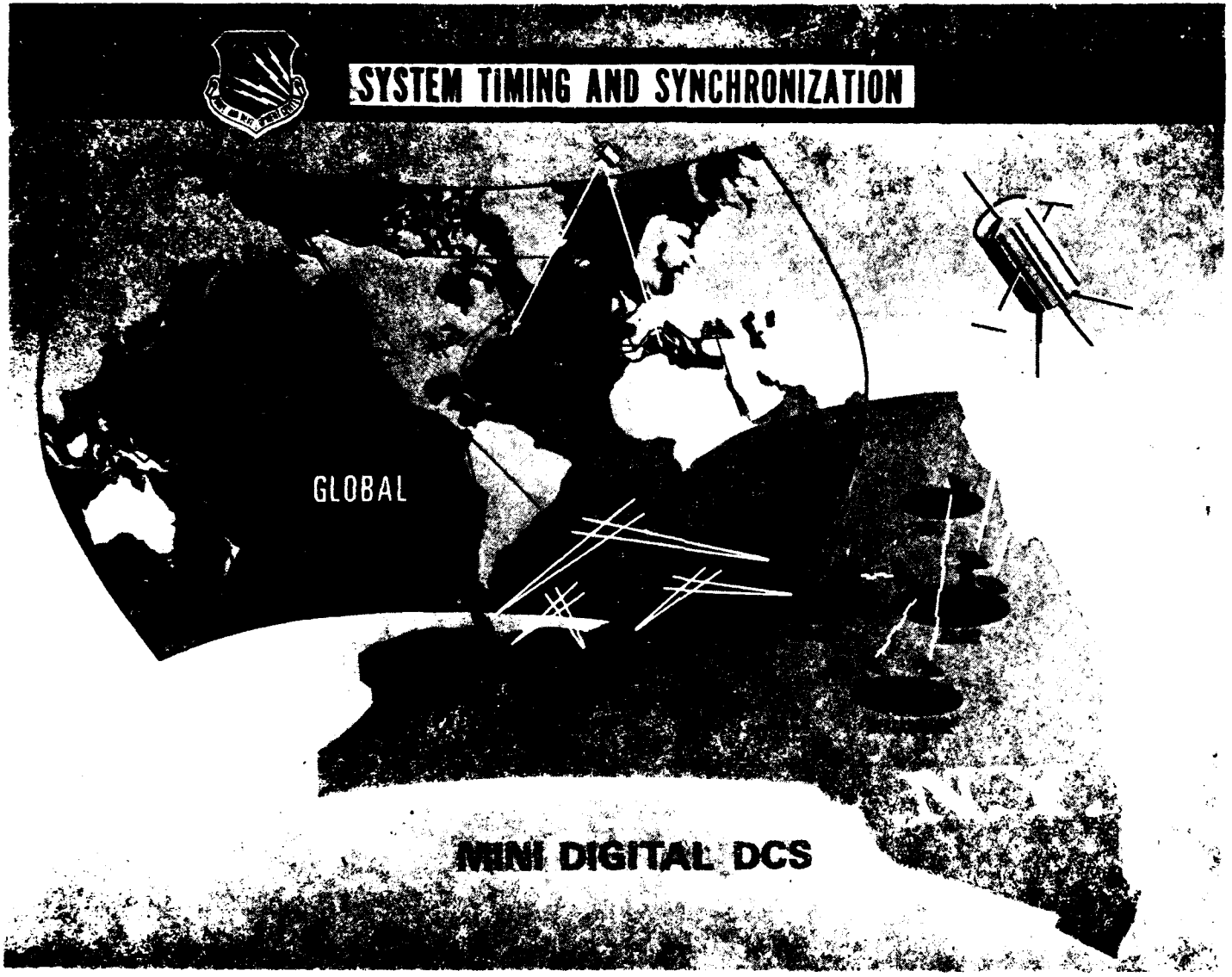
PROGRAM GOALS

DEVELOP TIMING SUBSYSTEMS REQUIRED FOR FUTURE DIGITAL TRANSMISSION SYSTEMS

TECHNICAL AREAS

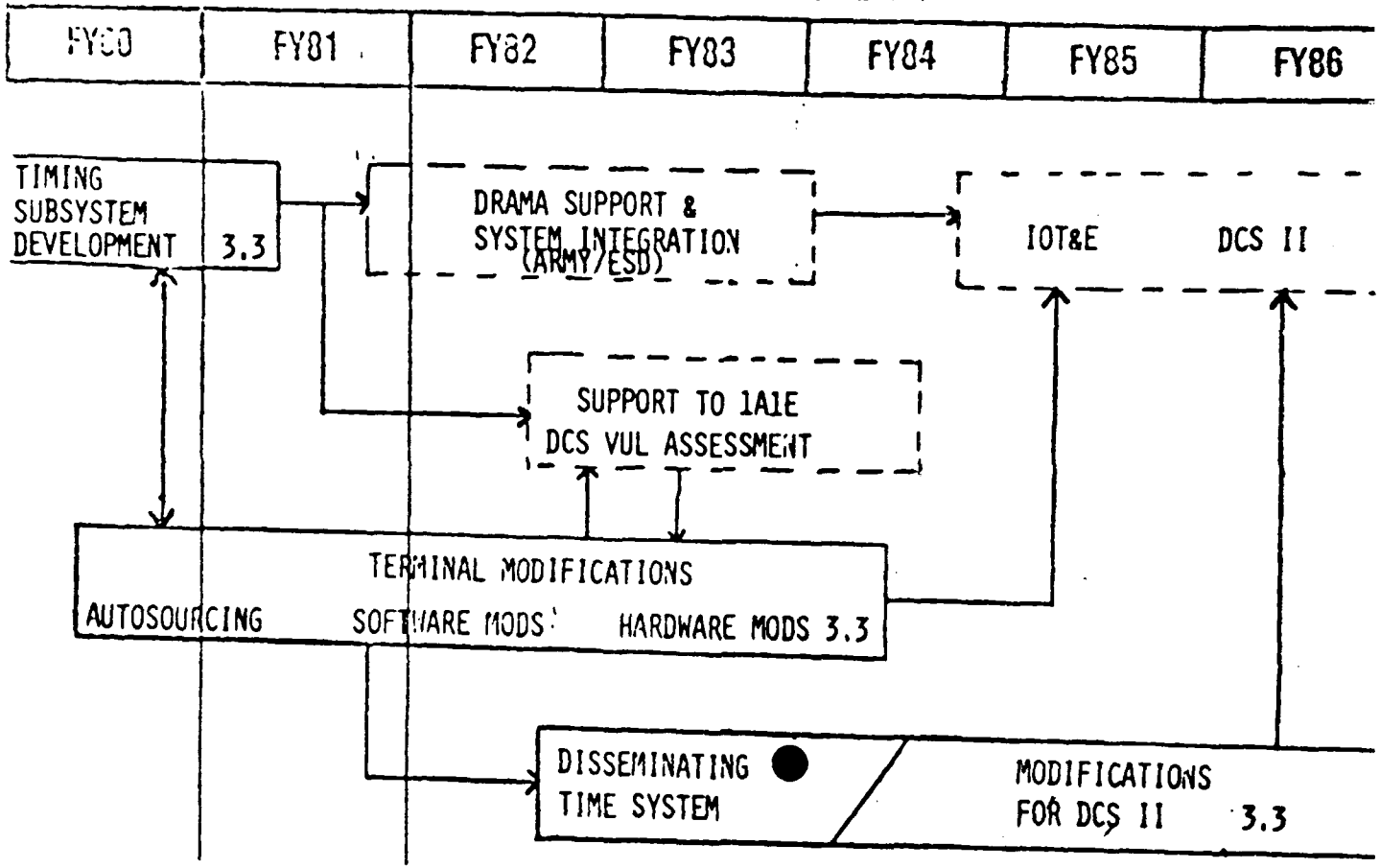
- DEVELOPMENT, TESTING & SELECTION OF TIMING TECHNIQUES
- ACCURATE TIME REFERENCES & TRANSFER TECHNIQUES

ESTIMATED FUNDING: FY80-83 (IN THOUSANDS)
$2,175


SYSTEM TIMING AND SYNCHRONIZATION
GLOBAL
MINI DIGITAL DCS

DCSC TPD 1A/SUPPORT $C^3$

THRUST: 1F/COMMUNICATION SYSTEM TIMING & SYNCHRONIZATION



# SUB-UHF COMMUNICATIONS (HF/VLF)

PROGRAM GOALS

PROVIDE SECURE, RELIABLE, LONG RANGE STRATEGIC COMMAND & CONTROL COMMUNICATIONS

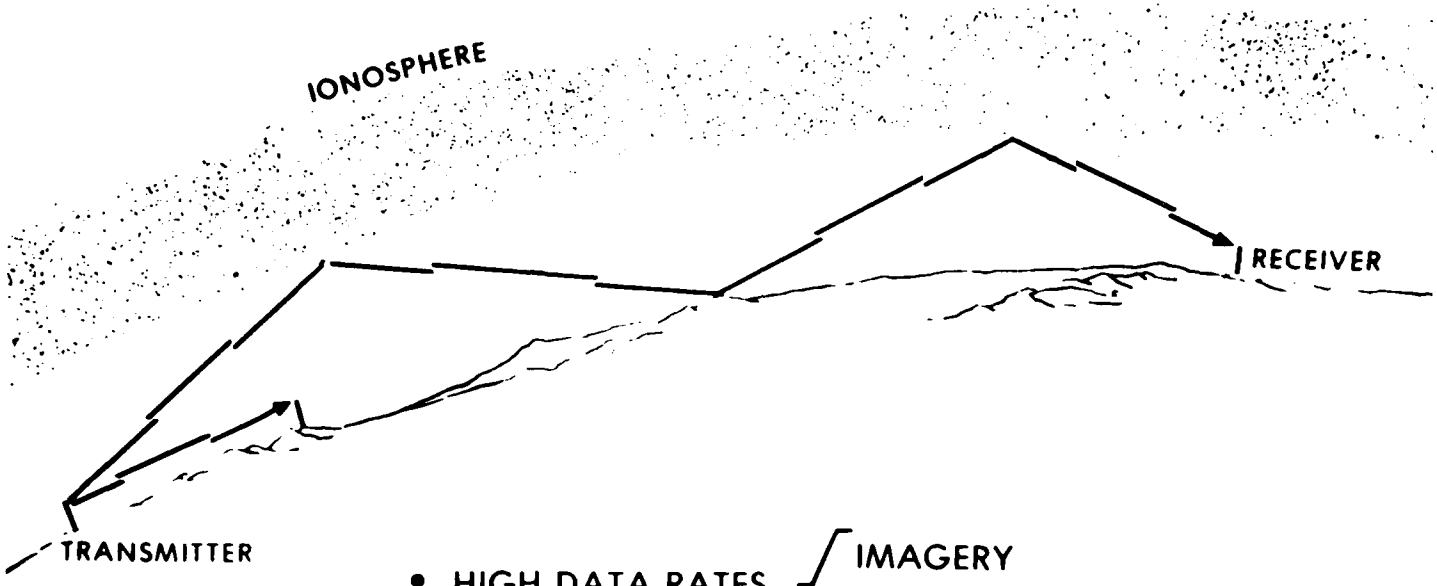
TECHNICAL AREAS

- BANDWIDTH EFFICIENT WAVEFORMS
- CHANNEL EQUALIZATION
- SPATIAL PROCESSING
- ADAPTIVE PROCESSING

ESTIMATED FUNDING FY80-83 (IN THOUSANDS)

$21,231

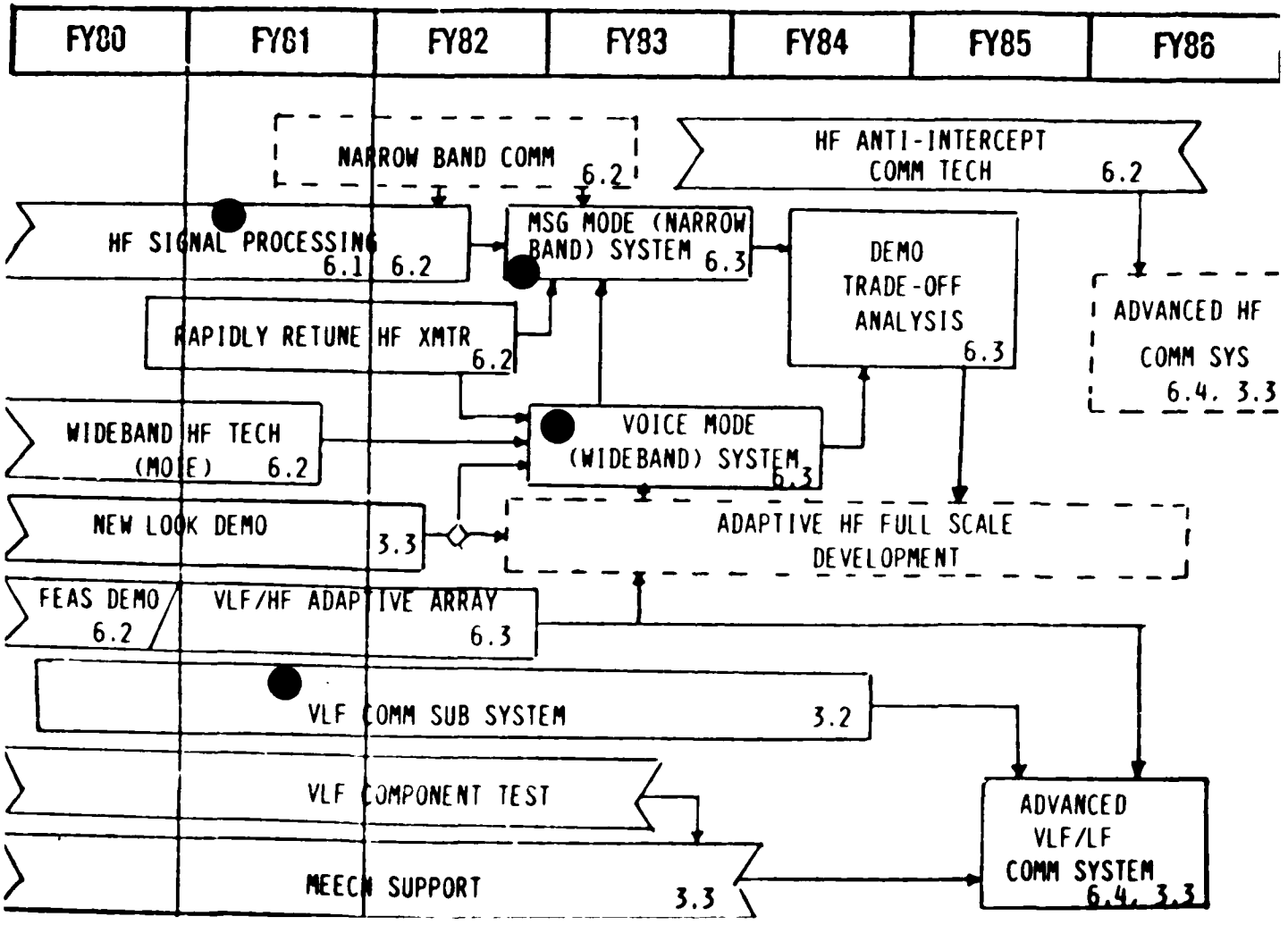
# HIGH FREQUENCY RADIO COMMUNICATIONS




- HIGH DATA RATES
  - IMAGERY
  - DIGITAL VOICE
- ANTI-JAM
  - ANTENNA PROCESSING
  - WAVEFORM PROCESSING
- SYSTEM UPGRADE

RADC TPO 1. $C^3$

THRUST: B.1. STRATEGIC $C^3$/SUB UHF COMMUNICATIONS



# OPTICAL COMMUNICATIONS

PROGRAM GOALS

APPLY OPTICAL COMMUNICATIONS TO REDUCE RELIANCE OF AF $C^3I$ SYSTEMS ON COPPER CONDUCTOR CABLE TO REDUCE WEIGHT & COST, & DECREASE EMITTER OPERATIONS CENTER VULNERABILITY

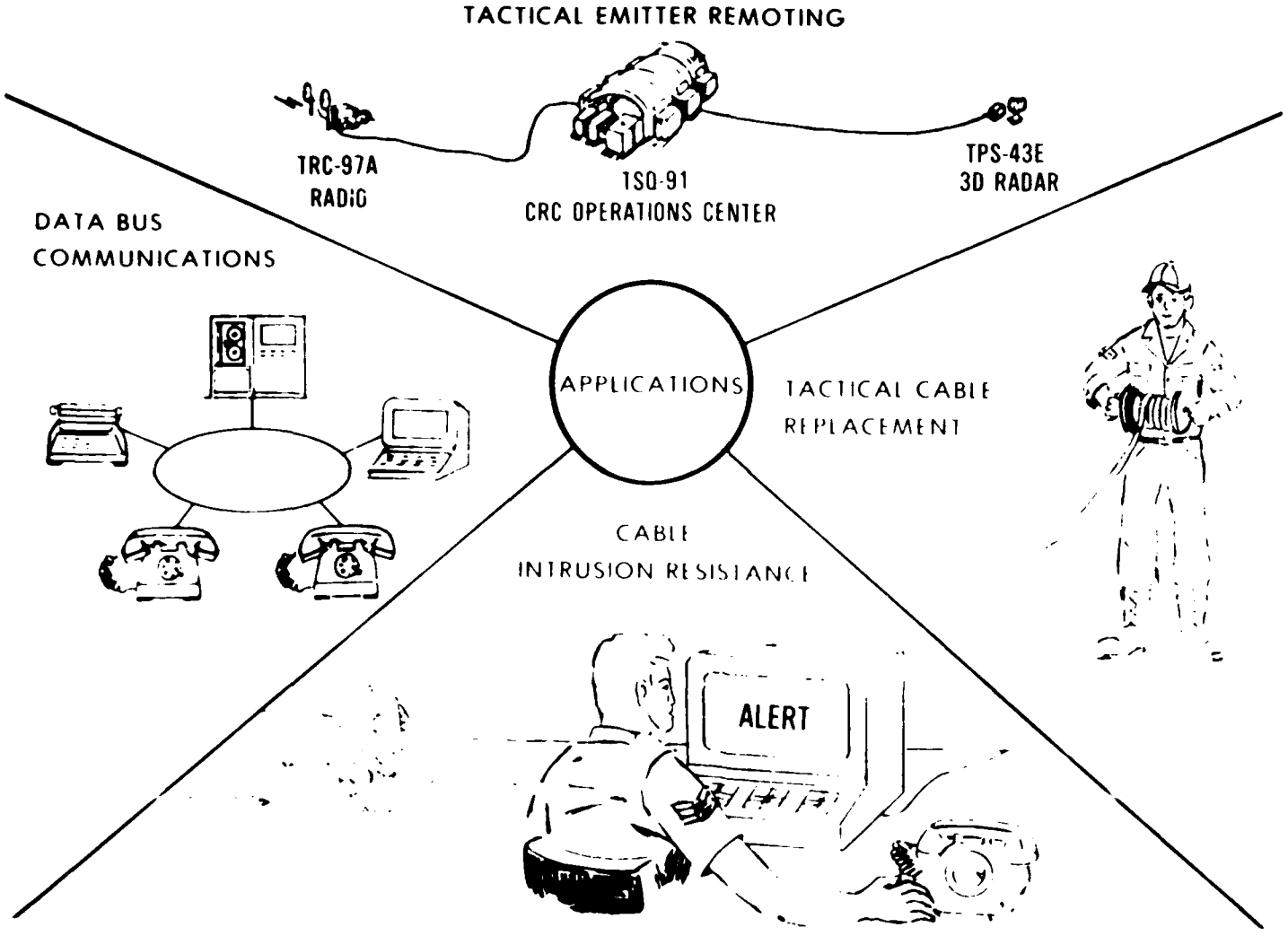
TECHNICAL AREAS:

- FIBER OPTICS
- ATMOSPHERIC OPTICS
- MULTIPLEXING
- BUS SYSTEMS

ESTIMATED FUNDING: FY80-83 (IN THOUSANDS)

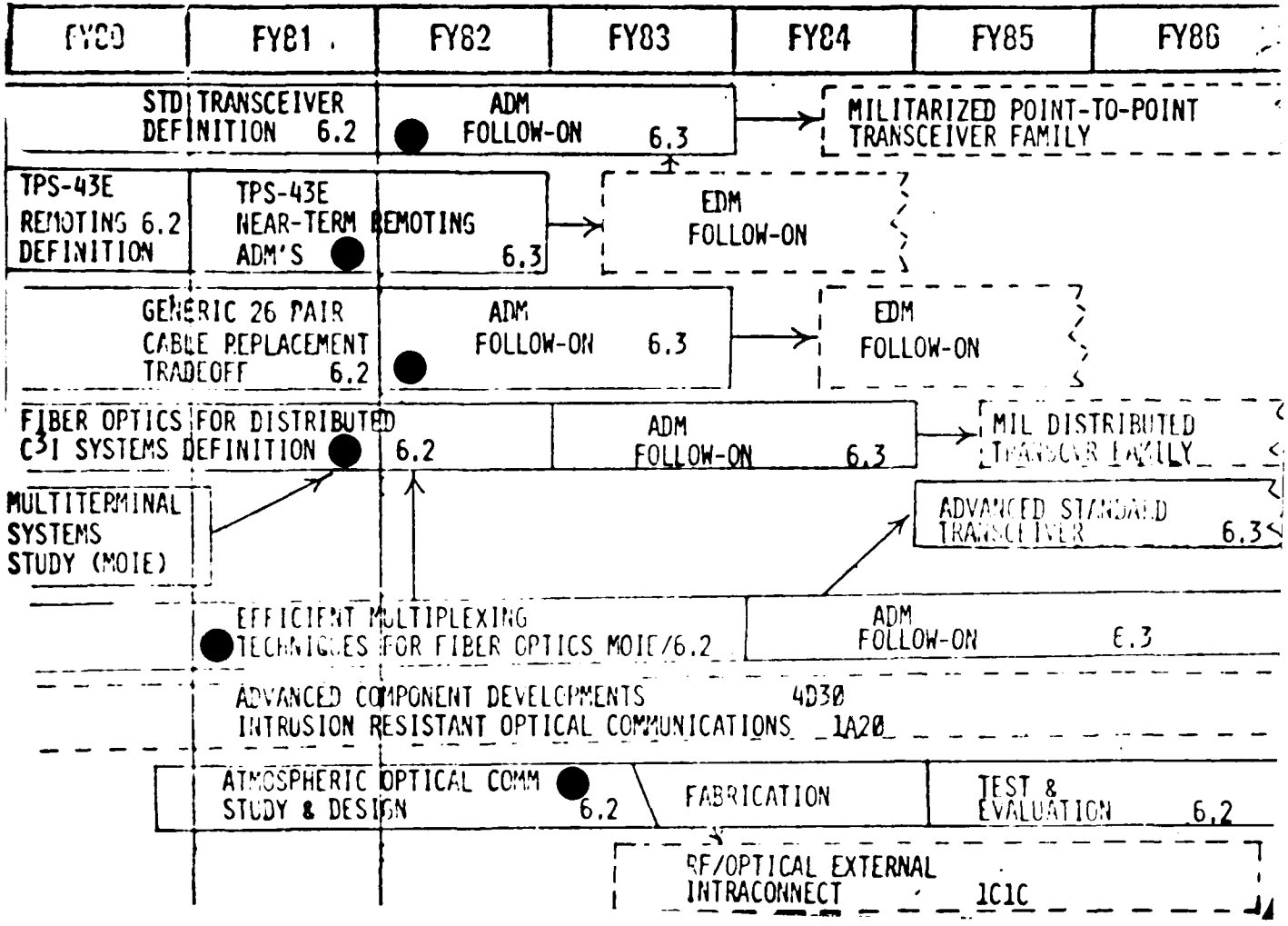
$1,982

# FIBER OPTICS C³I APPLICATIONS

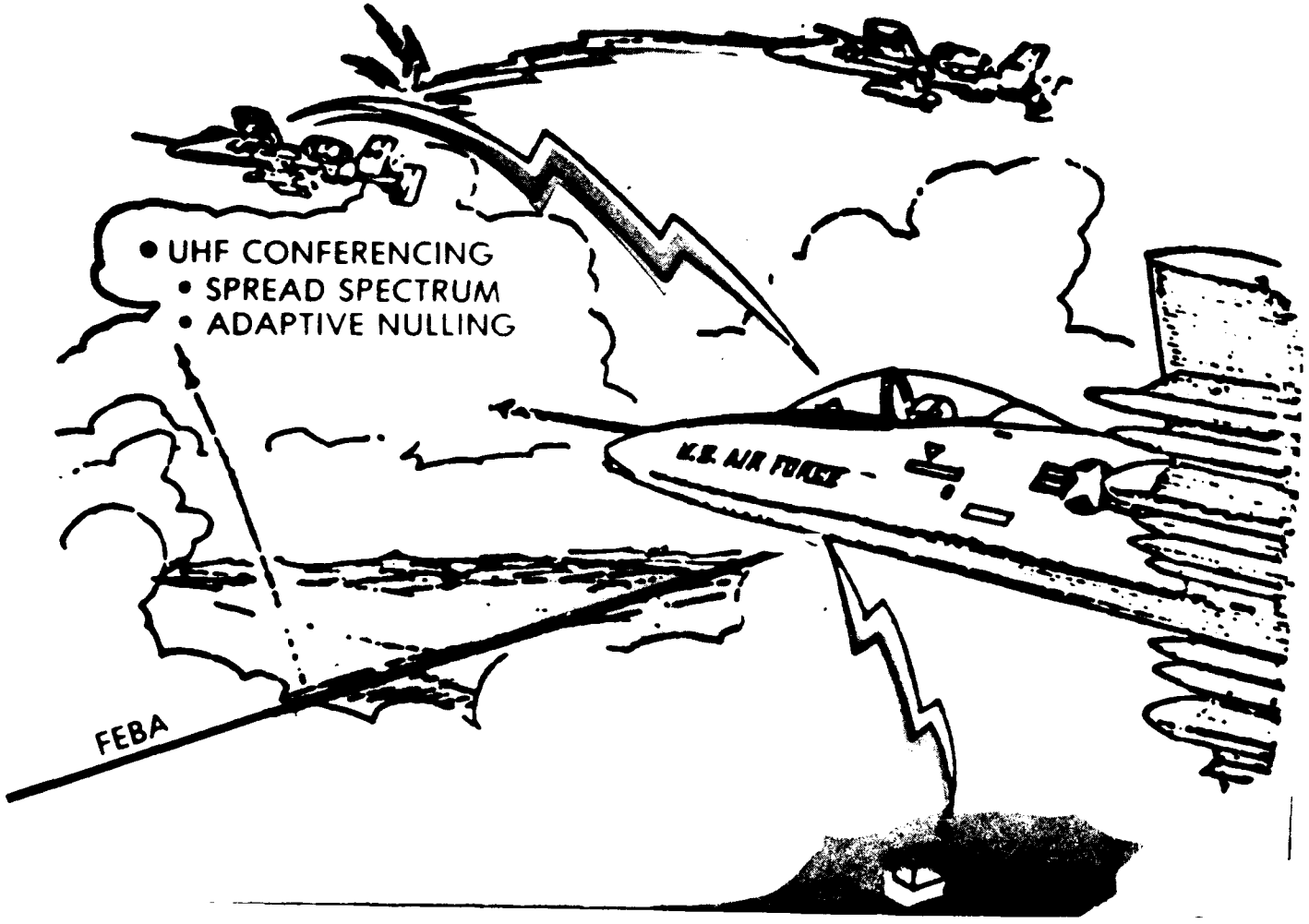


RELATED 1C/TACTICAL $C^3$

THRUST: 1A/COMMUNICATIONS OPTICAL COMMUNICATIONS



# SEEK TALK


• UHF CONFERENCING
• SPREAD SPECTRUM
• ADAPTIVE NULLING
U.S. AIR FORCE
FEBA

# DISTRIBUTED $C^3$

## PROGRAM GOALS

- STANDARDIZE WIDEBAND COMM SUBSYSTEM/ARCHITECTURE FOR $C^2$ CENTER DEVELOPMENT/ACQUISITION/OPERATION
- IMPROVE INTER-CENTER COMM SYSTEM SURVIVABILITY & ABILITY TO SUPPORT DISTRIBUTED PROCESSING

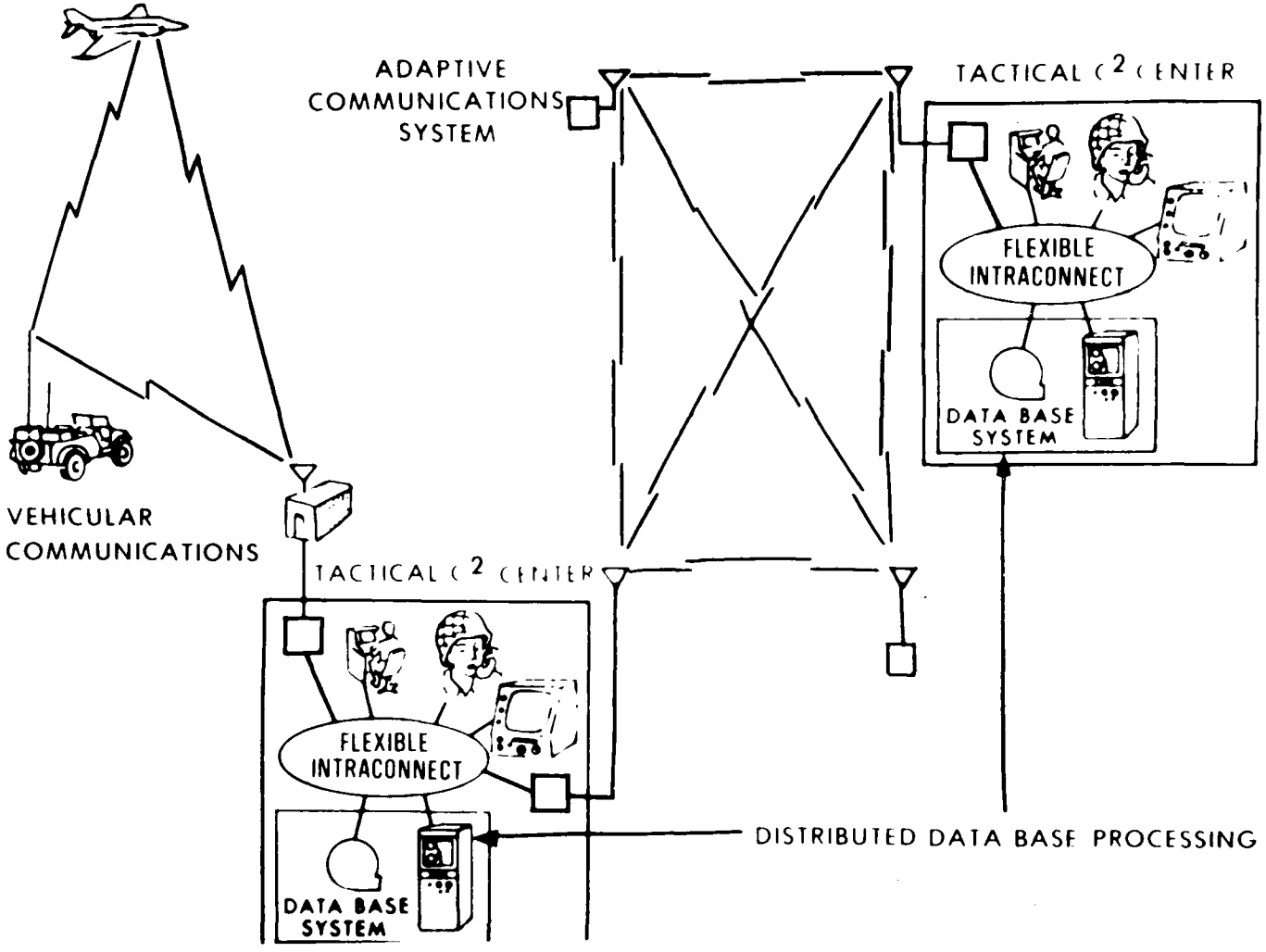
## TECHNICAL AREAS

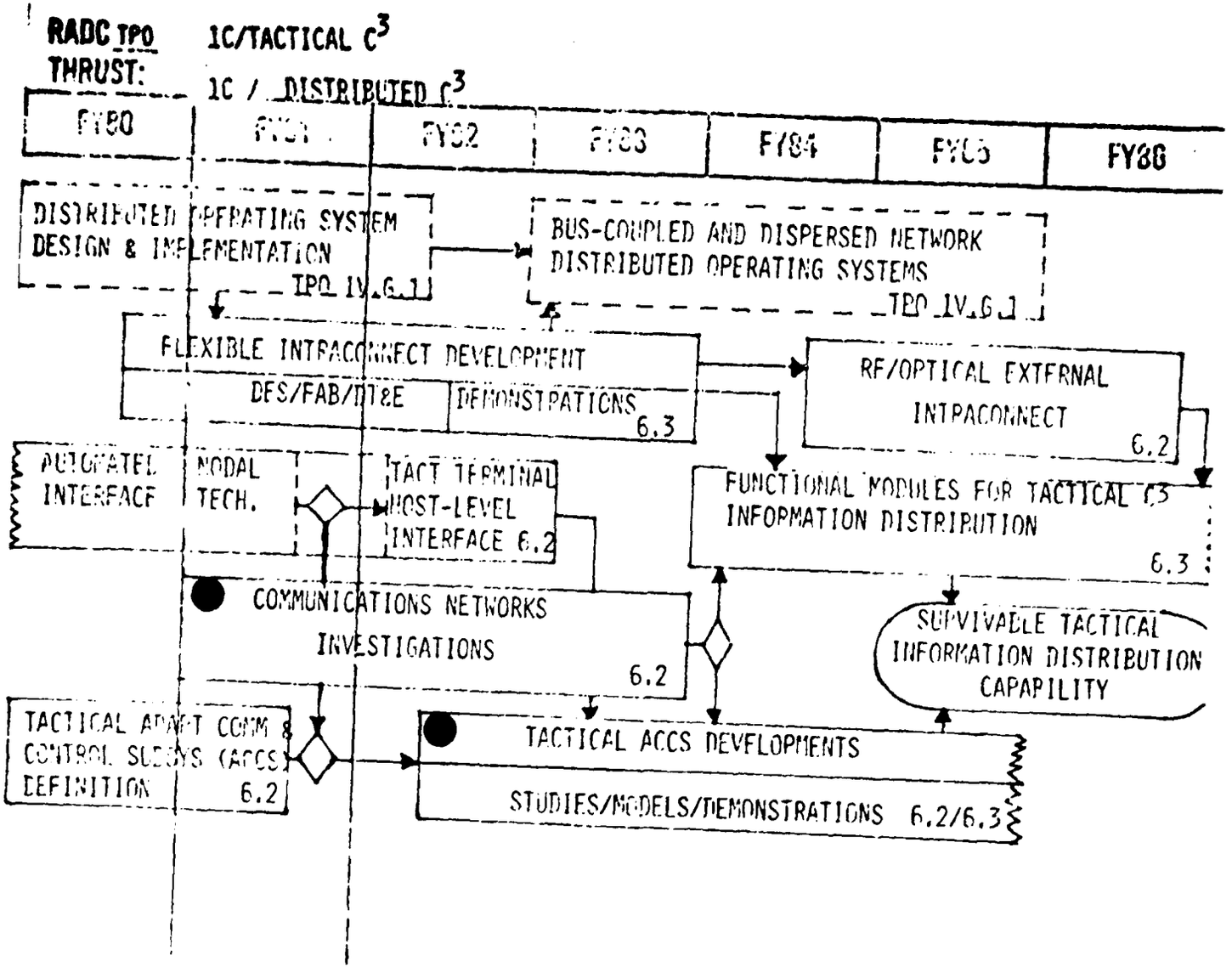
- MULTIPLEX/BUS COMMUNICATIONS
- PACKET COMMUNICATIONS
- SYSTEM CONTROL
- ADAPTIVE COMMUNICATIONS

ESTIMATED FUNDING: FY 80-83 (IN THOUSANDS)

$14,758

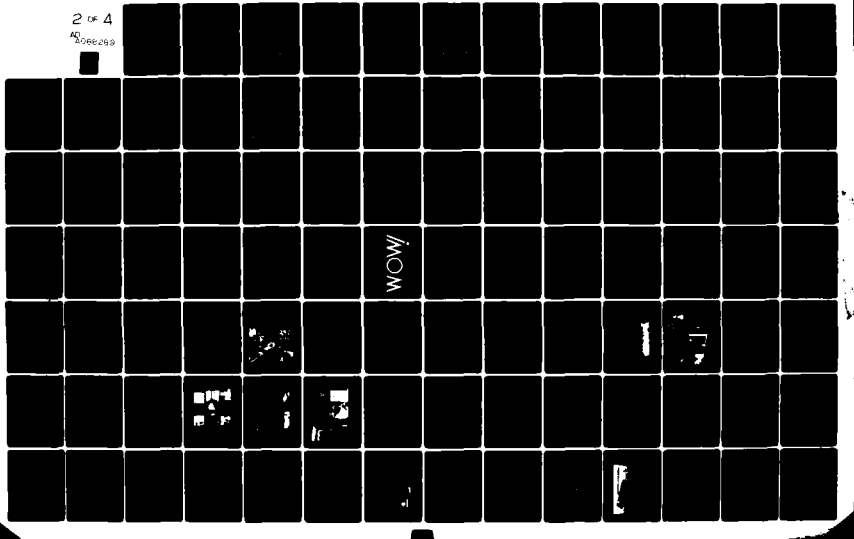
# DISTRIBUTED TACTICAL C³

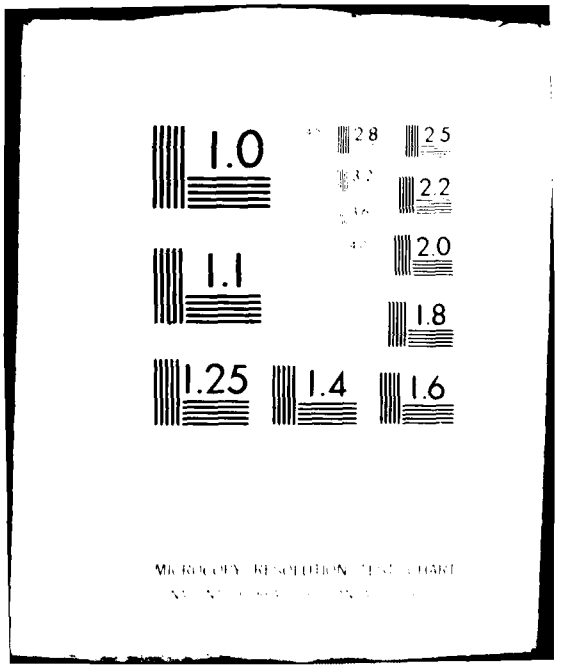



RADC TPO THRUST:
IC/TACTICAL C3
IC / DISTRIBUTED C3
FY80
FY81
FY82
FY83
FY84
FY85
FY86
DISTRIBUTED OPERATING SYSTEM DESIGN & IMPLEMENTATION
TPO IV.G.1
BUS-COUPLED AND DISPERSED NETWORK DISTRIBUTED OPERATING SYSTEMS
TPO IV.G.1
FLEXIBLE INTRACONNECT DEVELOPMENT
DFS/FAB/DT&E
DEMONSTRATIONS
6.3
RF/OPTICAL EXTERNAL INTRACONNECT
6.2
AUTOMATED INTERFACE
NODAL TECH.
TACT TERMINAL HOST-LEVEL INTERFACE 6.2
FUNCTIONAL MODULES FOR TACTICAL C3 INFORMATION DISTRIBUTION
6.3
COMMUNICATIONS NETWORKS INVESTIGATIONS
6.2
SURVIVABLE TACTICAL INFORMATION DISTRIBUTION CAPABILITY
TACTICAL ADAPT COMM & CONTROL SUBSYS (ACCS) DEFINITION
6.2
TACTICAL ACCS DEVELOPMENTS
STUDIES/MODELS/DEMONSTRATIONS 6.2/6.3

AD-A088 289 ROME AIR DEVELOPMENT CENTER GRIFFISS AFB NY F/6 5/1
INDUSTRY LOOKS AT RADC - 1980. VOLUME I.(U)
1980
UNCLASSIFIED RADC-TR-80-195-VOL-1 NL

2 OF 4
AD A088289




1.0
2.8
2.5
2.2
1.1
2.0
1.8
1.25
1.4
1.6

# COMMAND CONTROL COMMUNICATIONS COUNTERMEASURES ($C^3CM$)

PROGRAM GOALS

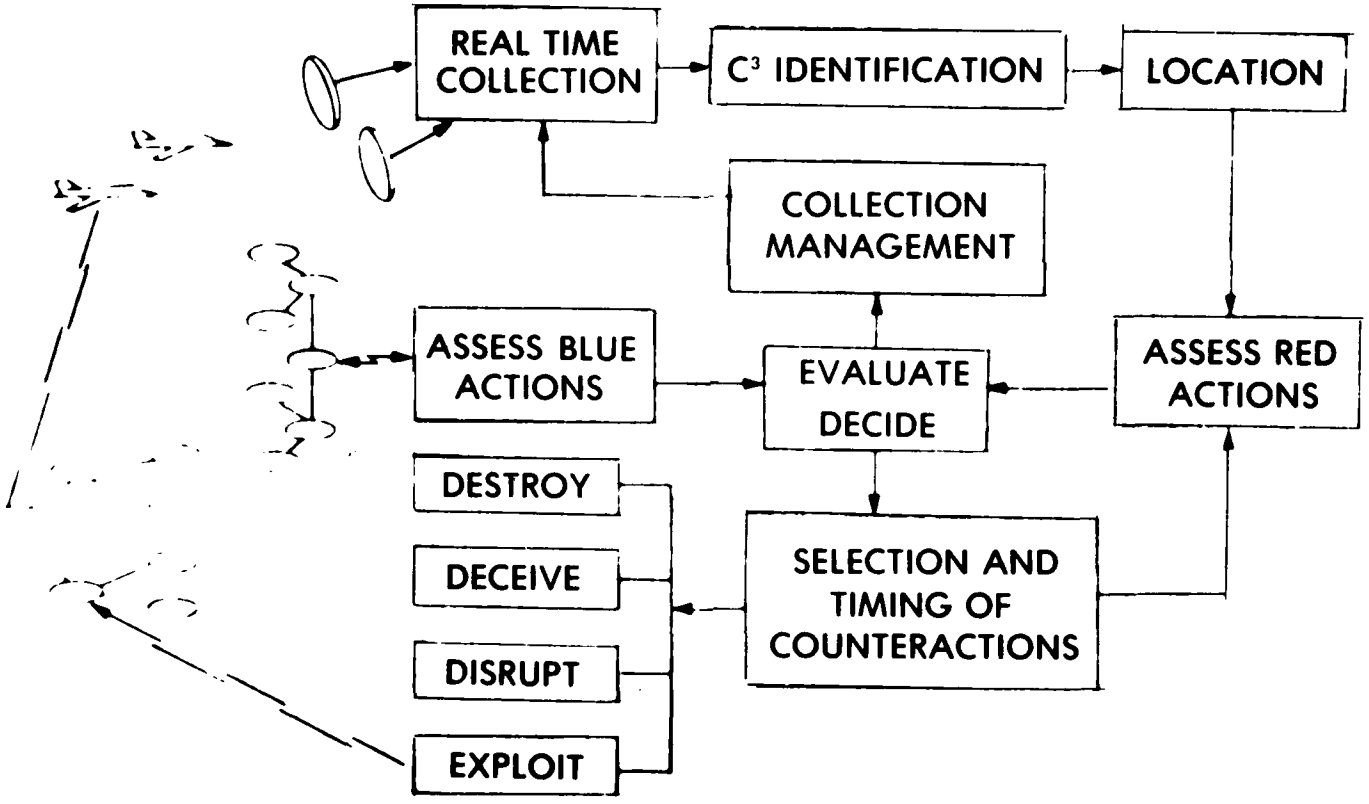
- EXPLOIT HIGH RATE, HIGH ACCURACY SENSORS
- BROAD BASE DECEPTION PROGRAM

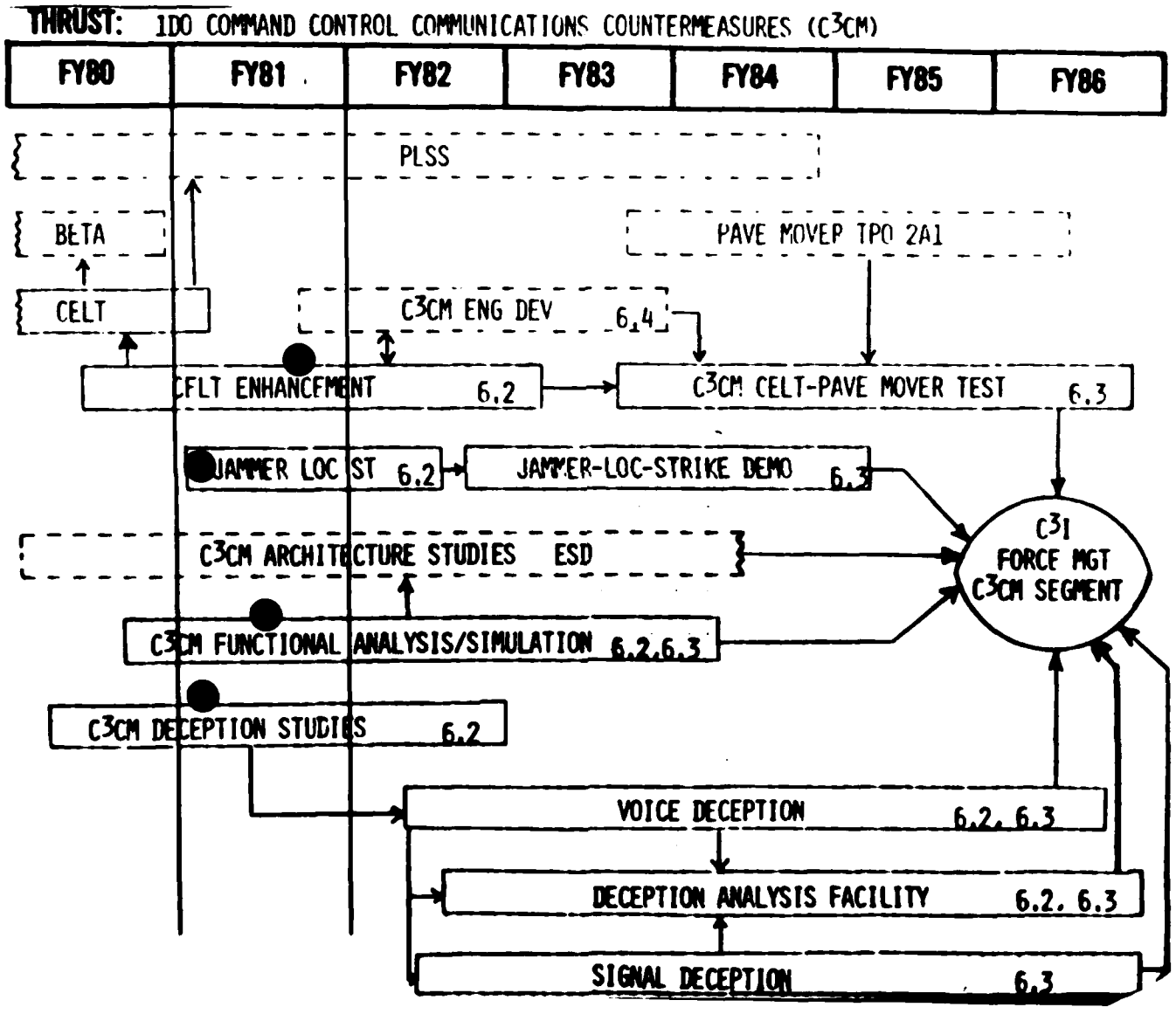
TECHNICAL AREAS

- CELT ENHANCEMENT/DATA COLLECTION
- $C^3CM$-$C^3$ FUNCTIONAL ANALYSIS
- JAMMER LOCATION
- VOICE DECEPTION
- COMMUNICATION-WEAPON LINK DECEPTION
- NAVIGATION DECEPTION

ESTIMATED FUNDING: FY 80-83 (IN THOUSANDS)
$16,715

# C²CM SYSTEM CONCEPT (NEW INITIATIVE)




THRUST: 1DO COMMAND CONTROL COMMUNICATIONS COUNTERMEASURES (C3CM)
FY80
FY81
FY82
FY83
FY84
FY85
FY86
PLSS
BETA
PAVE MOVER TPO 2A1
CELT
C3CM ENG DEV 6.4
CELT ENHANCEMENT 6.2
C3CM CELT-PAVE MOVER TEST 6.3
JAMMER LOC ST 6.2
JAMMER-LOC-STRIKE DEMO 6.3
C3CM ARCHITECTURE STUDIES ESD
C3CM FUNCTIONAL ANALYSIS/SIMULATION 6.2,6.3
C3CM DECEPTION STUDIES 6.2
C3I FORCE MGT C3CM SEGMENT
VOICE DECEPTION 6.2, 6.3
DECEPTION ANALYSIS FACILITY 6.2, 6.3
SIGNAL DECEPTION 6.3

# ADAPTIVE PROCESSING FOR COMM

**PROGRAM GOALS**

ADVANCE THE STATE-OF-THE-ART IN ADAPTIVE SPATIAL PROCESSING TO SATISFY ECCM REQUIREMENTS OF AF SYSTEMS AT AN AFFORDABLE COST

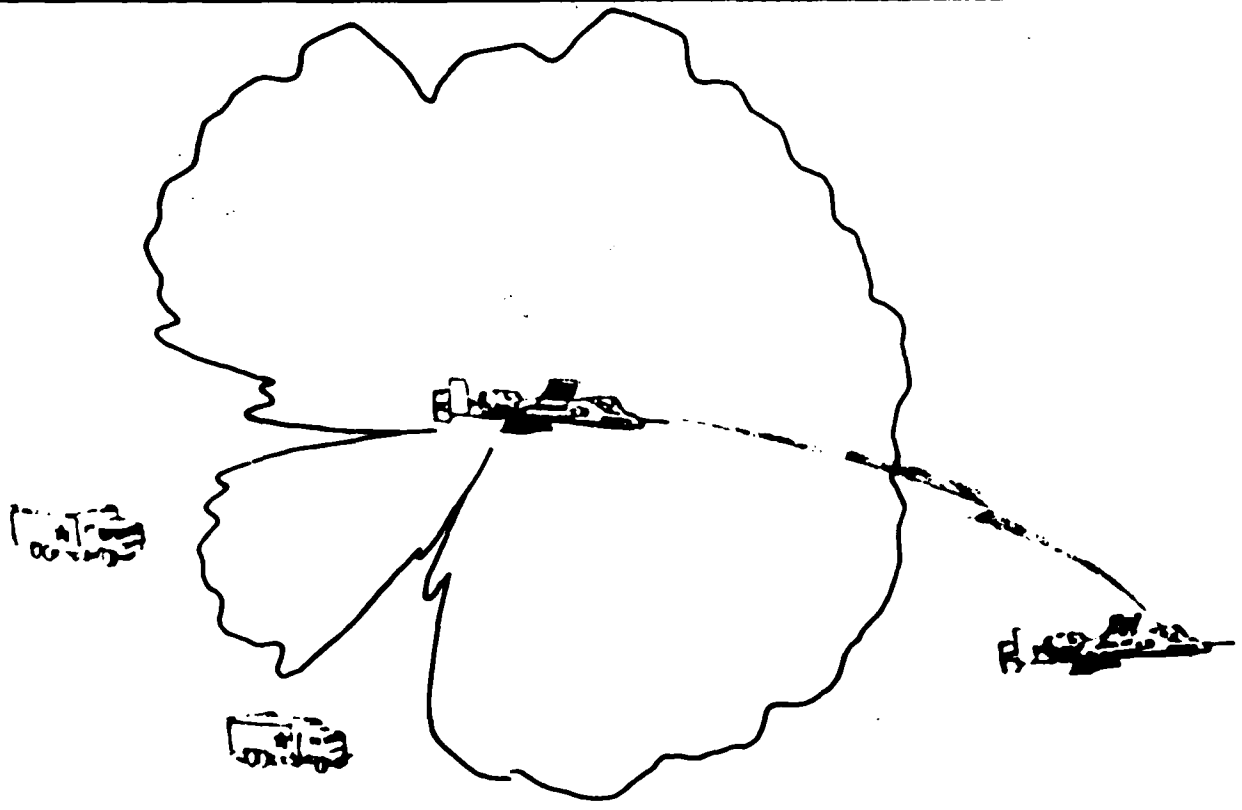
**TECHNICAL AREAS**

- ADAPTIVE ALGORITHMS
- ADAPTIVE PROCESSORS
- TEST METHODOLOGY OF ADAPTIVE ARRAYS

**ESTIMATED FUNDING:** FY80-83 (IN THOUSANDS)

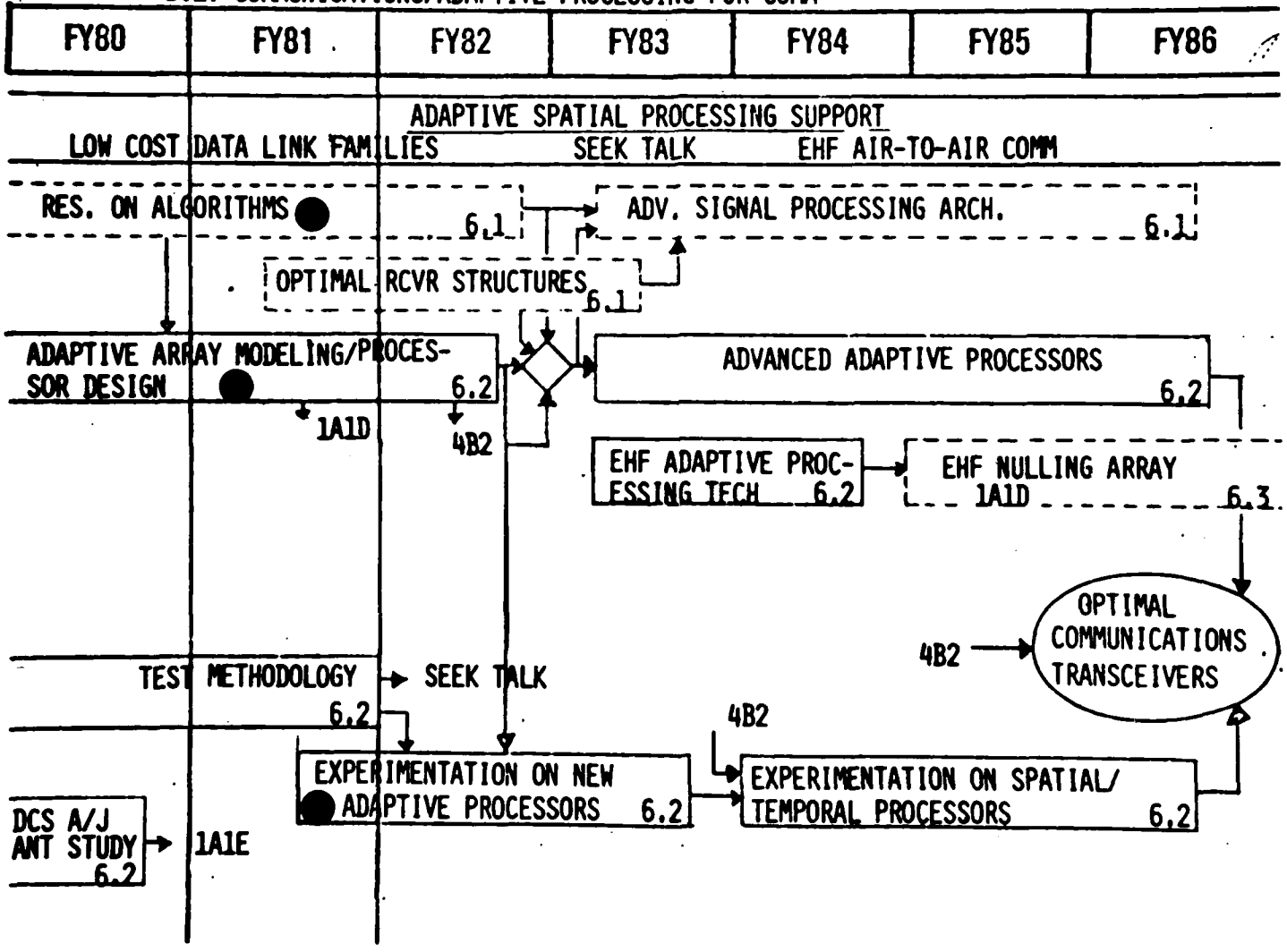
$2,754

# ADAPTIVE ANTENNA NULLING



RADC TPO 4. TECHNOLOGY

THRUST: B.1. COMMUNICATIONS/ADAPTIVE PROCESSING FOR COMM



# ADVANCED SURVIVABLE COMMUNICATIONS TECHNOLOGY

PROGRAM GOALS

ESTABLISH TECHNOLOGY BASE TO INSURE HIGHLY SURVIVABLE TACTICAL COMMAND, CONTROL & COMMUNICATIONS INFORMATION TRANSFER CAPABILITIES IN LIGHT OF PROJECTED THREAT



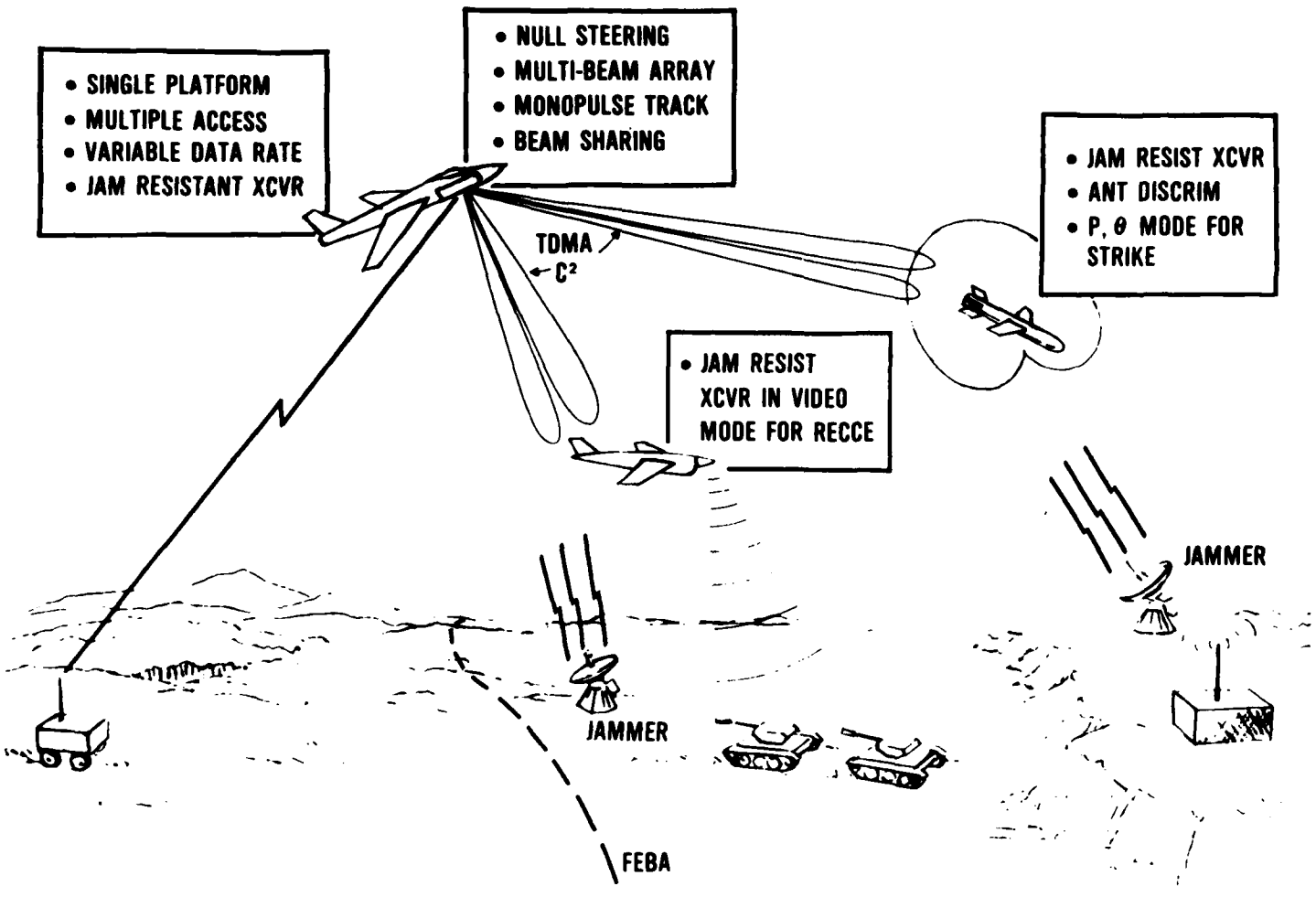
TECHNICAL AREAS

- SPREAD SPECTRUM
- ADAPTIVE INTERFERENCE REJECTION
- LOW PROBABILITY OF INTERCEPT
- PROGRAMMABLE DEVICES/SIGNAL PROCESSORS

ESTIMATED FUNDING: FY80-83 (IN THOUSANDS)

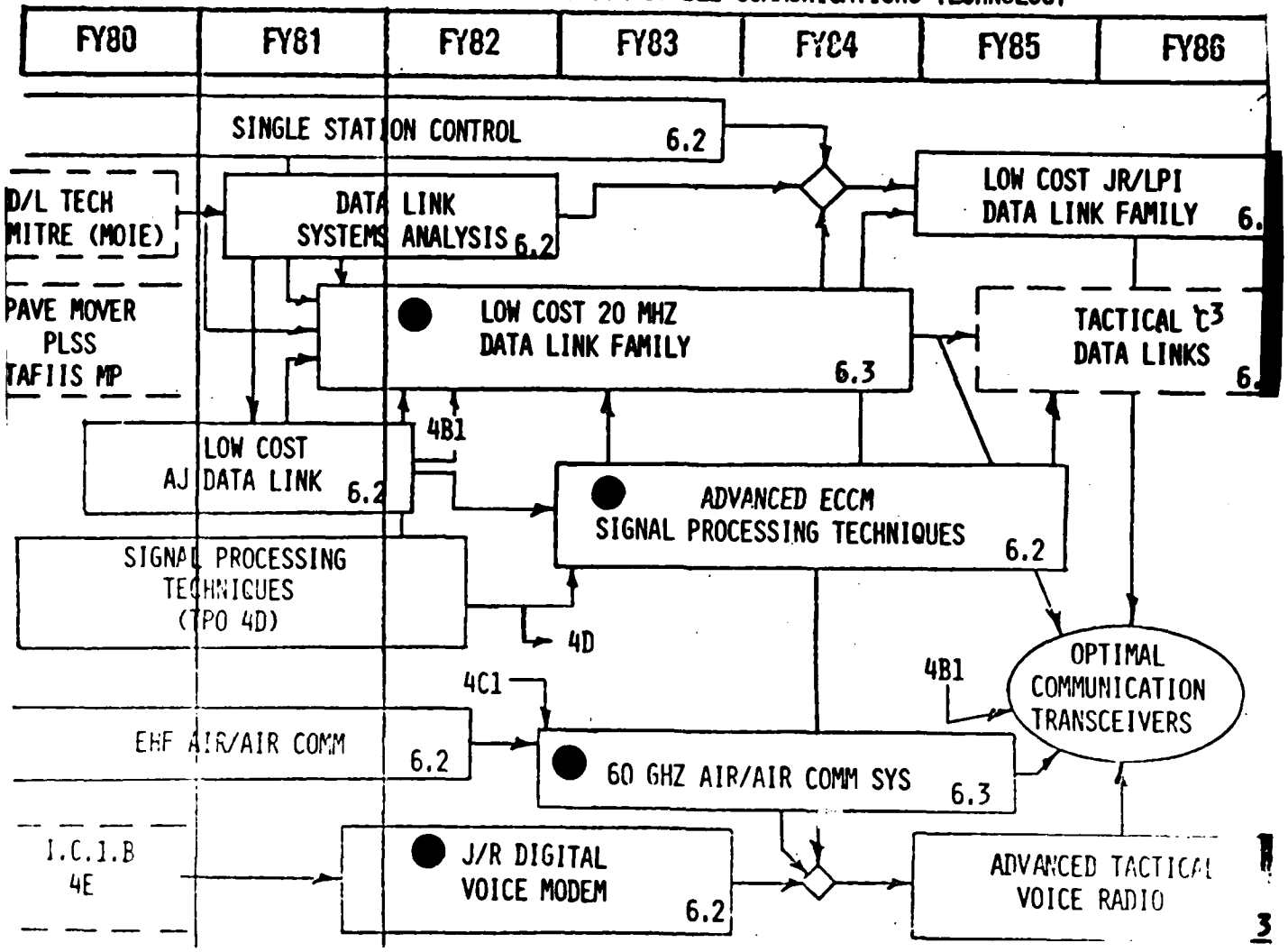
$6,786

# LOW COST JAM RESISTANT DATA LINK



FORCE TPO 4 - TECHNOLOGY

THRUST: B2 - COMMUNICATIONS/ADVANCED SURVIVABLE COMMUNICATIONS TECHNOLOGY



# $C^3$ SYSTEM DESIGN & ANALYSIS

PROGRAM GOALS

- EVOLVE NEW $C^2$ COMMUNICATIONS CONCEPTS/TECHNIQUES TO ENHANCE EXISTING SYSTEMS
- EVALUATION OF ADVANCED SYSTEM TECHNIQUES/CONCEPTS

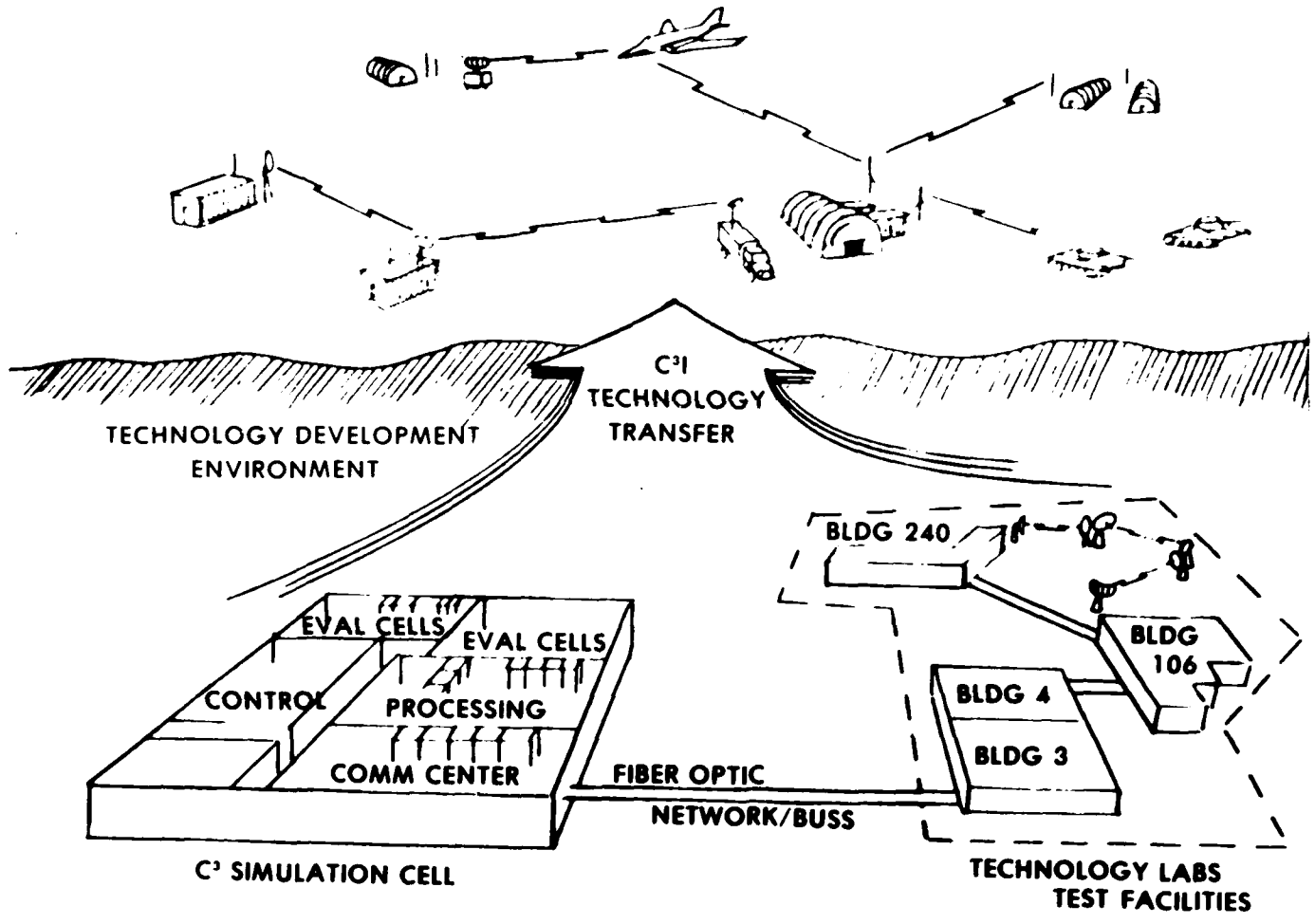
TECHNICAL AREAS

- COMMUNICATIONS DISTRIBUTION
- INTERFACES
- PROTOCOLS
- SIMULATION

ESTIMATED FUNDING: FY80-83 (IN THOUSANDS)

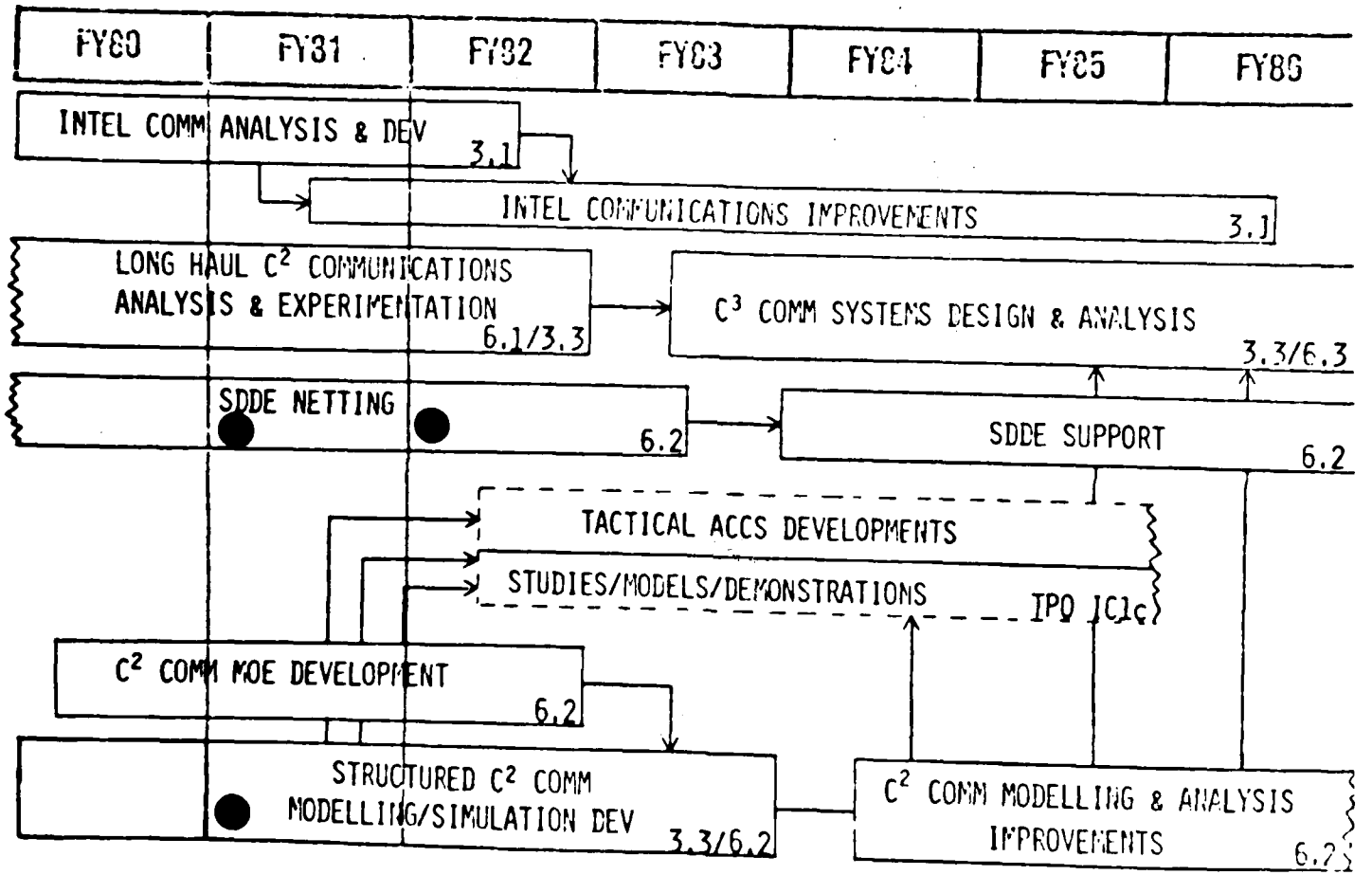
$7,419

# SDDE


C³I
TECHNOLOGY
TRANSFER
TECHNOLOGY DEVELOPMENT
ENVIRONMENT
BLDG 240
BLDG
106
EVAL CELLS
EVAL CELLS
CONTROL
PROCESSING
COMM CENTER
BLDG 4
BLDG 3
FIBER OPTIC
NETWORK/BUSS
C³ SIMULATION CELL
TECHNOLOGY LABS
TEST FACILITIES

TPO/THRUST: 4B/COMMUNICATIONS

SUB-THRUST: 3/$C^3$ SYSTEM DESIGN & ANALYSIS



# KEY PROGRAM MANAGERS

| | | | |
|---|---|---|---|
| SUPPORT $C^3$ | — | H. CROWLEY, RADC/DC | x3041 |
| STRATEGIC $C^3$ | — | L. DOUBLEDAY, RADC/DCC | x3171 |
| TACTICAL $C^3$ | — | J. KELLY, RADC/DCL | x7667 |
| $C^3$ COUNTERMEASURES | — | D. ZULCH, RADC/DCI | x4175 |
| COMMUNICATIONS TECHNOLOGY | — | A. SNYDER, RADC/DCC | x3171 |

# ELECTROMAGNETICS

LT COL WILLIAM BASCHNAGEL

IPO/THRUST: 4 TECHNOLOGY/4C ELECTROMAGNETICS

OBJECTIVE: BETTER PERFORMANCE OF AIR FORCE $C^3$ SYSTEMS THROUGH IMPROVEMENTS IN ELECTROMAGNETICS TECHNOLOGY (ANTENNAS, EM SCATTERING, AND PROPAGATION)

GOALS: IMPROVED ANTENNAS AND RF COMPONENTS
TARGET, CLUTTER, AND MULTIPATH MODELS FOR ADVANCED COMM & SURV SYSTEMS
NEW RF PROPAGATION TECHNOLOGY FOR GREATER $C^3$ SYSTEM CAPABILITY

TECHNICAL APPROACH: LIGHTWEIGHT ARRAY TECHNOLOGY FOR LARGE AIRCRAFT ANTENNAS
EHF LOW PROFILE AND CONFORMAL ANTENNAS
DUAL FREQUENCY BAND ARRAYS, ADAPTIVE SUBARRAY NULLING
TAPPED DELAY SAW CORRELATORS, NOVEL RF PHASOR TECHNOLOGY
INCLUSION OF TERRAIN GRADIENTS AND SCREENING IN CLUTTER/ MULTIPATH PREDICTIVE MODELING
CLOUD ATTENUATION AND BEYOND LOS DIFFRACTION MEASUREMENTS
PREDICTION OF PROPAGATION-CAUSED OUTAGE OF OTH RADAR

TPO/THRUST: 4 TECHNOLOGY/4C ELECTROMAGNETICS

SUB/THRUST: 4C10 ANTENNAS

PROGRAM GOALS:

- DEVELOP ADVANCED ANTENNA TECHNOLOGY FOR GROUND BASED, SPACE BASED AND AIRCRAFT APPLICATIONS

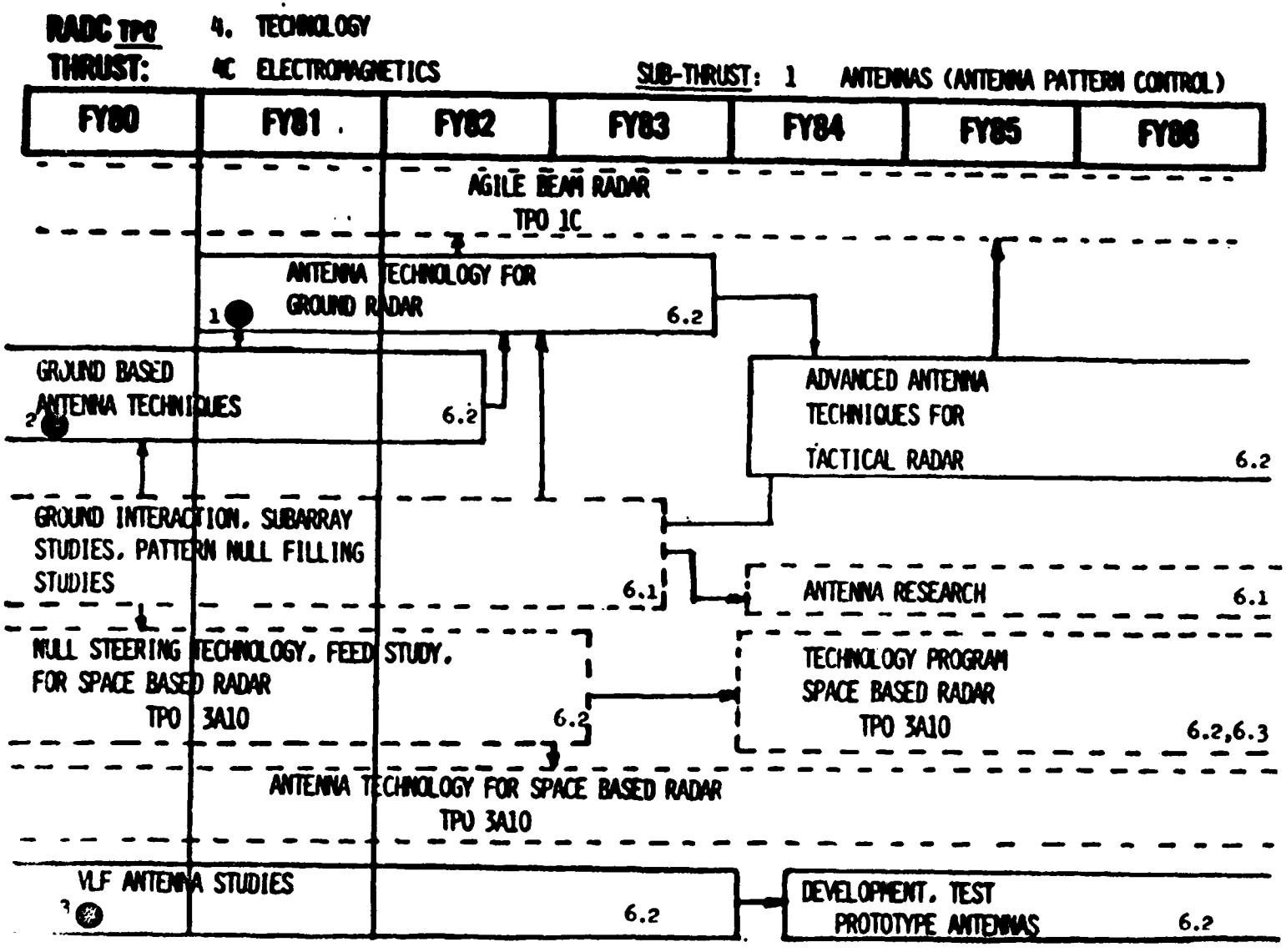
TECHNICAL AREAS:

- DETERMINISTIC AND ADAPTIVE RADIATION PATTERN CONTROL
- LOW PROFILE AND CONFORMAL AIRCRAFT ANTENNAS
- LONG WAVE ANTENNAS



PROGRAMS:

| | |
|---|---|
| 61102F | BASIC RESEARCH IN ANTENNA FEED AND PATTERN CONTROL |
| 62702F | EXPLORATORY DEVELOPMENT - ANTENNAS AND ARRAYS |
| 63431F | LOW PROFILE ANTENNAS FOR SATCOM |


RADC TPO 4. TECHNOLOGY
THRUST: 4C ELECTROMAGNETICS
SUB-THRUST: 1 ANTENNAS (ANTENNA PATTERN CONTROL)
FY80
FY81
FY82
FY83
FY84
FY85
FY86
AGILE BEAM RADAR
TPO 1C
ANTENNA TECHNOLOGY FOR GROUND RADAR
6.2
1
GROUND BASED ANTENNA TECHNIQUES
6.2
2
ADVANCED ANTENNA TECHNIQUES FOR TACTICAL RADAR
6.2
GROUND INTERACTION. SUBARRAY STUDIES. PATTERN NULL FILLING STUDIES
6.1
ANTENNA RESEARCH
6.1
NULL STEERING TECHNOLOGY. FEED STUDY. FOR SPACE BASED RADAR
TPO 3A10
6.2
TECHNOLOGY PROGRAM SPACE BASED RADAR
TPO 3A10
6.2,6.3
ANTENNA TECHNOLOGY FOR SPACE BASED RADAR
TPO 3A10
VLF ANTENNA STUDIES
3
6.2
DEVELOPMENT. TEST PROTOTYPE ANTENNAS
6.2

TPO/THRUST: 4C ELECTROMAGNETICS

SUB/THRUST: 4C10 ANTENNAS (ANTENNA PATTERN CONTROL)

EFFORT BLOCK TITLE: ANTENNA TECHNOLOGY FOR GROUND RADAR

OBJECTIVE: DEVELOP NEW ANTENNA TECHNOLOGY WITH IMPROVED ECCM FEATURES FOR GROUND BASED RADAR

TECHNICAL APPROACH: CONSTRAINED FEED SUBARRAY
DUAL BAND ARRAY FOR THE RADAR
ADAPTIVE SPACE FED ANTENNA SYSTEM
WIDE BAND LENS AND SUBARRAY STUDIES

PAYOFF: ANTENNA TECHNIQUES FOR RADAR SYSTEMS

LOW COST, HIGH PERFORMANCE RADAR SYSTEMS

THRUST: 4C ELECTROMAGNETICS

SUB/THRUST: 4C10 ANTENNAS

BLOCK TITLE: VLF ANTENNA STUDIES

OBJECTIVE: FURNISH AF C3 MISSION WITH NEW ANTENNA TECHNOLOGY FOR VLF EMERGENCY COMMUNICATIONS/JAM RESISTANT COMMUNICATION MODES

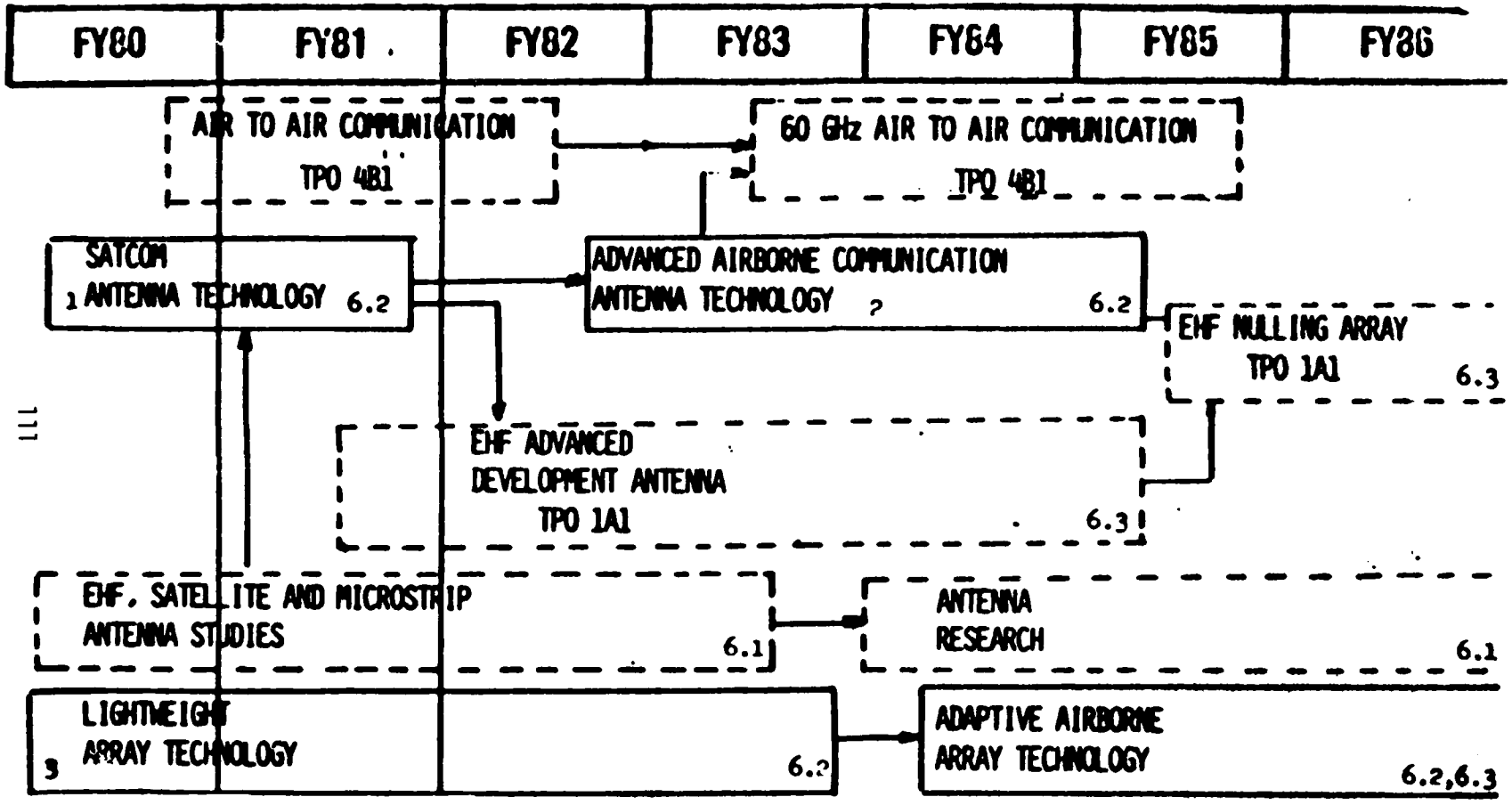
TECHNICAL APPROACH: EXAMINE RADIATION AND EFFICIENCY OF VLF LOOP AND GROUND BASED TE ANTENNAS. ANALYZE DISPERSIBLE ANTENNA AND POTENTIAL SUB-CUTOFF FREQUENCY ANTENNAS

PAY OFF: EXTENSION OF VLF COMMUNICATIONS RANGE, RELIABILITY, AND SURVIVABILITY

RADC TPO 4 TECHNOLOGY

THRUST: 4C ELECTROMAGNETICS

SUB-THRUST: 1 ANTENNAS (CONFORMAL AND HEMI-SCAN)



TPO THRUST: 4C ELECTROMAGNETICS

SUB/THRUST: 4C10 ANTENNAS (CONFORMAL AND HEMISPHERICAL COVERAGE ANTENNAS)

BLOCK TITLE: ADVANCED AIRBORNE COMMUNICATIONS ANTENNA TECHNOLOGY

OBJECTIVE: DEVELOP LOW COST LIGHTWEIGHT CONFORMAL ARRAY TECHNOLOGY WITH ADVANCED ECCM FEATURES FOR SATELLITE COMMUNICATION

TECHNICAL APPROACH: EXTEND PRINTED CIRCUIT ARRAY TECHNOLOGY TO EHF FREQUENCIES. INVESTIGATE USE OF ADVANCED MEANS OF NULLING, SIDELOBE CONTROL AND MULTIPLE FREQUENCY OPERATION. DEVELOP 60 GHz ANTENNA TECHNIQUES

PAY OFF: SUBSTANTIAL INCREASE IN SATCOM AND AIR-AIR ANTENNA PERFORMANCE THROUGH WIDEBAND NULL STEERING AND MULTIPLE FREQUENCY FEEDS

TPO/THRUST: 4C ELECTROMAGNETICS

SUB/THRUST: 4C10 ANTENNAS (CONFORMAL AND HEMISPHERICAL COVERAGE ANTENNAS)

EFFORT BLOCK TITLE: LIGHTWEIGHT ARRAY TECHNOLOGY

OBJECTIVE: TO DEVELOP LIGHTWEIGHT HIGH PERFORMANCE ANTENNAS FOR AIRBORNE RADAR AND COMMUNICATIONS APPLICATIONS



TECHNICAL APPROACH: VERY HIGH GAIN PRINTED CIRCUIT ANTENNAS FOR SAC COMMUNICATIONS
ADAPTIVE LOW SIDELOBE ARRAY FOR ADVANCED SURVEILLANCE RADAR

PAY OFF: LOW COST, LIGHTWEIGHT AIRCRAFT ARRAYS WOULD GREATLY INCREASE THE RANGE AND STATION TIME OF AIRBORNE SYSTEMS IN COMPARISON WITH ROTATING FIXED BEAM ANTENNAS

TPO/THRUST: RADC TPO 4C ELECTROMAGNETICS

SUB/THRUST: 4C20 RF COMPONENTS

PROGRAM GOALS: DEVELOP LOW COST, COMPACT RF COMPONENTS FOR $C^3I$ SYSTEMS

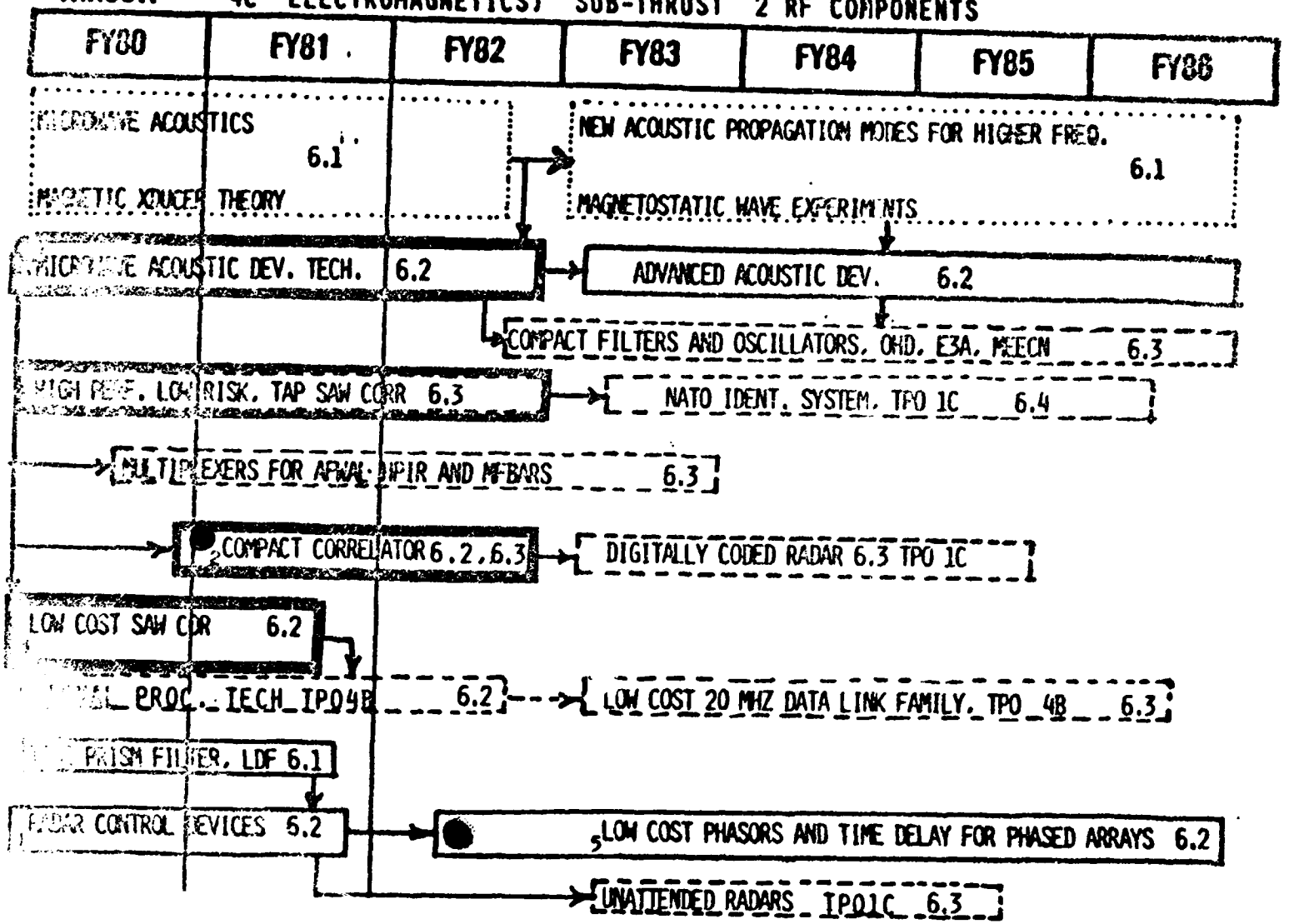
TECHNICAL AREAS:
- SURFACE ACOUSTIC WAVES (SAW)
- MAGNETOSTATIC WAVES (MSW)
- RF SWITCHES AND PHASE SHIFTERS

PROGRAMS:

| | |
|---|---|
| 61102F | RESEARCH IN MICROWAVE ACOUSTICS AND MAGNETICS |
| 62702F | EXPLORATORY DEVELOPMENT - RF COMPONENTS |
| 63789F | COMPACT CORRELATORS - WIDE BAND RADARS |
| 63742F | SAW CORRELATORS - NIS |
| 63718F | MULTIPLEXERS FOR HPIR |

**RADC TPO** 4 - TECHNOLOGY

**THRUST:** 4C ELECTROMAGNETICS, SUB-THRUST 2 RF COMPONENTS



TPO/THRUST: RADC TECHNOLOGY 4C ELECTROMAGNETICS

SUB/THRUST: RF COMPONENTS/4C20

EFFORT BLOCK TITLE: (1) MICROWAVE ACOUSTIC DEVICE TECHNOLOGY

TECHNICAL APPROACH: REDUCE AGING OF SAW OSCILLATORS, IMPROVE TIME-SPURIOUS PERFORMANCE OF SAW MULTIPLEXERS, DEVELOP LOW INTERMODULATION PRODUCT HF/VHF FILTERS, DEVELOP HIGH-Q MULTITONE FREQUENCY SYNTHESIZERS USING NEW BULK OVERTONE RESONATORS, DEVELOP BULK ACOUSTIC RESONATORS WITH HIGHER COUPLING AND Q THAN QUARTZ FOR MEDIUM-FREQUENCY FILTERS, AND DEVELOP HIGH FREQUENCY SAW CONVOLVERS.

PAYOFF: THE DEVELOPMENT OF NEW BULK AND SAW TECHNOLOGY WILL HAVE A HIGH PAYOFF FOR A LARGE NUMBER OF $C^3I$ SYSTEMS (OHD AND DCR RADAR, MEECN, NIS, JTIDS, AND E3A). SAW COMPONENTS ARE SMALL, LIGHTWEIGHT, LOW-COST RADIATION-HARDENED, AND PROVIDE NEW OPERATIONAL CAPABILITIES.

TPO/THRUST: RADC TECHNOLOGY/4C/ELECTROMAGNETICS

SUB/THRUST: RF COMPONENTS/4C20

EFFORT BLOCK TITLE: COMPACT CORRELATOR (2)

OBJECTIVES: REDUCE SIZE, WEIGHT, AND COST OF WIDE-BAND TACTICAL RADAR CORRELATORS

TECHNICAL APPROACHES: ACHIEVE A PROCESSING GAIN OF 47 DB BY ADVANCING SAW CORRELATOR TECHNOLOGY AND/OR NOVEL APPROACHES FOR COMBINING SAW AND CCD/DIGITAL CORRELATORS

PAY OFF: NEW TECHNOLOGY WILL OVERCOME THE PRESENT SIZE-WEIGHT LIMITATIONS OF TACTICAL SPREAD-SPECTRUM RADAR PROCESSORS

TPO/THRUST: RADC TECHNOLOGY/4C/ELECTROMAGNETICS

SUB/THRUST: RF COMPONENTS/4C20

EFFORT BLOCK TITLE: (5) LOW COST PHASORS AND TIME DELAY UNITS

OBJECTIVE: DEVELOP LOW-COST, 6-BIT PHASE SHIFTERS. DEVELOP ELECTRONICALLY VARIABLE, WIDEBAND ELECTRONICALLY VARIABLE TIME DELAY UNITS

TECHNICAL APPROACH: NEW TECHNOLOGICAL APPROACHES FOR LOW-COST, 6-BIT PHASE SHIFTERS WILL BE EXPERIMENTALLY INVESTIGATED. MAGNETO-STATIC WAVE TECHNOLOGY WILL BE ADVANCED TO DEMONSTRATE ELECTRONICALLY VARIABLE TIME DELAY UNITS FOR TACTICAL PHASED ARRAYS

PAY OFF: ELECTRONICALLY VARIABLE TIME DELAY UNITS ARE ESSENTIAL TO MAINTAIN POINTING ACCURACY FOR PHASED ARRAYS, WHICH USE WIDE-BAND SPREAD SPECTRUM WAVEFORMS FOR ANTI-JAM. COMPACT MAGNETOSTATIC WAVE UNITS PROMISE TO REPLACE BULKY SWITCHED COAXIAL LINES.

THRUST: 4C ELECTROMAGNETICS

SUB/THRUST: 4C30 ELECTROMAGNETICS OF TARGETS AND ENVIRONMENT

PROGRAM GOALS: DEVELOPMENT OF TARGET, CLUTTER AND MULTIPATH MODELS USEFUL IN THE DESIGN AND EVALUATION OF ADVANCED COMMUNICATIONS AND SURVEILLANCE SYSTEMS

- MEASUREMENTS
- FUNDAMENTAL STUDIES
- PHENOMENOLOGICAL CHARACTERIZATION

TECHNICAL AREAS:

- TARGET SCATTERING AND MODELING
- TERRAIN AND FOLIAGE SCATTERING
- TARGET/MULTIPATH COHERENCE MODELING
- CLUTTER SENSITIVITY AND REAL TIME PREDICTION
- BISTATIC/SPREAD SPECTRUM CLUTTER/MULTIPATH MODELING
- APPLICATIONS

PROGRAMS:

| | |
|---|---|
| 61102F | BASIC RESEARCH IN ELECTROMAGNETIC SCATTERING |
| 62702F | EXPLORATORY DEVELOPMENT |
| PEACE HAWK | PROPAGATION STUDIES |

THRUST: 4C - ELECTROMAGNETICS

SUB-THRUST: 4C30 ELECTROMAGNETICS OF TARGETS AND ENVIRONMENT

SIGNIFICANT PROGRAM CHANGES

- SUB-THRUST FOCUS ON CLUTTER/MULTIPATH AND TARGET CHARACTERIZATION, MEASUREMENTS, AND MODELING
- INCREASED STRESS ON GROUND REFLECTIVITY MODELING
- FUTURE PROGRAMS IN CLUTTER MEASUREMENTS AND TARGET/MULTIPATH COHERENCE

THRUST: 4C - ELECTROMAGNETICS

SUB-THRUST: 4C30 ELECTROMAGNETICS OF TARGETS AND ENVIRONMENT

CLUTTER/MULTIPATH MODELING DEFICIENCIES

- DATA AND MODEL REQUIREMENTS
  - LOW DEPRESSION ANGLE
  - BISTATIC
  - SPREAD SPECTRUM
  - AIRBORNE CLUTTER
  - TERRAIN AND FOLIAGE SCREENING
- MODELING TECHNOLOGY
  - THEORETICAL - EXPERIMENTAL CORRELATION
  - HETEROGENEOUS CLUTTER MODELING
  - TARGET - CLUTTER COUPLING
- MEASUREMENT TECHNIQUES
  - STANDARDIZATION AND CALIBRATION
  - COST

THRUST: 4C - ELECTROMAGNETICS

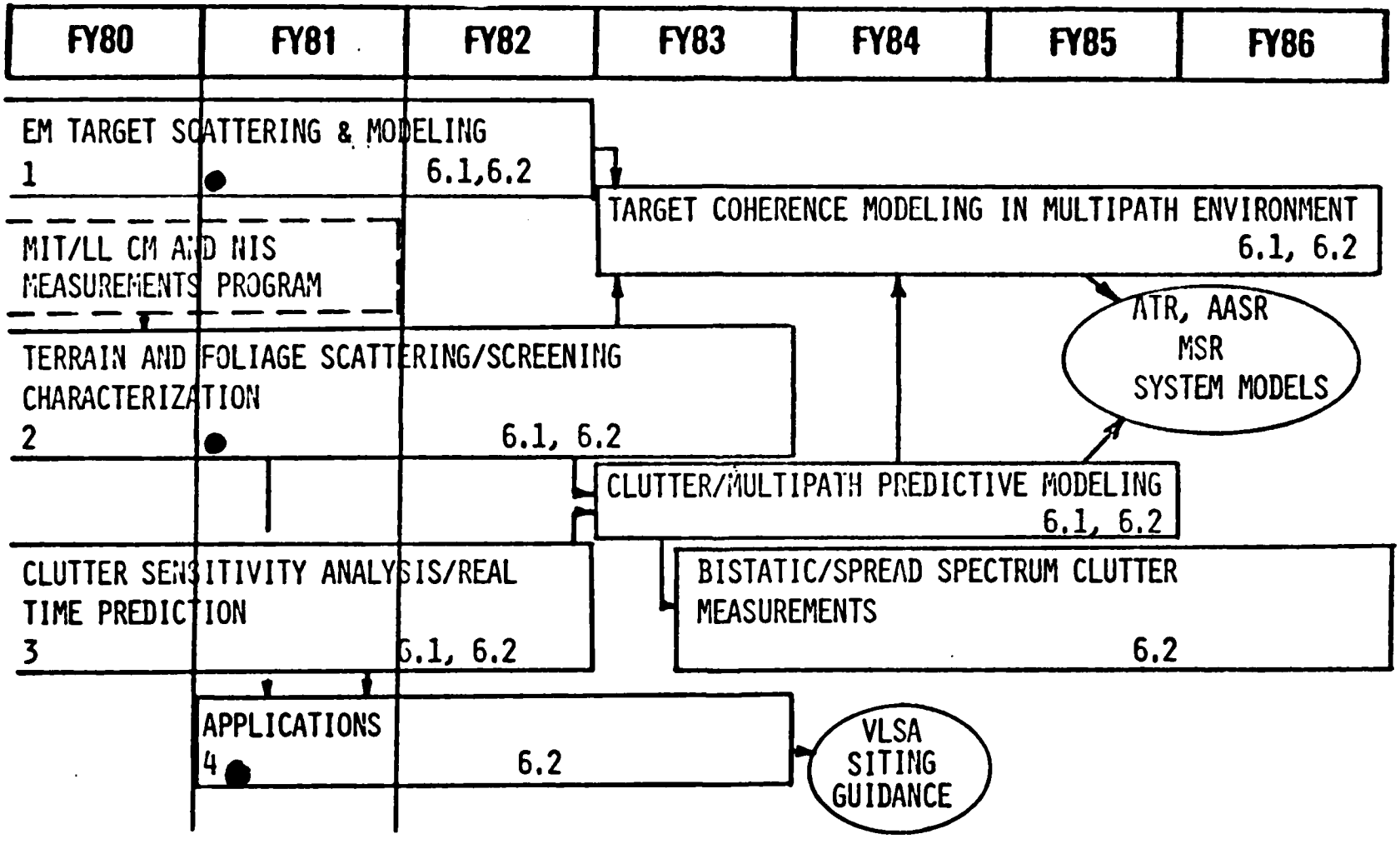
SUB-THRUST: 4C30 ELECTROMAGNETICS OF TARGETS AND ENVIRONMENT

## PROGRAM FEATURES

- ADVANCED EM SCATTERING THEORIES
- NEW STATISTICAL CHARACTERIZATION OF TERRAIN PROPERTIES
- MEASUREMENTS AND COMPARISON WITH THEORY
- SENSITIVITY ANALYSIS FOR PHENOMENOLOGICAL MODELS
- ADVANCED STOCHASTIC MODELING OF COHERENCE PROPERTIES

**RADC TPO** 4 - TECHNOLOGY

**THRUST:** 4C ELECTROMAGNETIC; 4C30 ELECTROMAGNETIC OF TARGETS AND ENVIRONMENT



THRUST: 4C ELECTROMAGNETICS

SUB/THRUST: 4C30 ELECTROMAGNETICS OF TARGETS AND ENVIRONMENT

BLOCK TITLE: EM TARGET SCATTERING AND MODELING

OBJECTIVE:

- DEVELOP TECHNIQUES TO COMPUTE AND MEASURE THE ELECTROMAGNETIC SCATTERING FROM TARGETS
- DEVELOP PRACTICAL TARGET MODELS FOR RADAR SYSTEM ANALYSIS/SPECIFICATION

TECHNICAL APPROACH:

- ADVANCED COMPUTATIONAL AND MODELING PROCEDURES
- FIELD MEASUREMENT TECHNIQUES
- TARGET - CLUTTER INTERACTION MODELS

PAY OFF: ADVANCED TARGET MODELS FOR SPREAD SPECTRUM/BISTATIC DETECTION SYSTEM ANALYSIS AND SPECIFICATION

THRUST: 4C ELECTROMAGNETICS

SUB/THRUST: 4C30 ELECTROMAGNETICS OF TARGETS AND ENVIRONMENT

BLOCK TITLE: TERRAIN AND FOLIAGE SCATTERING/SCREENING CHARACTERIZATION

OBJECTIVE:

- DEVELOP AND CONFIRM IMPROVED TERRAIN SCATTERING MODELS FOR CLUTTER/MULTIPATH PREDICTION
- DEVELOP TECHNIQUES FOR OBTAINING SENSITIVE MODEL PARAMETERS FROM TOPOGRAPHIC MAPS AND OTHER SOURCES

TECHNICAL APPROACH:

- ROUGH SURFACE SCATTERING THEORIES
- SURFACE FEATURE EXTRACTION TECHNIQUES

PAY OFF: IMPROVED GROUND CLUTTER/MULTIPATH CHARACTERIZATION AND MORE EFFECTIVE USE OF MODERN RADAR SYSTEM CLUTTER SUPPRESSION AND DETECTION TECHNOLOGY

THRUST: 4C ELECTROMAGNETICS

SUB/THRUST: 4C30 ELECTROMAGNETICS OF TARGETS AND ENVIRONMENT

BLOCK TITLE: APPLICATIONS

OBJECTIVE: EVALUATE ENVIRONMENTAL CONSTRAINTS ON PERFORMANCE OF VERY LOW SIDE ANTENNAS AND INTERFERENCE BETWEEN SPREAD SPECTRUM SYSTEMS

TECHNICAL APPROACH:

- DETERMINE DEGRADED SIDELOBE LEVEL DUE TO SPECULAR AND DIFFUSE GROUND REFLECTIVITY; DEVELOP SITING CRITERIA
- EVALUATE INTERFERENCE MODELS FOR GROUND SITED SPREAD SPECTRUM RADARS; DEVELOP INTERFERENCE REDUCTION CRITERIA

PAY OFF: SITING CRITERION AND IMPROVED FIELD PERFORMANCE

THRUST: 4C ELECTROMAGNETICS

SUB/THRUST: 4 PROPAGATION

PROGRAM GOALS: DEVELOP NEW RADIO WAVE PROPAGATION TECHNIQUES TO IMPROVE COMMUNICATION, NAVIGATION AND DETECTION CAPABILITIES WITHIN THE AIR FORCE

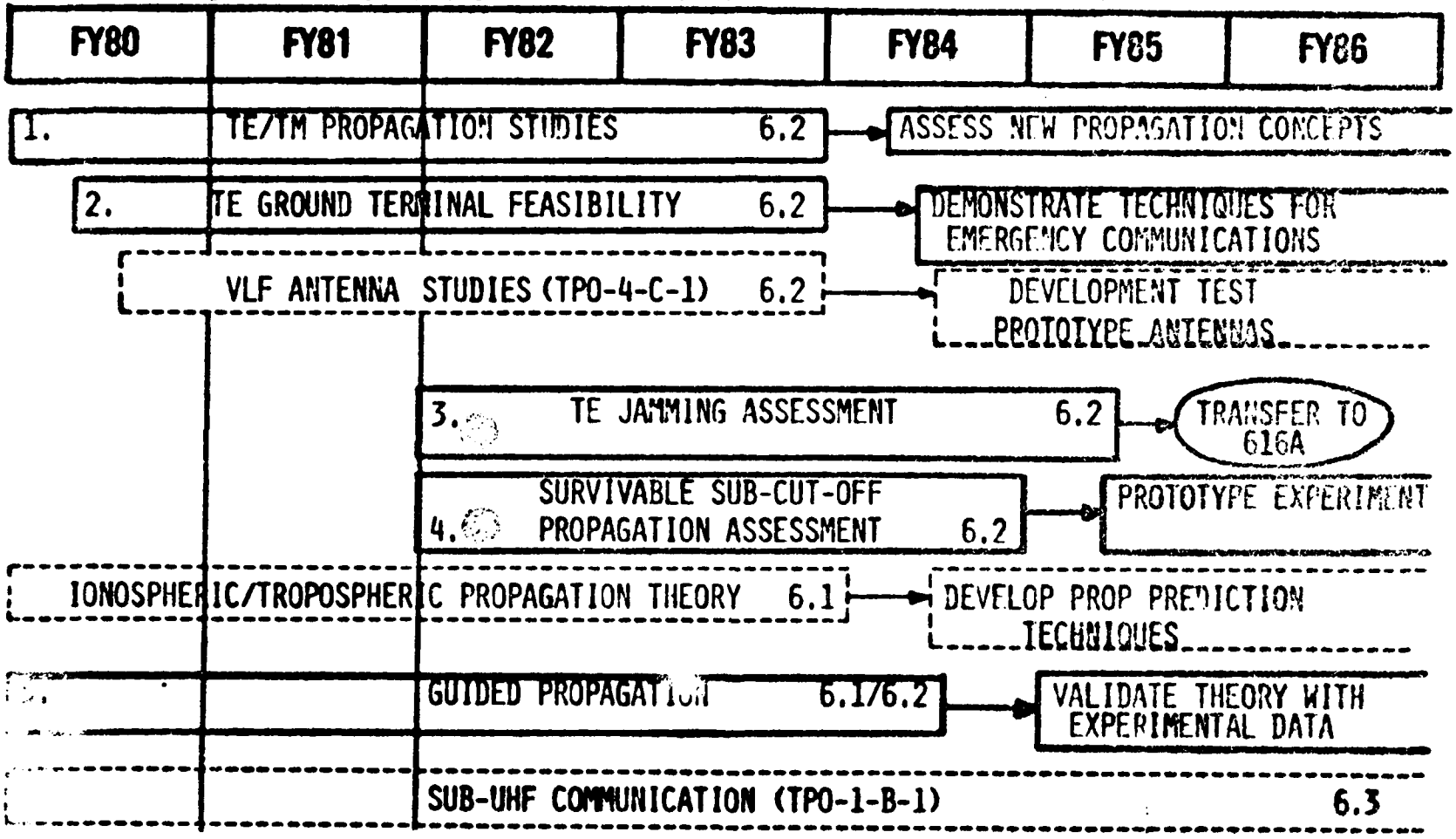
TECHNICAL AREAS: LONG-WAVE, MICROWAVE, HIGH-FREQUENCY PROPAGATION

PROGRAMS:

| | |
|---|---|
| 61102F | BASIC RESEARCH IN WAVE PROPAGATION THEORY, MICROWAVE PROPAGATION AND AURORAL CLUTTER |
| 62702F | EXPLORATORY DEVELOPMENT IN EM PROPAGATION |
| 63703F | CONUS OTH PROPAGATION SIMULATION |
| 33131F | MEECN MEASUREMENTS AND CALCULATIONS |

RADC TPO 4 TECHNOLOGY

THRUST: 4C ELECTROMAGNETICS SUB-THRUST: 4 PROPAGATION (LONGWAVE)



THRUST: 4C ELECTROMAGNETICS

SUB/THRUST: 4 PROPAGATION

BLOCK TITLE: TE JAMMING ASSESSMENT

OBJECTIVE: ASSESS INHERENT JAMMING/ANTI-JAM FEATURES OF TRANSVERSE ELECTRIC (TE) AND TRANSVERSE MAGNETIC (TM) MODES OF PROPAGATION

TECHNICAL APPROACH: DEVELOP TE/EM JAMMING ASSESSMENT MODELS (THEORETICAL) AND CONDUCT EXPERIMENTS USING EEP POWERLINE TRANSMITTING FACILITY IN NORTHERN GREENLAND. COMPARE THEORY AND EXPERIMENTAL DATA

PAY OFF: POSSIBLE EXPLOITATION OF THE PROPAGATION MEDIUM FOR JAMMING/ANTI-JAM PURPOSES.

THRUST: 4C ELECTROMAGNETICS

SUB-THRUST: 4 PROPAGATION

BLOCK TITLE: SURVIVABLE SUB CUT-OFF PROPAGATION ASSESSMENT

OBJECTIVE: DETERMINE FEASIBILITY/DESIRABILITY OF COMMUNICATIONS USING LONG RADIO WAVES WITH FREQUENCIES BELOW THE CUTOFF OF THE EARTH-IONOSPHERE WAVEGUIDE.



TECHNICAL APPROACH: DEVELOP PROPAGATION PREDICTION THEORY AND COMPUTER CODES FOR ASSESSING THE FEASIBILITY OF BELOW CUTOFF PROPAGATION, AND FOR DETERMINING ENGINEERING PARAMETERS FOR A DEMONSTRATION EXPERIMENT.

PAY-OFF: POSSIBLE NEW TECHNIQUE FOR SURVIVABLE, JAM-RESISTANT COMMUNICATIONS.

THRUST: 4C ELECTROMAGNETICS

SUB-THRUST: 4 PROPAGATION

BLOCK TITLE: GUIDED PROPAGATION

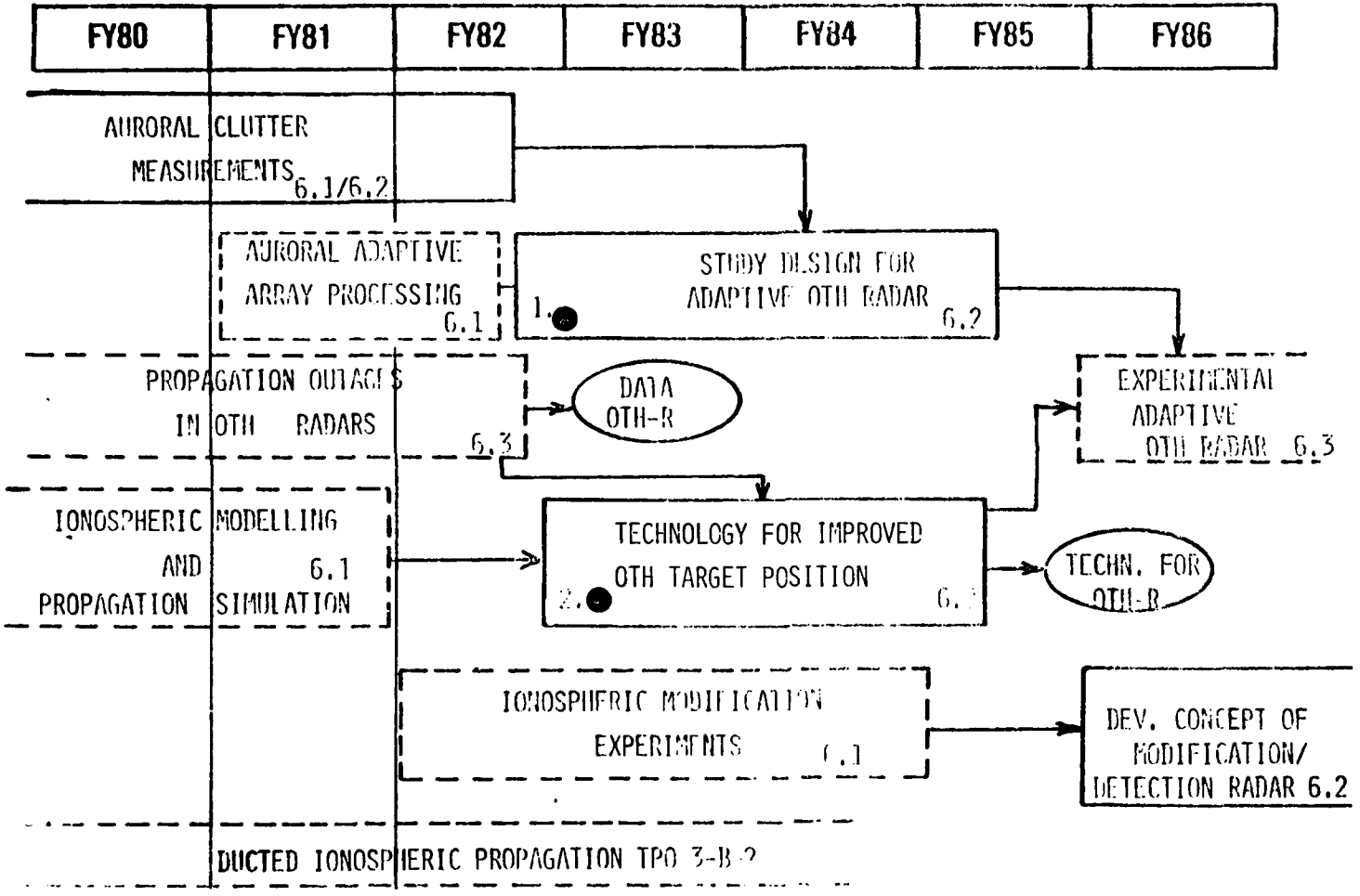
OBJECTIVE: DEVELOP MATHEMATICAL THEORY FOR SURFACE WAVE, TROPOSPHERIC DUCT AND WHISPERING GALLERY MODE



TECHNICAL APPROACH: COMBINE RAY WITH MODE SOLUTIONS AND TEST EXPERIMENTALLY

PAY-OFF: IMPROVE RANGE AND SECURITY OF COMMUNICATION LINKS

**RADC TPO 4 TECHNOLOGY**
**THRUST: 4C ELECTROMACNETICS SUB-THRUST: 4 PROPAGATION (HIGH-FREQUENCY)**



THRUST: 4C ELECTROMAGNETICS

SUB-THRUST: 4 PROPAGATION

BLOCK TITLE: STUDY DESIGN FOR ADAPTIVE OTH RADAR

OBJECTIVE: DEVELOP TECHNIQUE FOR ADAPTING OTH RADAR OPERATION TO COMPENSATE FOR AURORAL CLUTTER.



TECHNICAL APPROACH: USE DATA COLLECTED BY HIGH RESOLUTION AURORAL BACKSCATTER SOUNDING TO FORMULATE REQUIREMENTS FOR RADAR ANTENNA RESOLUTION AND DATA PROCESSING

PAY-OFF: IMPROVED TARGET VISIBILITY AND DETECTION PERFORMANCE OF OTH RADARS

THRUST: 4C ELECTROMAGNETICS

SUB-THRUST: 4 PROPAGATION

BLOCK TITLE: TECHNOLOGY FOR IMPROVED OTH TARGET POSITION

OBJECTIVE: DEVELOP REAL TIME TECHNIQUES FOR COMPENSATION OF IONOSPHERIC-INDUCED RADAR TARGET POSITION/MOVEMENT.

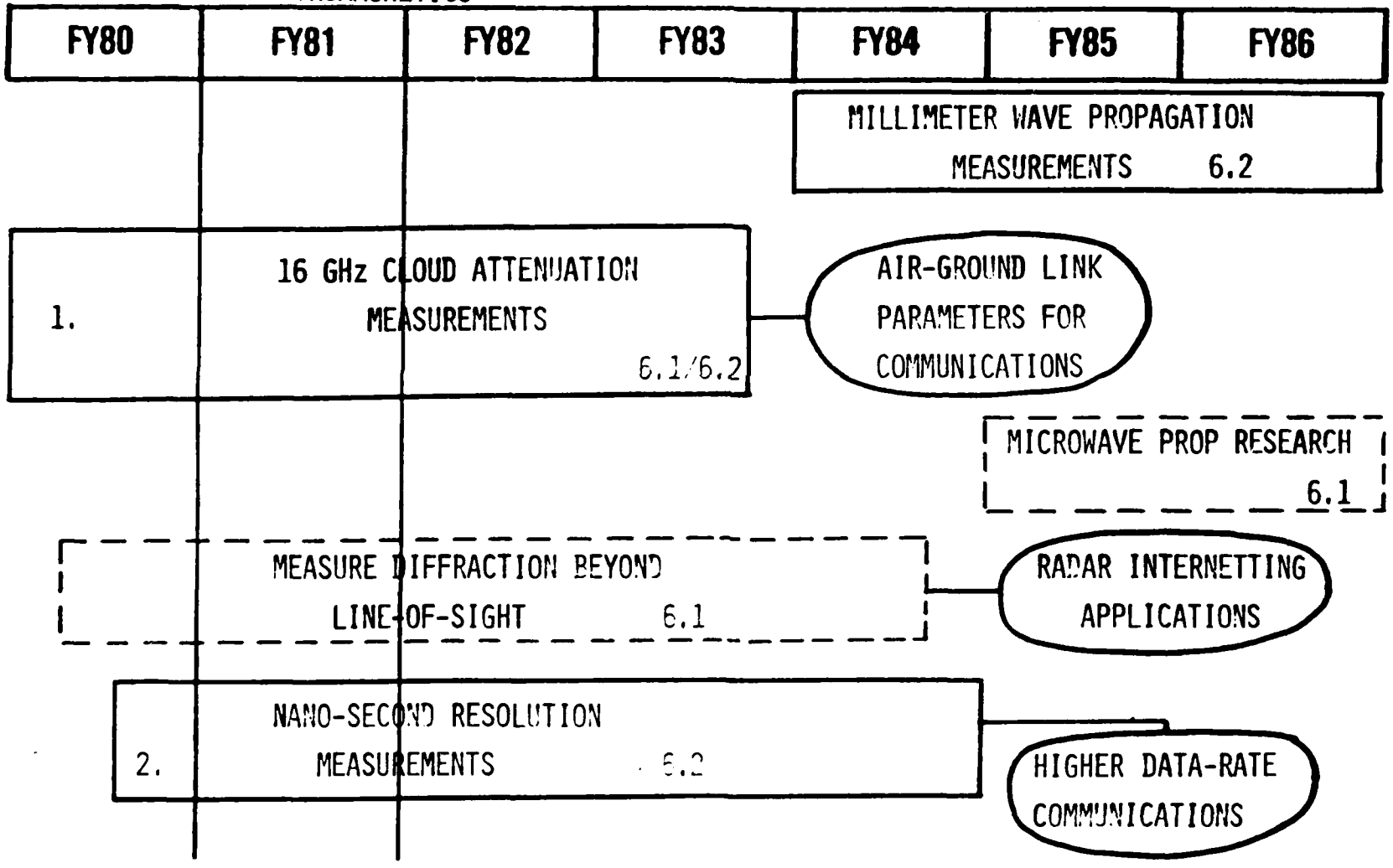


TECHNICAL APPROACH: DEVELOP SIMULATION PROCEDURES BASED ON IONOSPHERIC MODELS AND HIGH RESOLUTION SOUNDING OF THE AURORAL IONOSPHERE

PAY-OFF: ENHANCED ACCURACY OF OTH RADAR TARGET LOCATION IN THE AURORAL REGIONS AND ELSEWHERE

**RADC TPO** 4 TECHNOLOGY

**THRUST:** 4C ELECTROMAGNETICS SUB-THRUST: 4 PROPAGATION (MICROWAVE)



## KEY PROGRAM MANAGERS

| | | | |
|---|---|---|---|
| ANTENNAS | DR R. J. MAILLOUX | RADC/EEA | 617-861-3710 |
| RF COMPONENTS | DR PAUL CARR | RADC/EEA | 617-861-3686 |
| TARGETS & ENVIRONMENT | DR J. K. SCHINDLER | RADC/EEC | 617-861-3723 |
| HF PROPAGATION | DR T. J. ELKINS | RADC/EEP | 617-861-2900 |
| LONG WAVE PROPAGATION | JOHN RASMUSSEN | RADC/EEP | 617-861-4239 |
| MICROWAVE PROPAGATION | DR E. E. ALTSHULER | RADC/EEP | 617-861-4662 |

# SOLID STATE DEVICES

## (INDUSTRY LOOKS AT RADC)



SPEAKER

BOBBY L. BUCHANAN
RADC/ESR, HANSCOM AFB
TEL. 617-861-4051

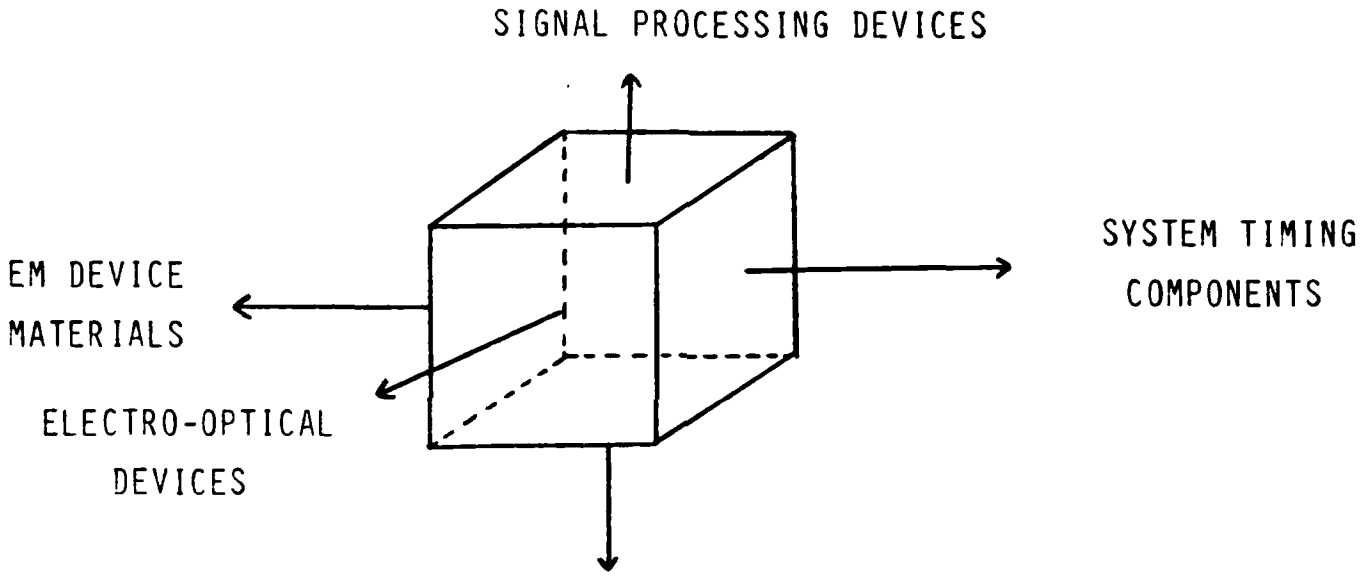
SOLID STATE DEVICES

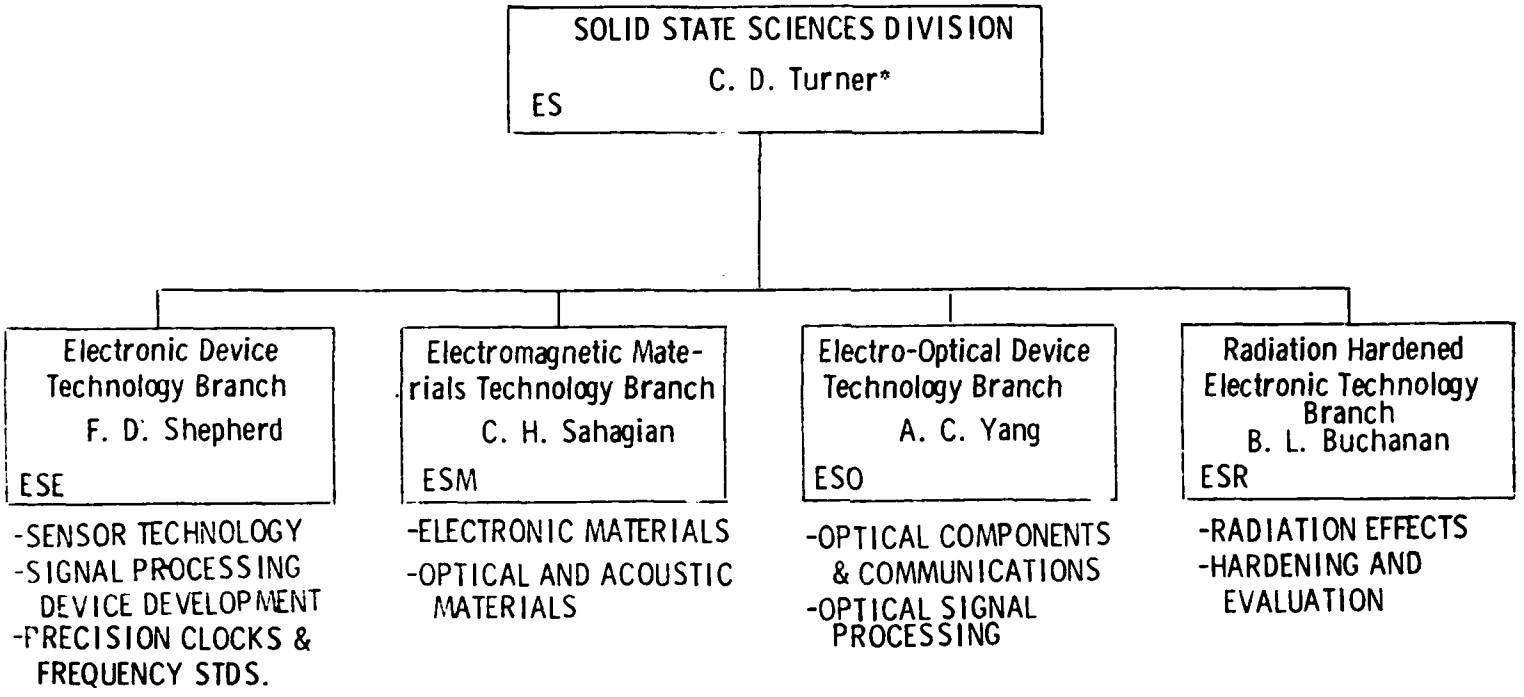
WHAT

# WHY

# WOW!

SOLID STATE DEVICES





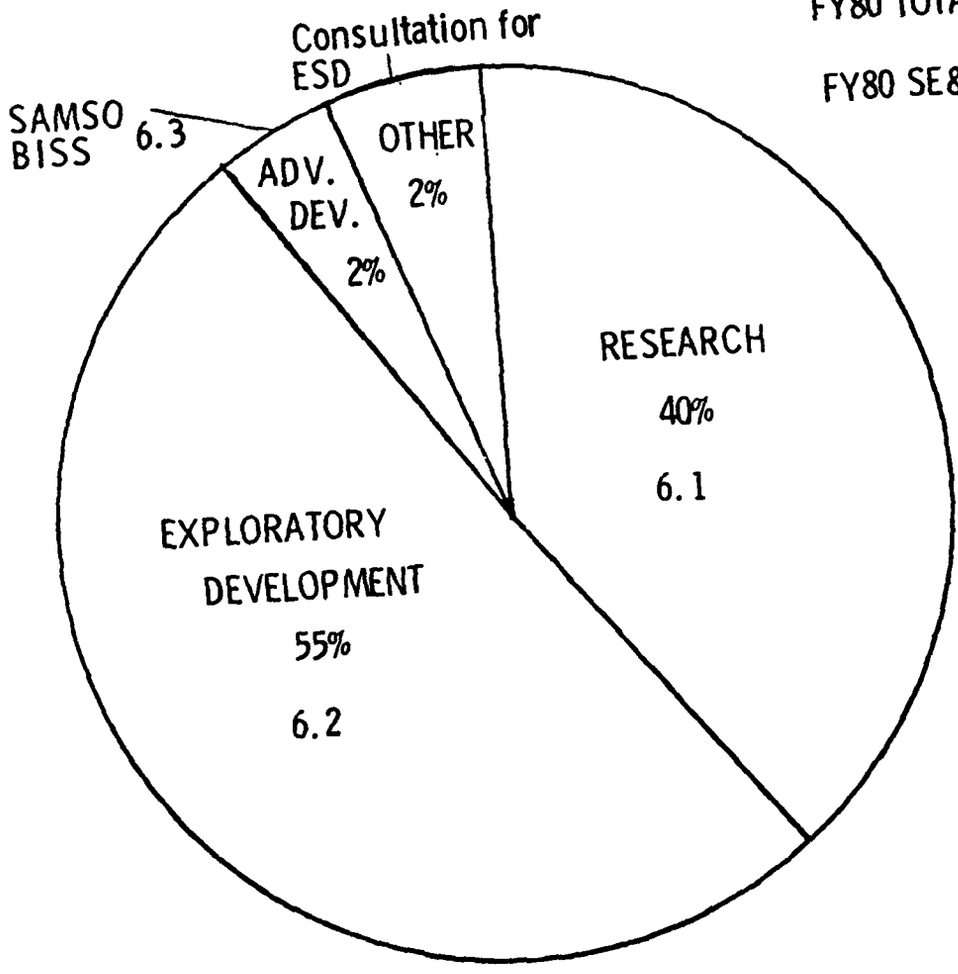

*Acting Director

## SOLID STATE SCIENCES DIVISION

### FY80 MANPOWER

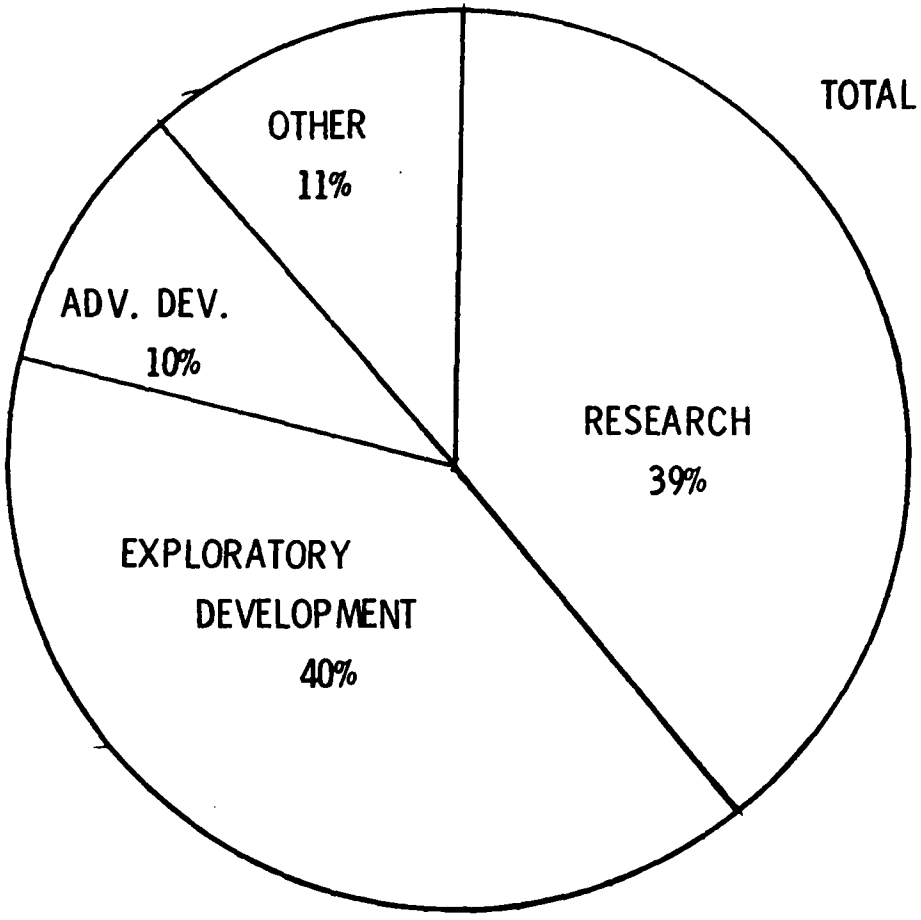
FY80 TOTAL MANPOWER - 92

FY80 SE&T MANPOWER - 78



SOLID STATE SCIENCES DIVISION

FY80 CONTRACT FUNDING




TOTAL FY80 CONTRACT FUNDS
$5.8M

## SOLID STATE DEVICES

### SYSTEM TIMING COMPONENTS - DR. YANNONI

PROGRAM GOALS:

- o DEVELOP PRECISE TIME AND TIME INTERVAL TECHNOLOGY REQUIRED BY AIR FORCE SYSTEMS
- o ADVANCE THE STATE OF THE ART IN THE AREAS OF PERFORMANCE, RELIABILITY, AND ECONOMY

TECHNICAL AREAS:

- o QUARTZ RESONATORS AND OSCILLATORS
- o ATOMIC FREQUENCY STANDARDS AND CLOCKS
- o TEST AND EVALUATION

TPO THRUST #/TITLE: 4D / SOLID STATE DEVICES

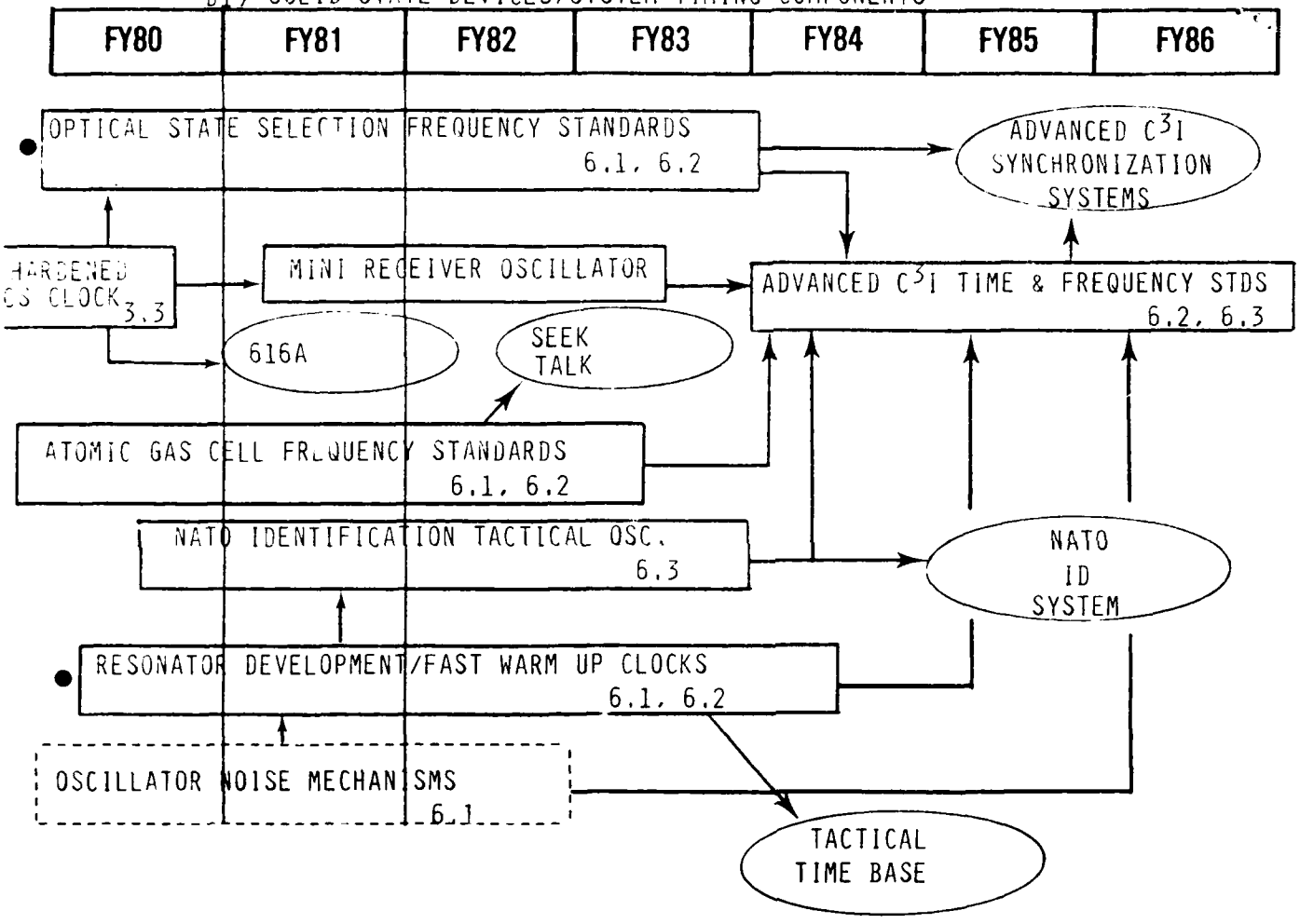
SUB-THRUST #/TITLE: 1 / SYSTEM TIMING COMPONENTS

MAJOR NON-DL PROGRAMS SUPPORTED

| NON-DL PROGRAM | SUPPORT PROVIDED | CUSTOMER |
|---|---|---|
| 616A/AF SUPPORT TO MEECN | DEVELOPMENT OF PORTABLE REAL-TIME CLOCK (CESIUM) | ESD |
| NIS/NATO IDENTIFICATION SYSTEM | TEST/EVALUATION OF CANDIDATE TIME BASE, QUARTZ OSCILLATOR DEVELOPMENT | ASD |
| SEEK TALK | DEVELOPMENT OF SMALL MILITARIZED RUBIDIUM STANDARD AND NEW DESIGN RUBIDIUM STANDARD | RADC/ESD |
| 61102F | COMPONENT RESEARCH | AFOSR |

**RADC TPO** 4 / TECHNOLOGY

**THRUST:** D1 / SOLID STATE DEVICES/SYSTEM TIMING COMPONENTS



## SOLID STATE DEVICES

### ELECTRO OPTICAL COMPONENTS - DR. YANG

PROGRAM GOALS:

- o COMPONENTS AND TECHNIQUES FOR FIBER OPTIC COMMUNICATIONS
- o INTRUSION ALARM CONCEPTS AND FIELD TEST INTRUSION RESISTANT FIBER OPTIC LINK
- o PRACTICAL, REAL-TIME, OPTICAL SIGNAL PROCESSING

TECHNICAL AREAS:

- o OPTICAL COMMUNICATION AND COMPONENTS
- o OPTICAL SIGNAL PROCESSING AND COMPONENTS

TPO THRUST #/TITLE: 4D / SOLID STATE DEVICES

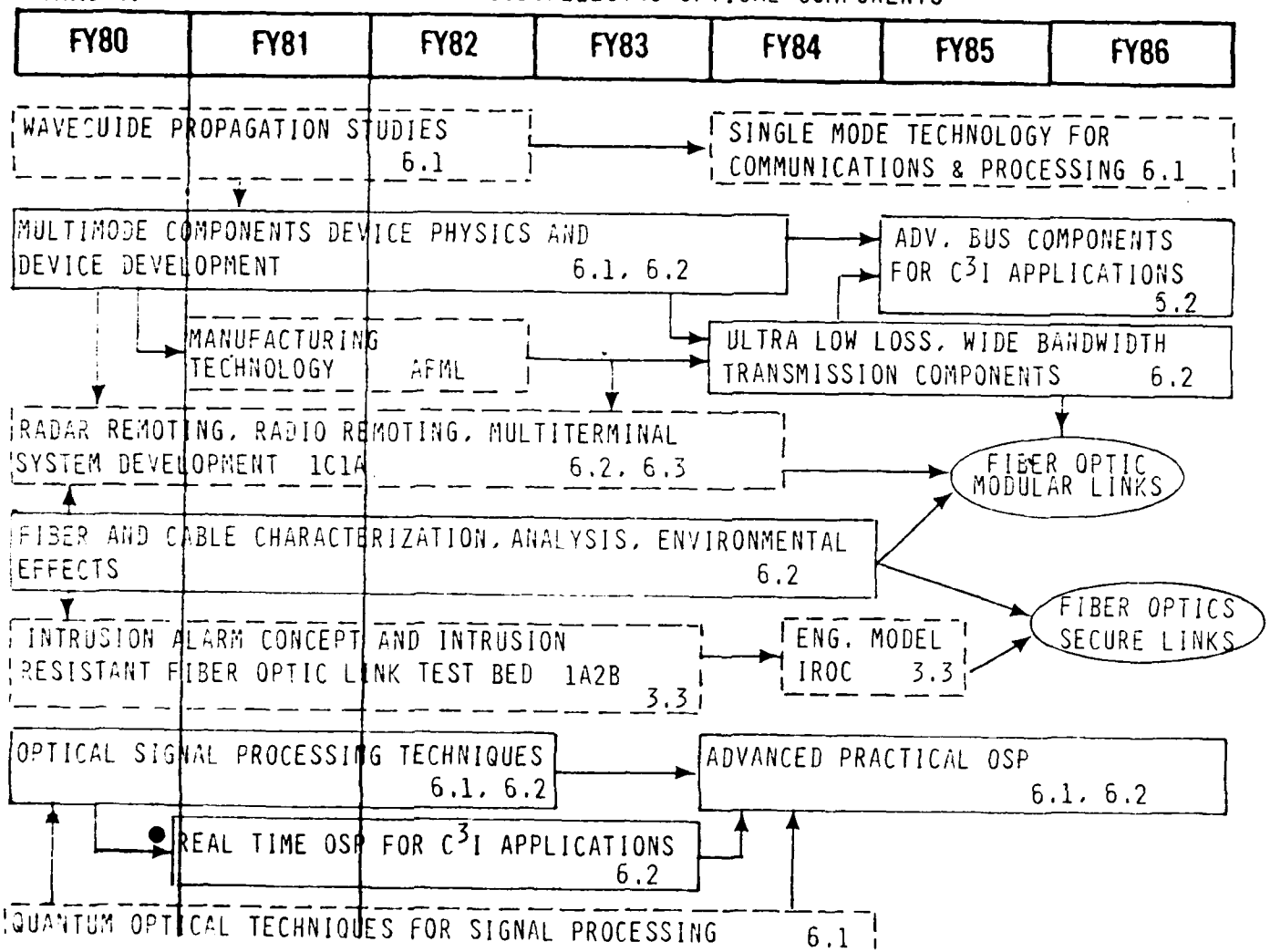
SUB-THRUST #/TITLE: 3 / ELECTRO-OPTICAL COMPONENTS

## MAJOR NON-DL PROGRAMS SUPPORTED

| NON-DL PROGRAM | SUPPORT PROVIDED | CUSTOMER |
|---|---|---|
| NUMBER/SHORT TITLE | SHORT DESCRIPTIVE PHASES | |
| PE33401G<br>PE33401F/P7820 | OPTICAL TIME DOMAIN REFLECTING MEASUREMENTS AND THEORY | NSA<br>RADC/EEV |
| FIBER OPTICS INTRUSION ALARM CONCEPTS | EXHAUSTIVE CHARACTERIZATION AND ANALYSIS OF SYSTEMS SHOW FEASIBILITY | |
| | ENVIRONMENTAL EFFECTS | |
| | LINK STABILITY | |
| 61102F | COMPONENT RESEARCH | AFOSR |

**RADC TPO** 4 / TECHNOLOGY

**THRUST:** D3 / SOLID STATE DEVICES/ELECTRO-OPTICAL COMPONENTS



## SOLID STATE SCIENCES

### SIGNAL PROCESSING DEVICES - DR. SHEPHERD



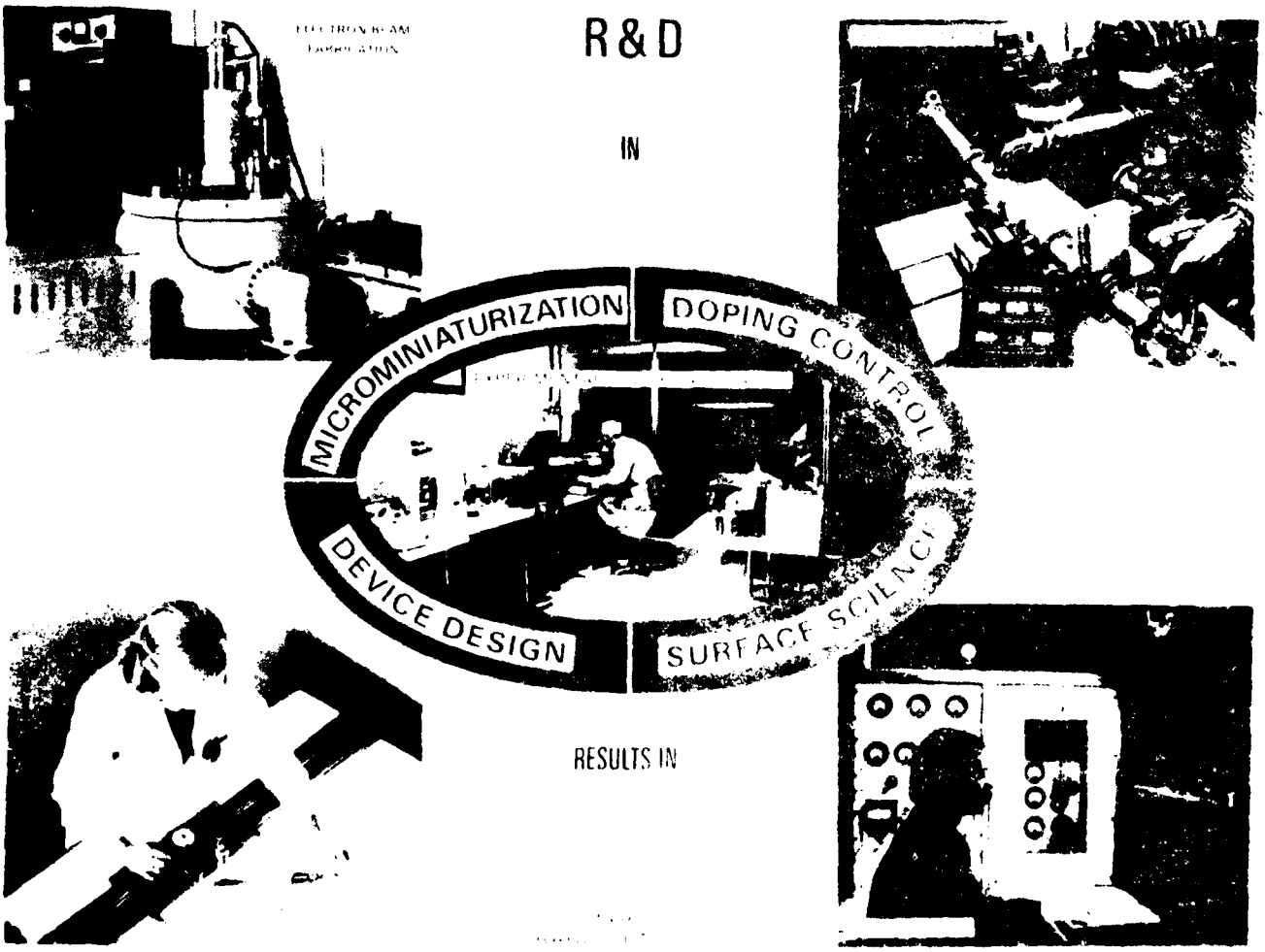
PROGRAM GOALS:

- DEVELOP ADVANCED SIGNAL PROCESSING DEVICES

TECHNICAL AREAS:

- DEVICE DESIGN-DEVELOPMENT AND DEMONSTRATION
- VHSIC
- ADVANCED LITHOGRAPHY

# DEVICE FABRICATION TECHNOLOGY



# SIGNAL PROCESSING DEVICES – ANALOG CCD's

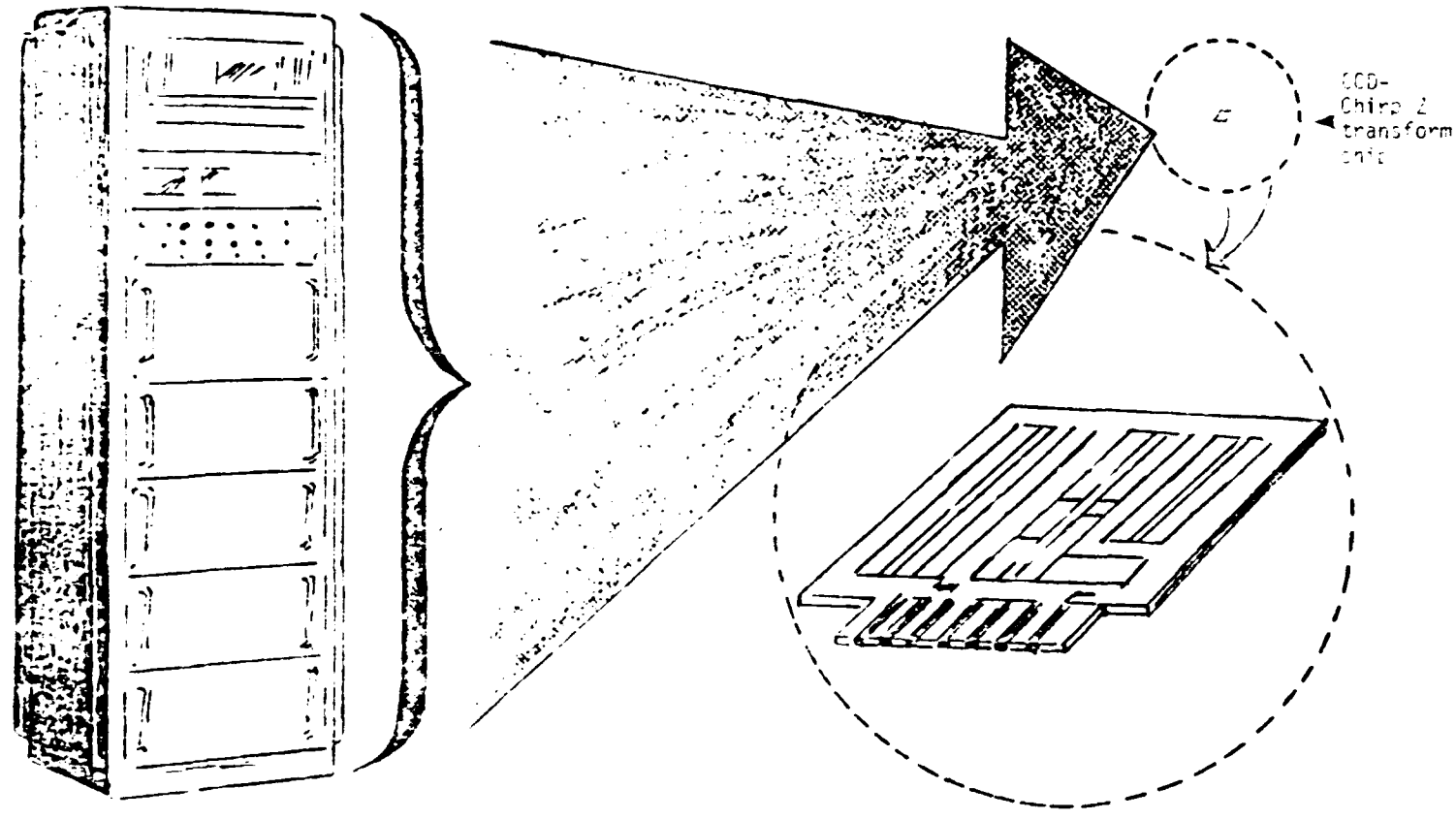
APPLICATIONS:
- SPREAD SPECTRUM COMMUNICATIONS
- SONAR PROCESSING
- SYNTHETIC APERTURE PROCESSING
- SIGNAL TRACKING

ADVANTAGES:
- REDUCE SUBSYSTEM COMPLEXITY & COST
  - NUMBER OF COMPONENTS
  - NECESSARY OPERATING SPEED
  - FULL FUNCTION OPERATIONS
    - REPLACE INSTRUCTION SETS

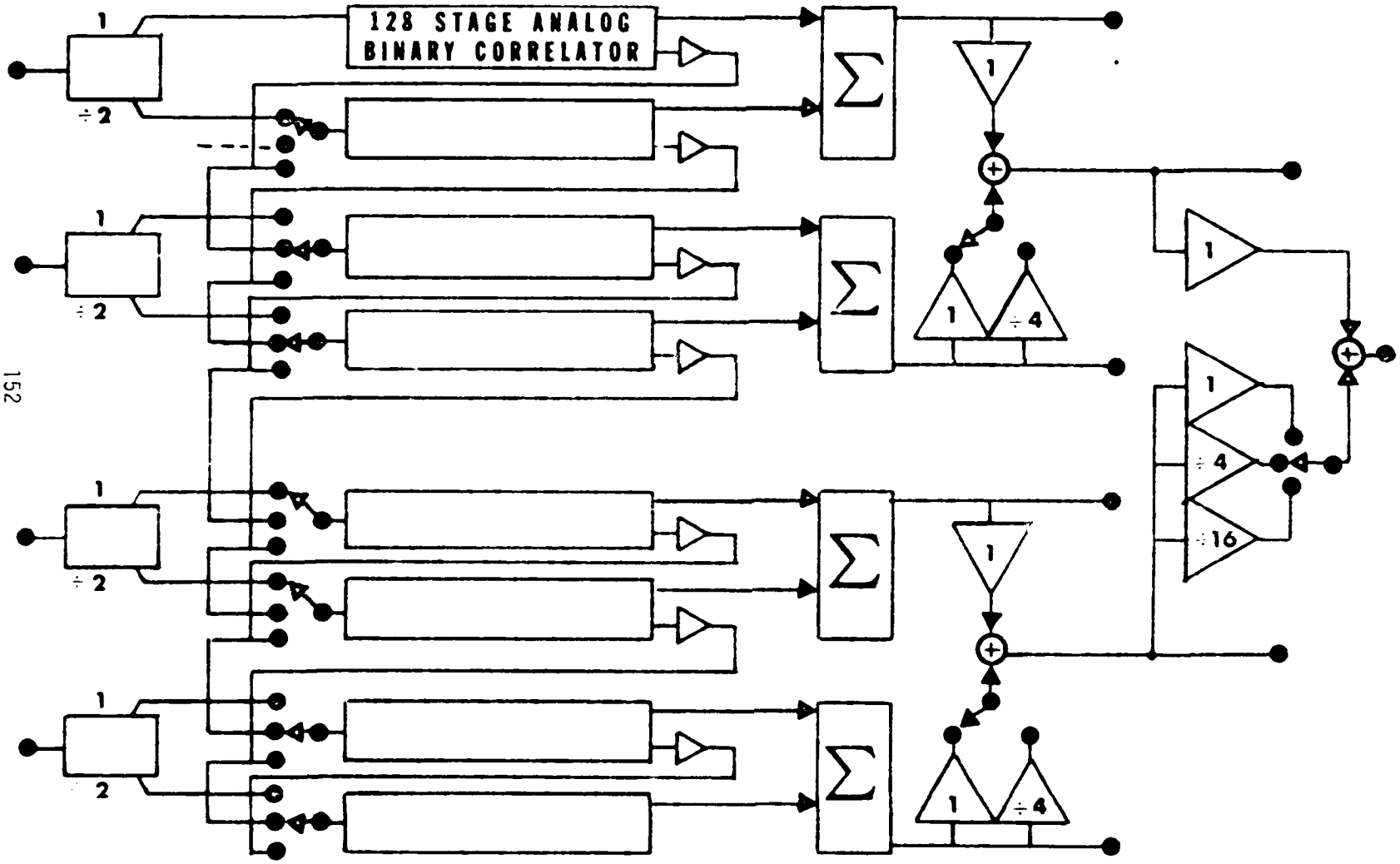
DISADVANTAGES:
- REDUCED PRECISION
- REDUCED FLEXIBILITY

DIGITAL SIGNAL PROCESSOR

1 GIGA BIT/SEC THROUGHPUT
400 MILLION INSTRUCTIONS/SEC



# CCD-SCALAR PRODUCT OPERATOR



TPO THRUST #/TITLE: 4D / SOLID STATE DEVICES

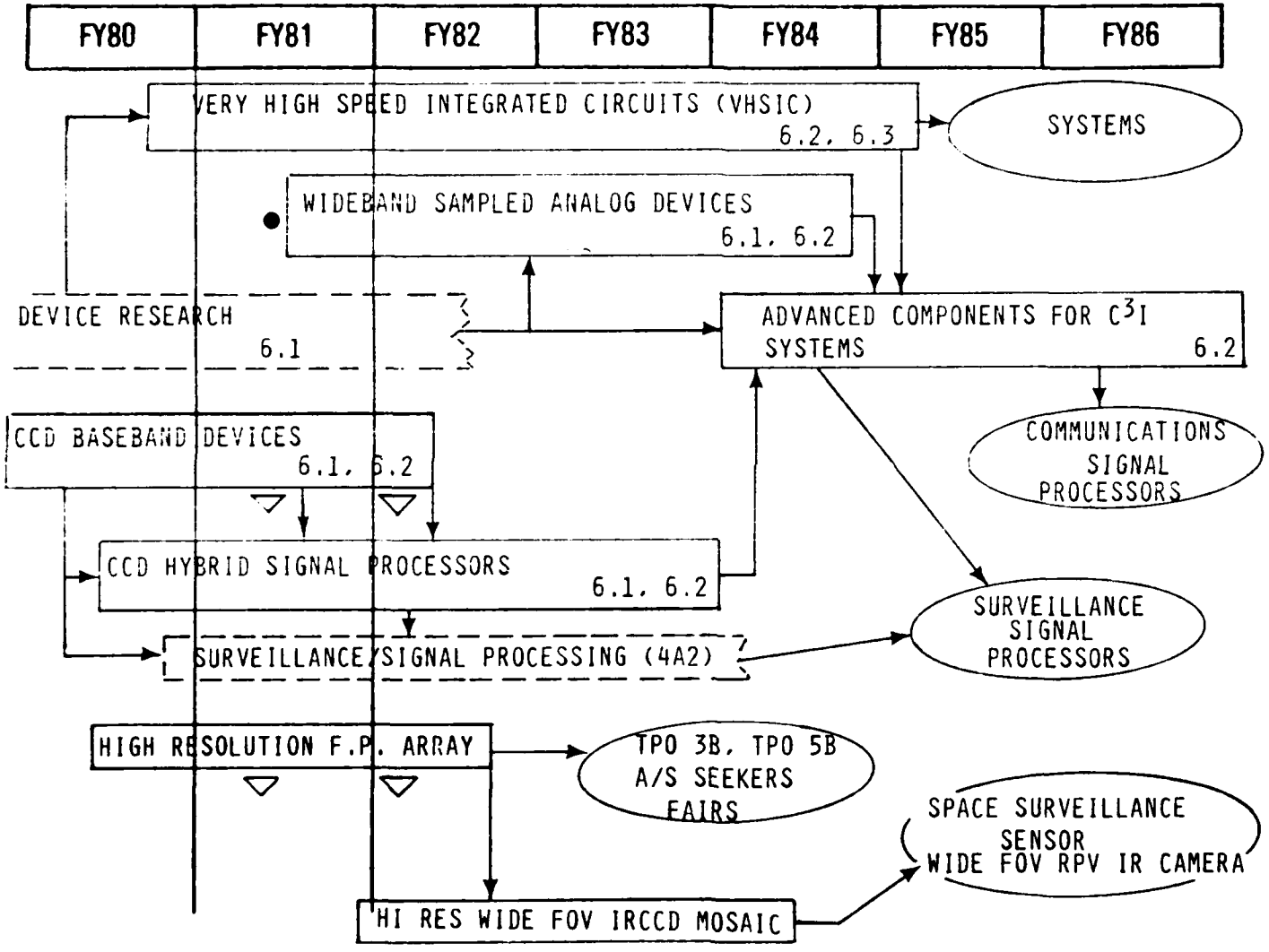
SUB-THRUST #/TITLE: 2 / SIGNAL PROCESSING DEVICES

## MAJOR NON-DL PROGRAMS SUPPORTED

| NON-DL PROGRAM | SUPPORT PROVIDED | CUSTOMER |
|---|---|---|
| VHSIC | PROGRAM MANAGEMENT<br>TECHNICAL EVALUATION | |
| ADVANCED DEVICE PROCESSING | TECHNICAL MANAGEMENT | DARPA |
| MINI HALO | SIGNAL PROC. DEV. | RADC/OC - DARPA |
| AOSP | SIGNAL PROC. DEV. | RADC/OC - DARPA |
| TEAL AMBER | FOCAL PLANE MOSAIC CONSULTATION | RADC/OC - DARPA |
| SCHOTTKY FPA | FOCAL PLANE MOSAIC DEVELOPMENT | ESD - ARMY - DNA |
| 61102F | DEVICE RESEARCH | AFOSR |

RADC TPO 4 / TECHNOLOGY

THRUST: D2 / SOLID STATE DEVICES/SIGNAL PROCESSING DEVICES

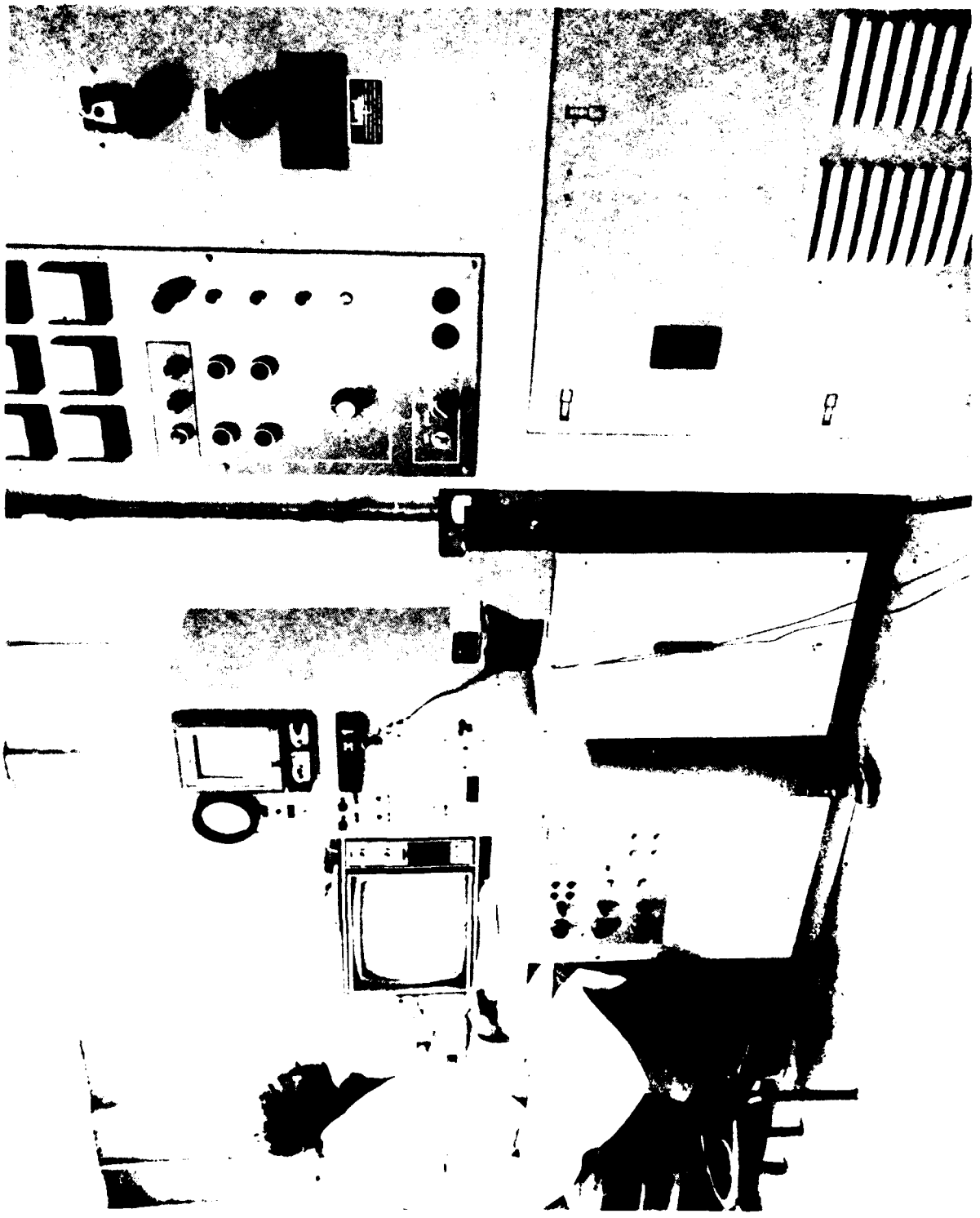


## SOLID STATE DEVICES

### EM DEVICE MATERIALS - MR. SAHAGIAN

PROGRAM GOALS: TO IMPROVE $C^3$ SYSTEM PERFORMANCE AND COST FACTORS VIA THE RESEARCH AND DEVELOPMENT OF ADVANCED ELECTROMAGNETIC MATERIALS.

TECHNICAL AREAS: SEMICONDUCTOR, OPTICAL, ACOUSTIC MATERIALS



SOLID STATE DEVICES

EM DEVICE MATERIALS

LONG TERM EMPHASIS

- FIBER OPTIC MATERIAL - FLOURIDE GLASSES

  LONG WAVELENGTH (1 TO 10$\mu$) FOR LOW ATTENUATION FOR LONG LINE COMMUNICATION

- INDIUM PHOSPHIDE MATERIAL

  InP FOR SUBSTRATE WITH GOOD LATTICE WATCH FOR InGaAsP

- ULTRA QUALITY QUARTZ

  FOR HIGH PRECISION RADIATION TOLERANT ETC. TIMING APPLICATIONS

SOLID STATE DEVICES

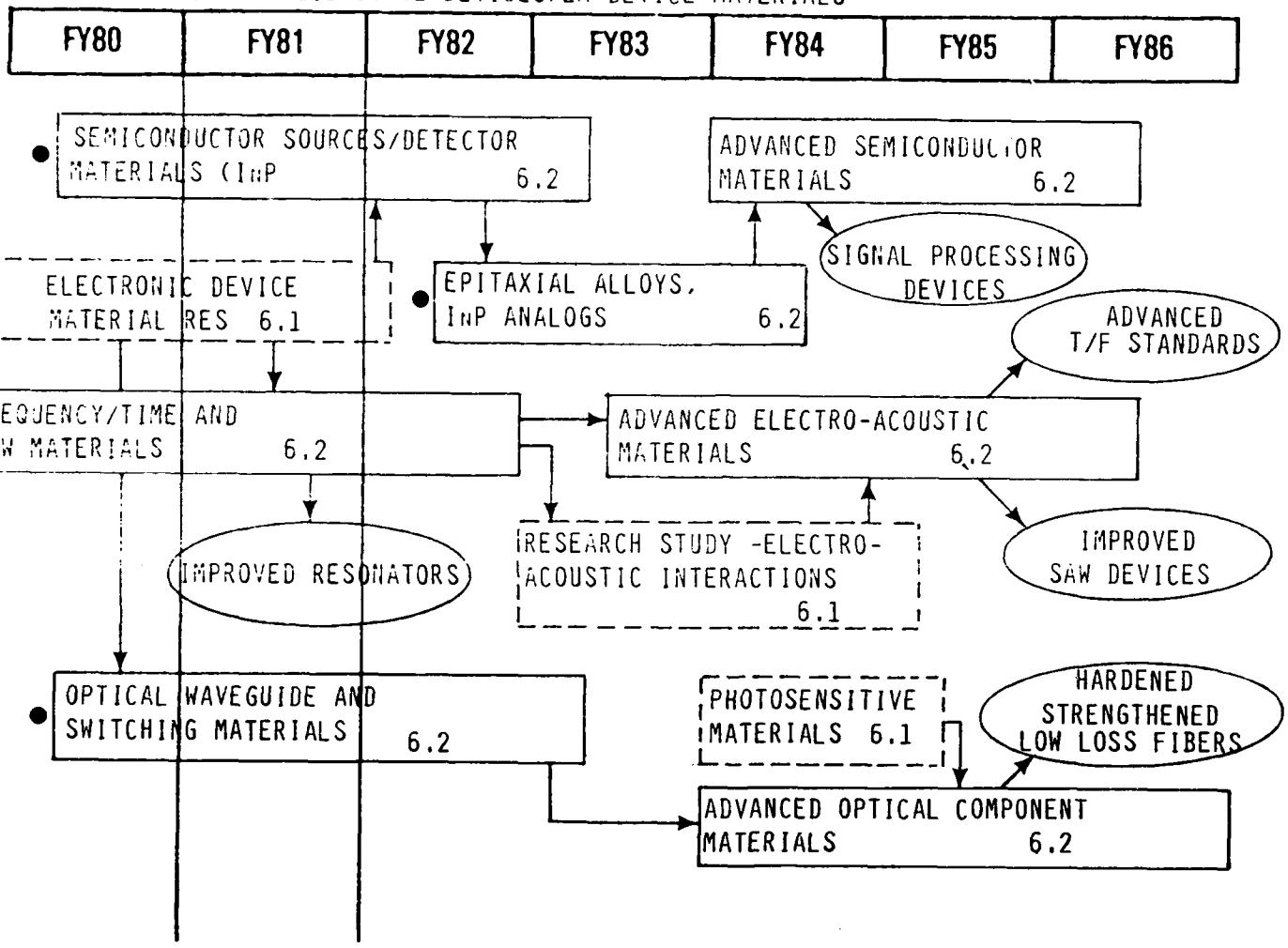
EM DEVICE MATERIALS

INDIUM PHOSPHIDE - NEW KID ON THE SEMICONDUCTOR BLOCK

- SOLID STATE MICROWAVE APPLICATIONS
- SOLAR CELLS
- INTEGRATED CIRCUITS
- LATTICE MATCHED ELECTRO OPTIC DEVICES

RADC TPO 4 / TECHNOLOGY

THRUST: D4 / SOLID STATE DEVICES/EM DEVICE MATERIALS



## SOLID STATE DEVICES

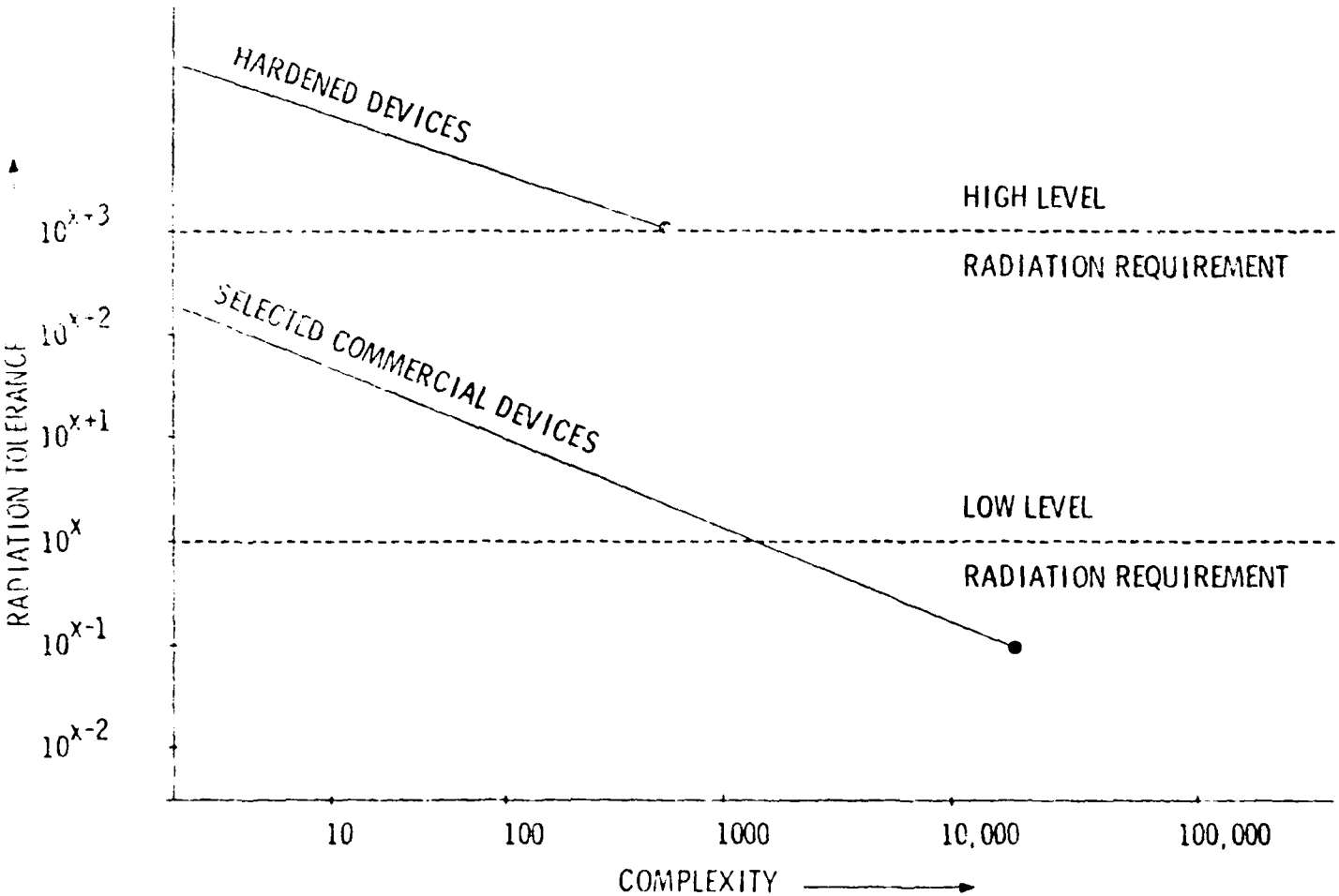
### EM DEVICE RADIATION HARDENING - BOBBY BUCHANAN

PROGRAM GOALS:

- DEVELOP TECHNOLOGY BASE FOR COST EFFECTIVE "HARDENING" OF AF ELECTRONICS
- DEVELOP RADIATION HARDENED LSI/VLSI/VHSI AND MICROPROCESSORS
- PROVIDE CONSULTATION, RADIATION TEST AND TECHNOLOGY ASSESSMENTS TO AIR FORCE SYSTEMS OFFICES

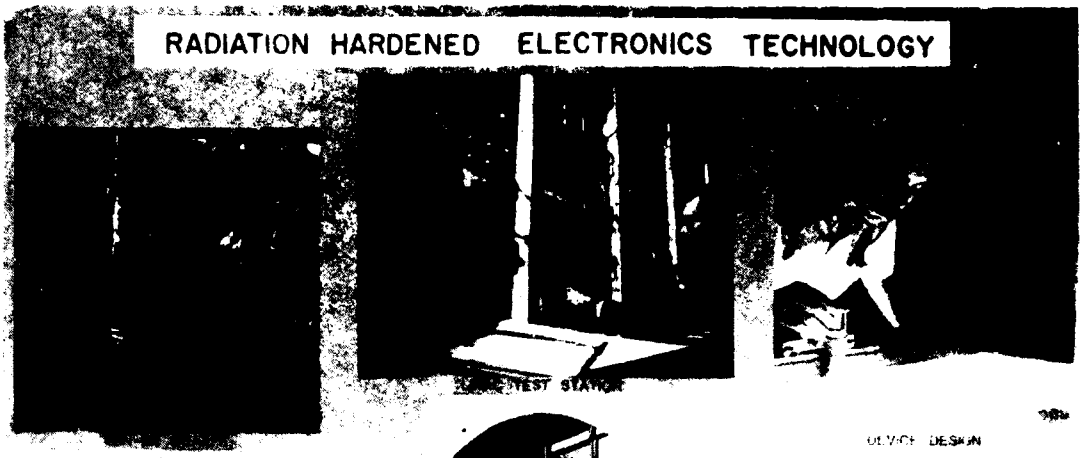
TECHNICAL AREAS:

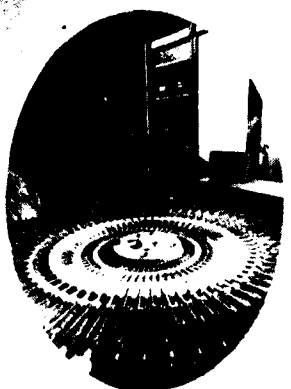
- RADIATION EFFECTS
- HARDENING AND EVALUATION
- IRRADIATION AND DOSIMETRY



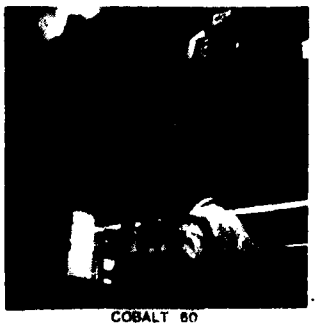

RADIATION TOLERANCE OF MONOLITHIC SEMICONDUCTOR DEVICES AS A FUNCTION OF COMPLEXITY.

# RADIATION HARDENED ELECTRONICS TECHNOLOGY





MICROPROCESSOR TESTER



COBALT 60

RADIATION
AREA
DO NOT ENTER
FEET ABOVE
FLOOR WITHOUT
PERMISSION OF
SUPERVISOR

SOLID STATE DEVICES

EM DEVICE HARDENING

## HARDENED LSI BASIC TECHNOLOGY DEVELOPMENT

OBJECTIVE: TO DEVELOP THE UNDERLYING TECHNOLOGIES WHICH ARE COMMON TO HARDENED INTEGRATED CIRCUITS - THIS INCLUDES ALL DIELECTRIC ISOLATION TECHNOLOGIES. TO DEVELOP INTRINSICALLY HARD INTEGRATED CIRCUIT STRUCTURES.

TECHNICAL APPROACH:

- o STANDARDIZED DIELECTRIC ISOLATION DEVELOPMENT
- o NOVEL DI TECHNOLOGY FOR FET's
- o RADIATION HARD MESFET TECHNOLOGY

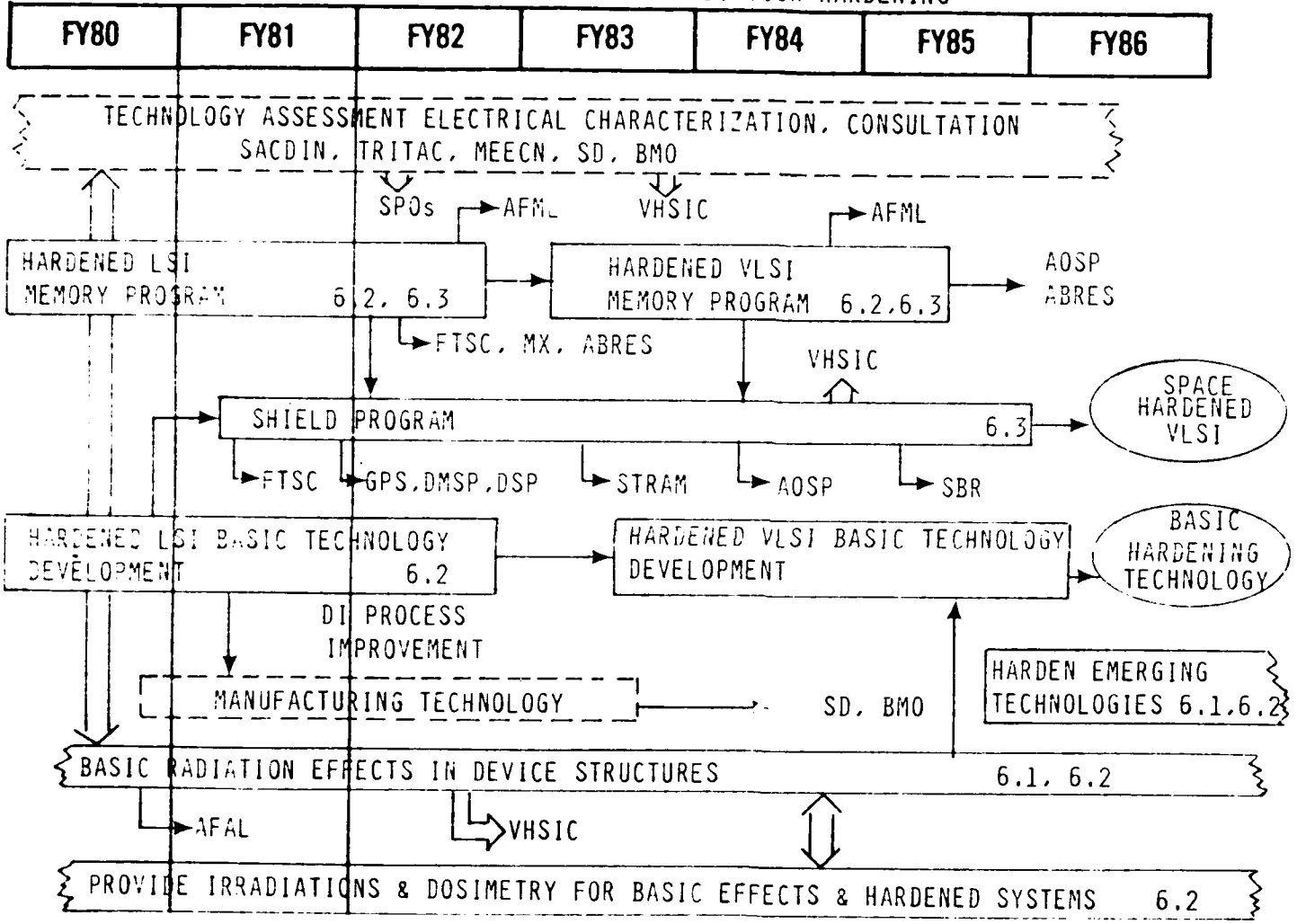
TPO THRUST #/TITLE: 4D / SOLID STATE DEVICES

SUB-THRUST #/TITLE: 5 / EM DEVICE RADIATION HARDENING

MAJOR NON-DL PROGRAMS SUPPORTED

| NON-DL PROGRAM | SUPPORT PROVIDED | CUSTOMER |
|---|---|---|
| TRITAC | CONSULTATION | ESD |
| SACDIN | CONSULTATION | ESD |
| MEECN | CONSULTATION | ESD |
| MX | CONSULTATION<br>RADIATION TESTING<br>CHARACTERIZATION | BMO |
| SPACE PROBE | RADIATION TESTING | NASA |
| FTSC | CONSULTATION<br>RADIATION TESTING<br>HARDENED DEVICE DEVELOPMENT<br>CHARACTERIZATION | SD |
| VHSIC | CONSULTATION | DOD |
| 61102F | RADIATION RESEARCH | AFOSR |

**RADC TPO** 4 / TECHNOLOGY
**THRUST:** D5 / SOLID STATE DEVICES/EM DEVICE RADIATION HARDENING



SOLID STATE DEVICES

EM DEVICE HARDENING

SHIELD

(SPACE HARDENED INTEGRATED ELECTRONICS DEVELOPMENT)

PROGRAM



OBJECTIVE: HARDEN LARGE AND VERY LARGE SCALE INTEGRATED CIRCUIT TECHNOLOGIES FOR USE IN SPACE SYSTEMS.

PLAYERS: SD, RADC, DARPA

SCHEDULE: 3 - 5 YEARS TO DEVELOP RADIATION HARDENED VLSI WITH THE COMPLEXITY OF A 64 K-BIT RAM.

# PROGRAM CHANGES AND TRENDS

INCREASING EMPHASIS

- High Throughput Signal Processing Devices (CCD)
- Advanced Time and Frequency Standards
- Establishment of Technology Base for Advanced Application of Fiber Optics
- Increased Support to Other RADC Divisions
- Radiation Hardening of Advanced Electronics

- Optical Signal Processing

SURVEILLANCE DIVISION
MINI-SESSION PRESENTATIONS
TUESDAY, 3 JUNE 1980

RADC - BLDG 106 - AUDITORIUM

1:45 PM SURVEILLANCE ECCM - MR. SHIELDS ●
AIR CRAFT IDENTIFICATION - MR. WOLF

3:15 PM SPACE BASED RADAR - MR. SIMONS
CRUISE MISSILE SURVEILLANCE - MR. OGRODNIK

TPO/THRUST: 1C / TACTICAL $C^3$

SUB-SUB-THRUST: 2B / SURVEILLANCE-ECCM

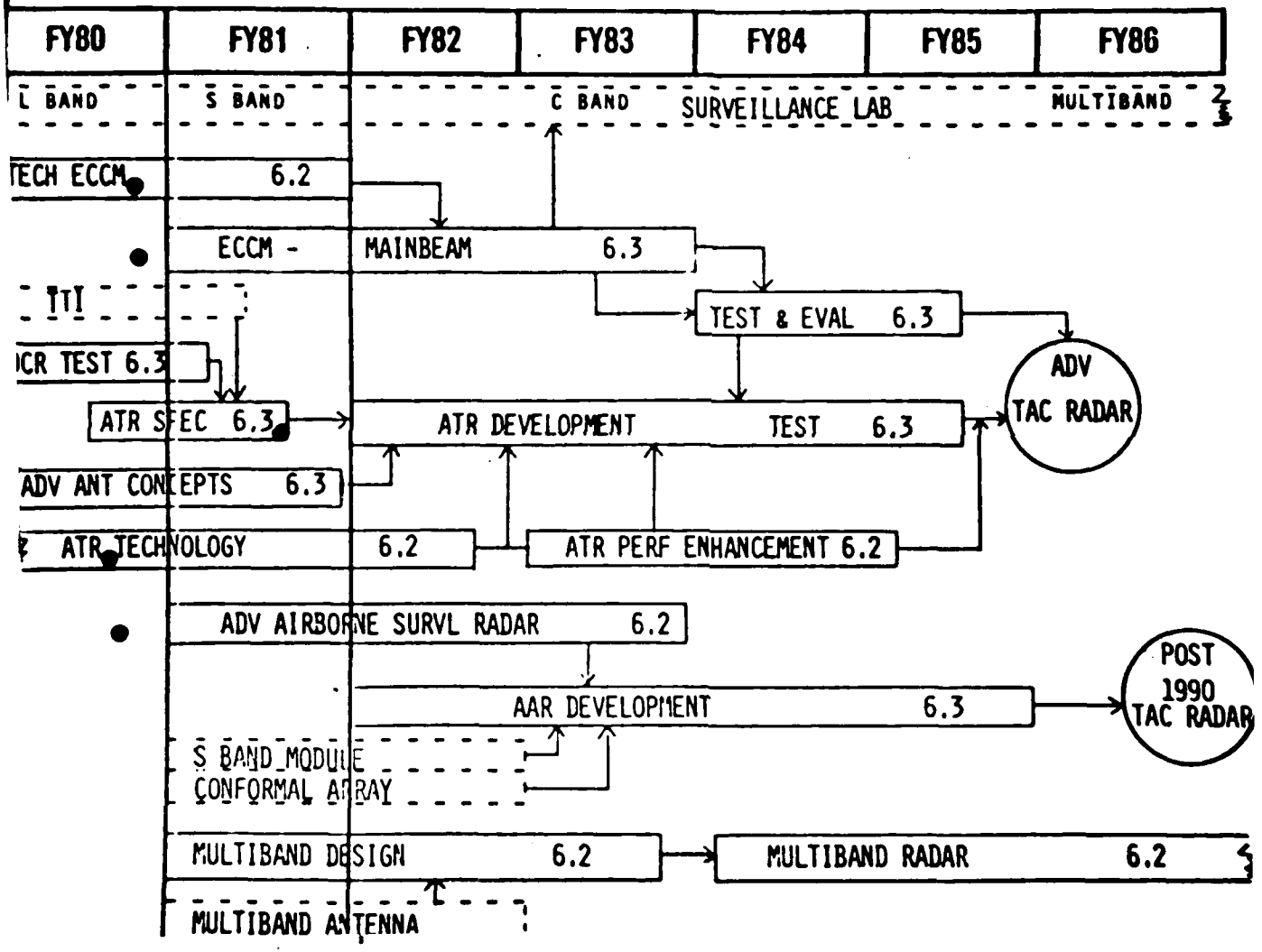
PROGRAM GOALS: DEVELOP AND DEMONSTRATE AN ADVANCED TACS WITH AUTOMATED, DISTRIBUTED COVERAGE CONTROL; AUTOMATED ECCM AND THREAT ADAPTIVITY; AND HIGH SYSTEM SURVIVABILITY.

TECHNICAL AREAS:
- ECCM & RADAR DEVELOPMENT
- RADAR SURVIVABILITY
- SURVEILLANCE SYSTEMS TECHNOLOGY

ANTICIPATED FUNDS: FY81-83 - $20,407,000

RADC TPO 1 $C^3$

THRUST: C2B TACTICAL $C^3$/SURVL/SURVL-ECCM/ECCM & RADAR DEVELOPMENT



TPO/THRUST #/TITLE: 1C TACTICAL $C^3$

SUB-SUB-THRUST #/TITLE: 2B SURVEILLANCE-ECCM/ECCM & RADAR DEVELOPMENT

BLOCK TITLE: TECHNOLOGY ECCM

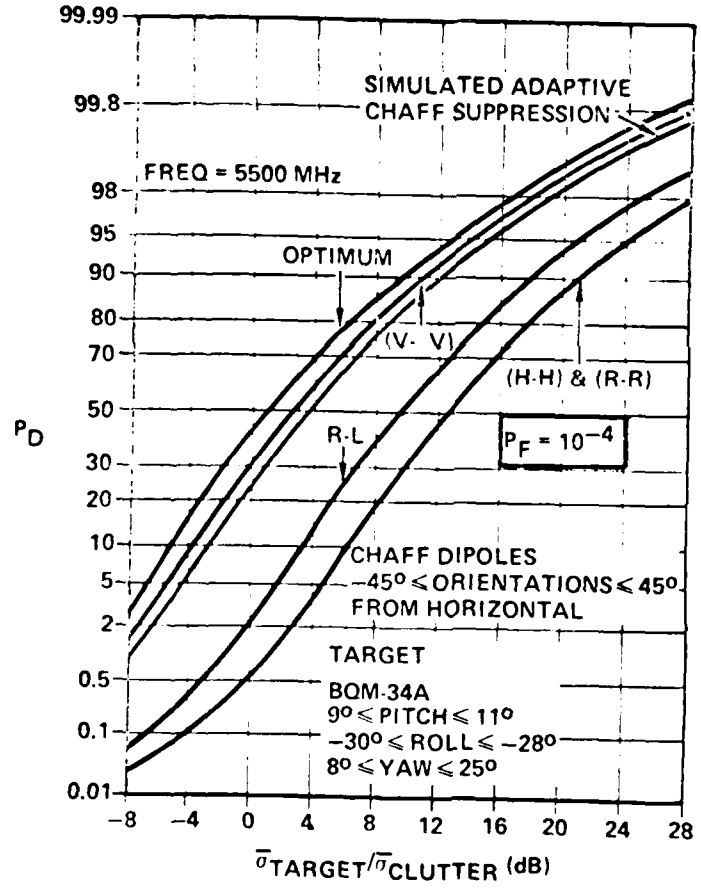
OBJECTIVE: INVESTIGATE AND EVALUATE COUNTER ECM TECHNIQUES FOR APPLICATION TO TACTICALLY DEPLOYED RADARS



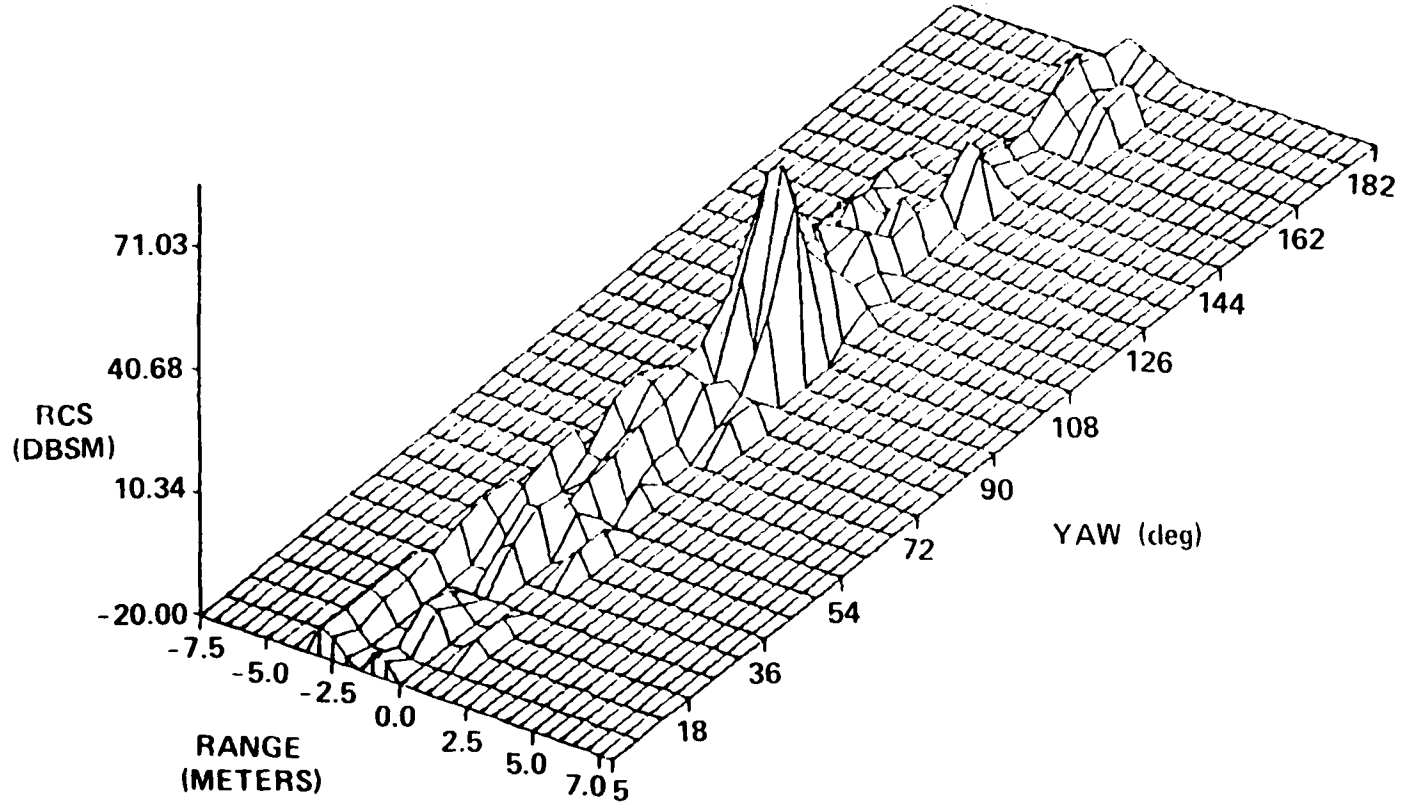
TECHNICAL APPROACH: SELECTION OF CANDIDATE MAINLOBE CANCELLATION TECHNIQUES FOR ANALYSIS AND EXPERIMENTAL VERIFICATION

PAY OFF: PRESENTLY DEPLOYED AND FAR TERM SENSOR WILL BE CAPABLE OF OPERATING IN A HEAVY JAMMING ENVIRONMENT

# SINGLE PULSE DETECTION PROBABILITIES FOR VARIOUS (TRANSMIT-RECEIVE) POLARIZATIONS

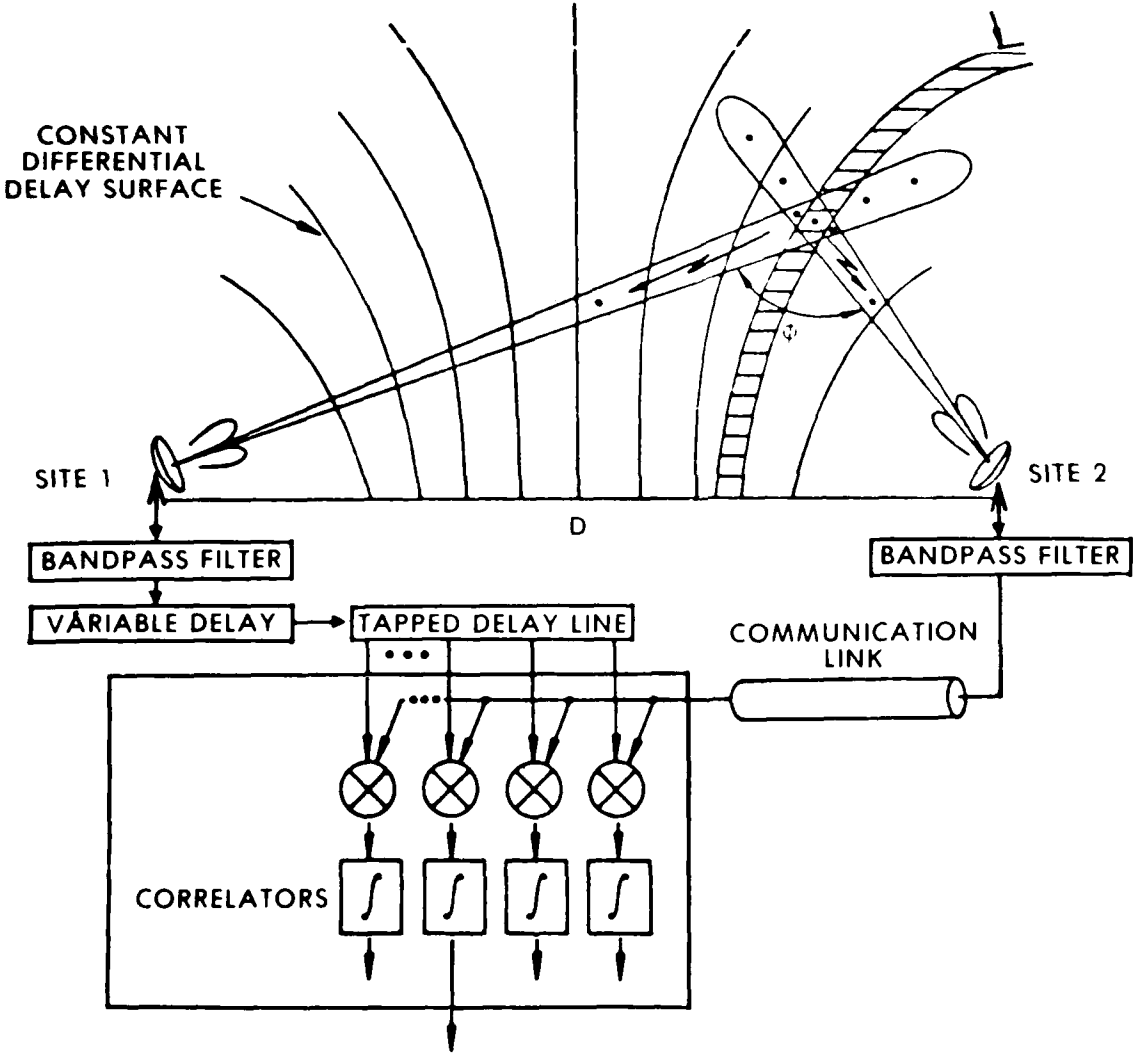


# RESPONSE OF BQM-34A SIMULATION MODEL TO 300 MHz GAUSSIAN PULSE




BQM34-A 5500 MHz HH RESPONSE AT 300 MHz BANDWIDTH

# JAMMER LOCATION
## (VIA CROSS CORRELATION)



TPO/THRUST #/TITLE: 1C TACTICAL $C^3$

SUB-SUB-THRUST #/TITLE: 2B SURVEILLANCE ECCM/ECCM & RADAR DEVELOPMENT

BLOCK TITLE: ECCM MAINBEAM

OBJECTIVE: ELIMINATE THE EFFECTS OF MAINBEAM JAMMING VIA POLARIZATION DIVERSITY, BEAM NULLING, ETC.

TECHNICAL APPROACH: DEVELOP & TEST MAINLOBE AND NEAR-IN SIDELOBE CANCELLATION TECHNIQUES VIA USE OF LABORATORY PHASED ARRAY RADAR.

PAY OFF: HIGH. A GOOD SOLUTION TO MAINBEAM JAMMING WILL ALLOW THE DETECTION OF MOST TARGETS PRESENT IN COVERAGE.

TPO THRUST #/TITLE: 1C TACTICAL $C^3$

SUB-SUB-THRUST #/TITLE: 2B SURVEILLANCE-ECCM/ECCM & RADAR DEVELOPMENT

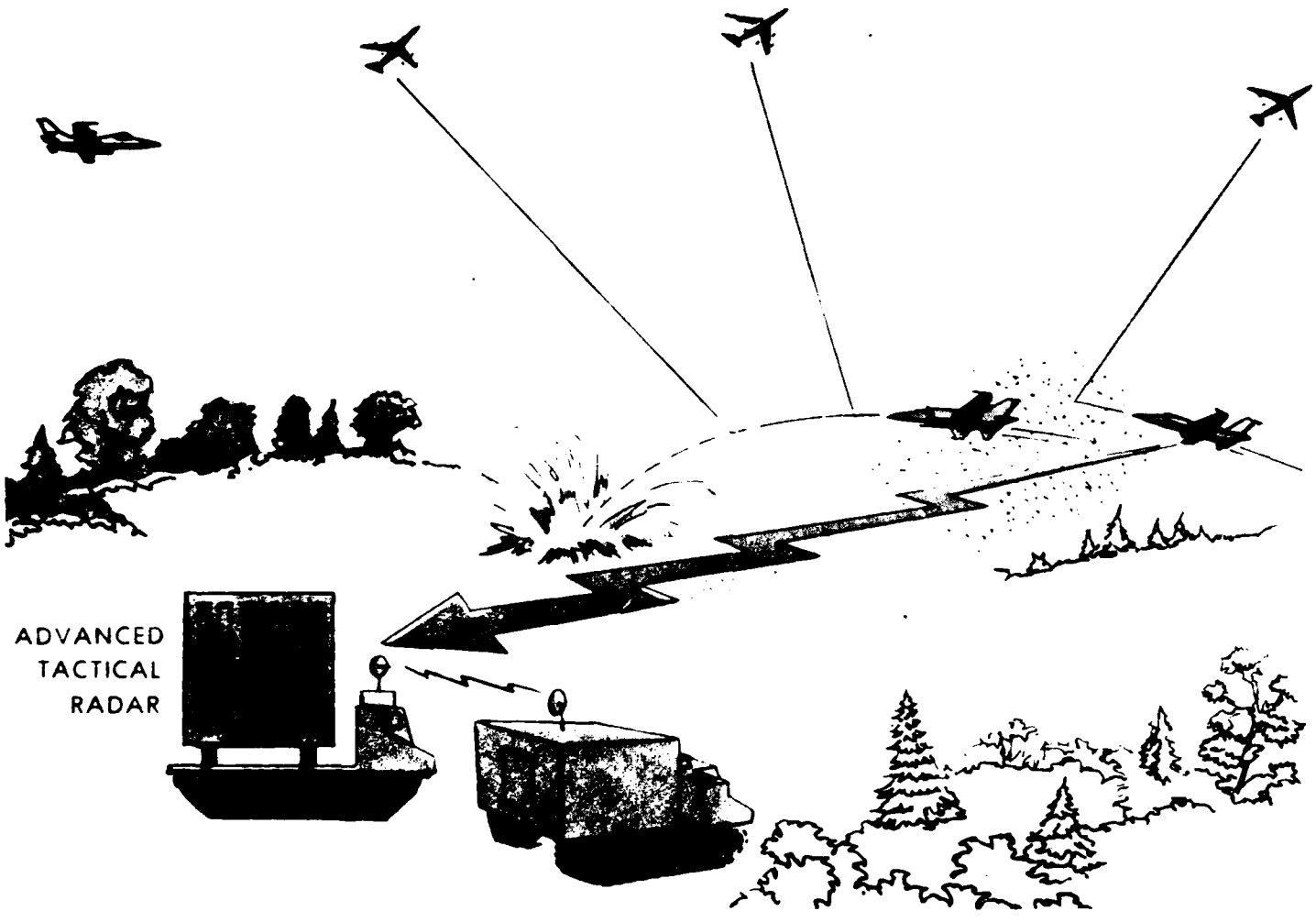
BLOCK TITLE: ADVANCED TAC RADAR DEVELOPMENT

OBJECTIVE: TO DEVELOP MOBILE ADVANCED TACTICAL RADAR TO MEET THE MULTI THREAT ENVIRONMENT OF 1990s

TECHNICAL APPROACH: TO DESIGN, FABRICATE AND FULLY TEST TWO ADVANCED TACTICAL RADAR DIVERGENT DESIGN (S-BAND, C-BAND) RADAR MODELS

PAY OFF: SENSOR TO BE DEVELOPED TO MEET ADVANCED ENEMY THREAT AND MISSION REQUIREMENTS OF 1990s WHICH PRESENT RADARS CANNOT COPE WITH

# TACTICAL AIR SURVEILLANCE



## ADVANCED TACTICAL RADAR

- MOBILE LONG RANGE SURVEILLANCE RADAR WITH MULTIPLE TRACK + IDENTIFICATION MODES
- VERSATILE WAVEFORMS FOR OPTIMIZED PERFORMANCE + ENHANCED SURVIVABILITY
- ON-BOARD DATA PROCESSING FOR AUTONOMOUS AND NETTED OPERATION
- GRACEFUL DEGRADATION
- MOBILE DESIGN

TPO THRUST #/TITLE: 1C TACTICAL $C^3$

SUB-SUB-THRUST #/TITLE: 2B SURVEILLANCE-ECCM/ECCM & RADAR DEVELOPMENT

BLOCK TITLE: ADVANCED TAC RADAR TECHNOLOGY

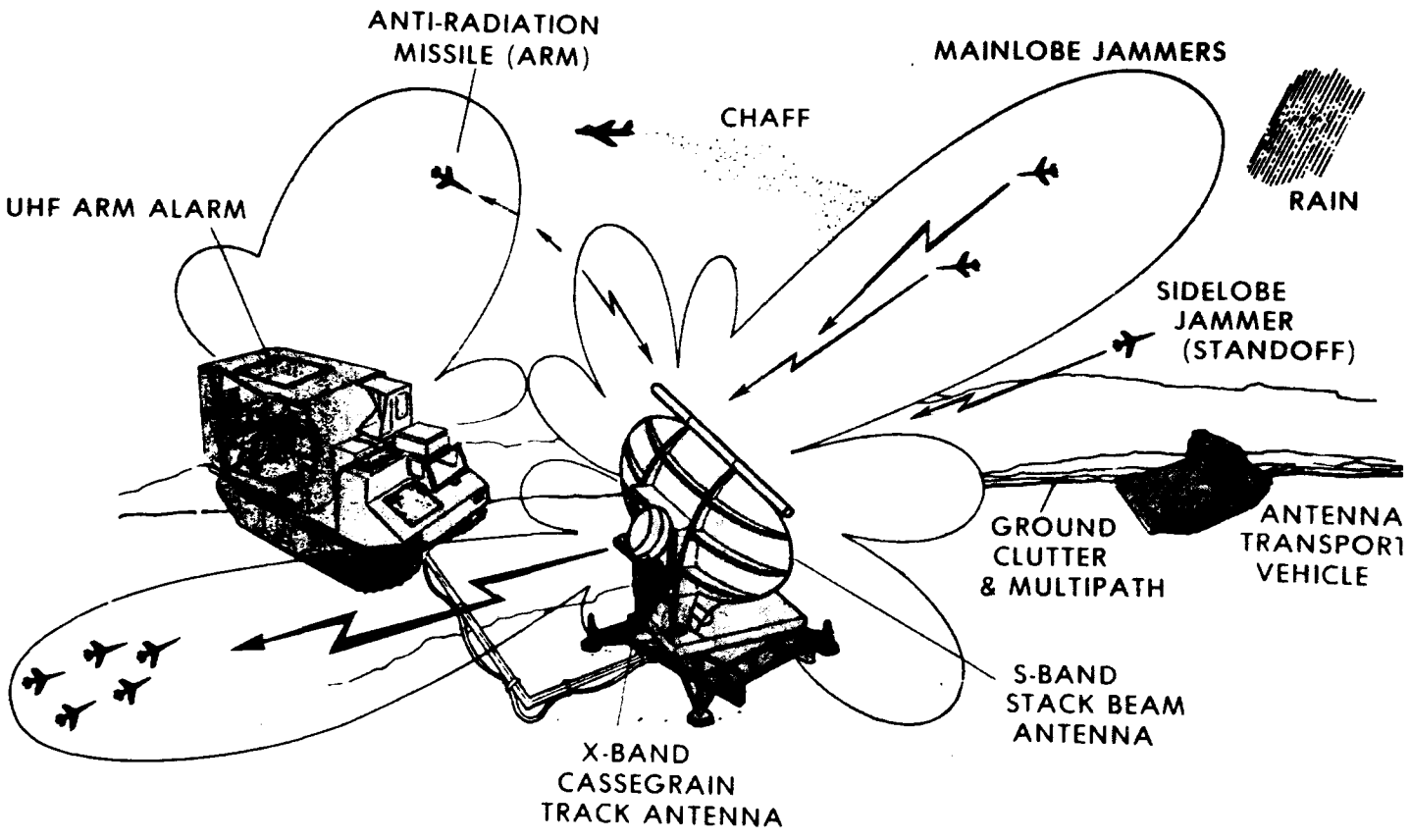
OBJECTIVE: TO DEVELOP REQUIRED TECHNOLOGY IN SUPPORT OF THE MOBILE ADVANCED TACTICAL RADAR PROGRAM

TO DEVELOP HIGH PAY OFF TECHNOLOGY TO ENHANCE PERFORMANCES OF THE ATR

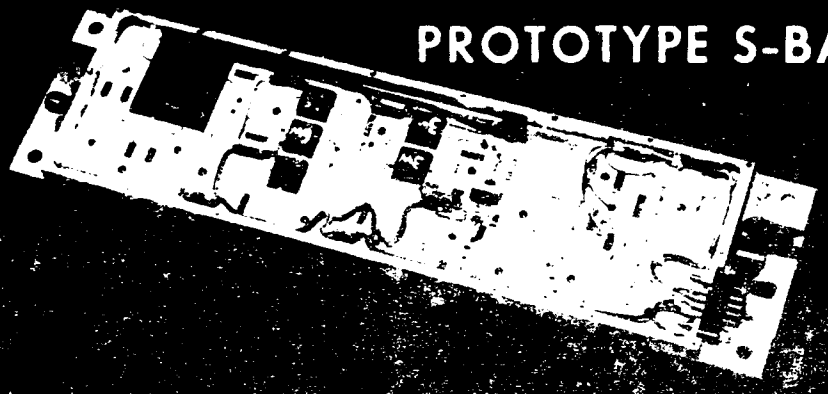
TECHNICAL APPROACH: DEVELOP ADAPTIVE POLARIZATION CAPABILITY, RADAR/COMM INTEGRATION, SOLID STATE MODULES, MULTIPLE SITE TRACKING ALGORITHMS

PAY OFF: PROVIDE A MAXIMUM SELECTION OF DESIGN OPTIONS FOR ENGINEERING MODEL APPLICATION

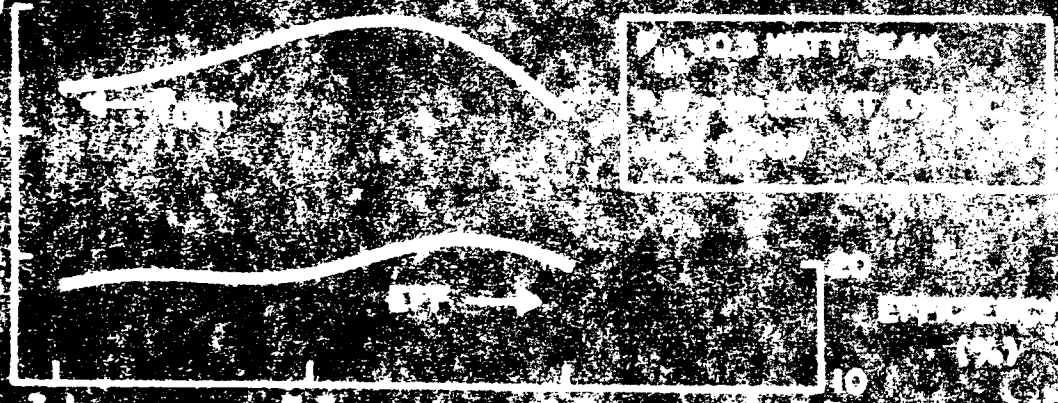
# TACTICAL RADAR TECHNOLOGY CONCEPTS



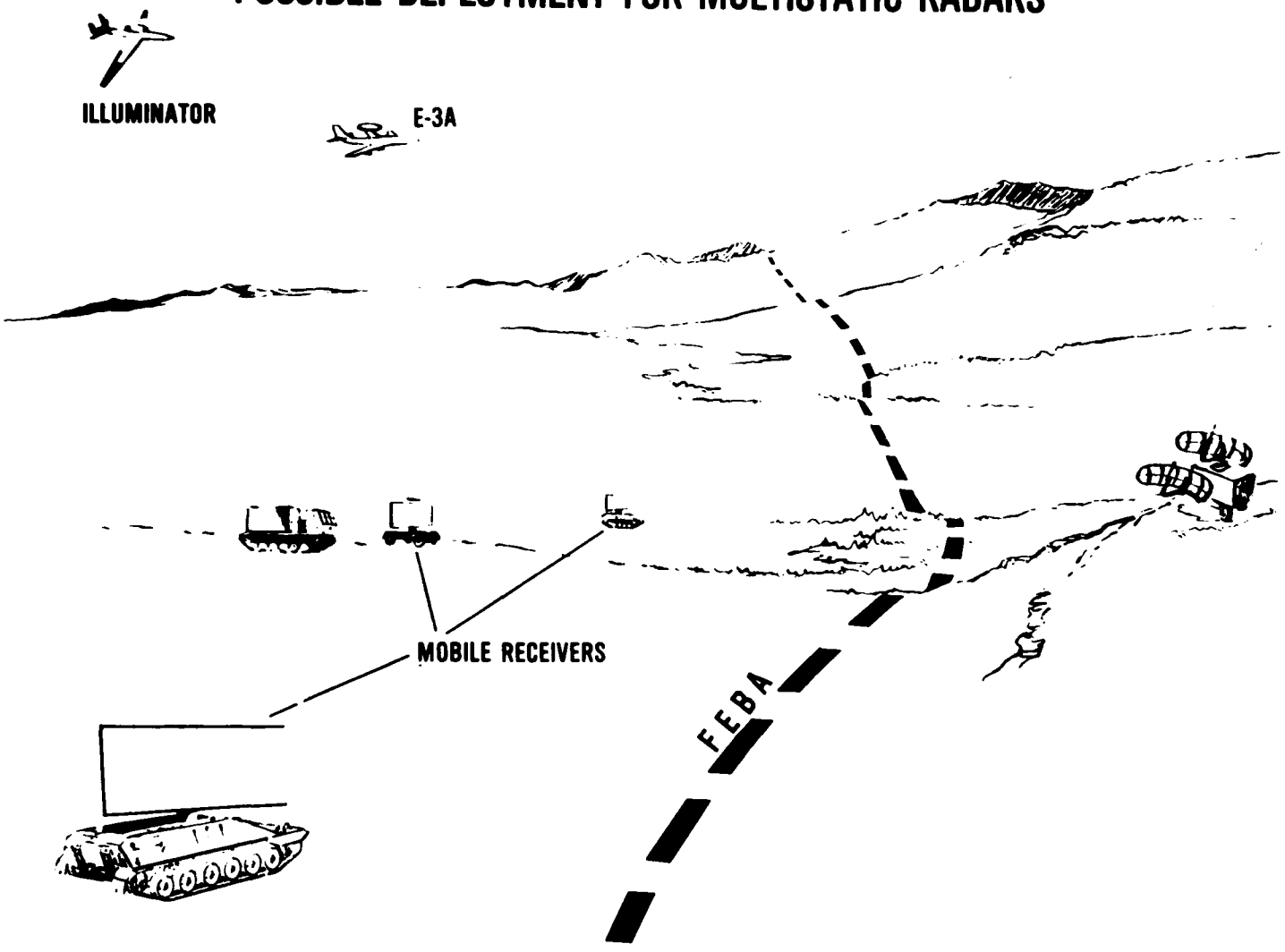
# PROTOTYPE S-BAND MODULE



TEST DATA OF POWER OUTPUT AND EFFICIENCY



# POSSIBLE DEPLOYMENT FOR MULTISTATIC RADARS



TPO THRUST #/TITLE: 1C TACTICAL $C^3$

SUB-SUB-THRUST #/TITLE: 2B SURVEILLANCE-ECCM/ECCM & RADAR DEVELOPMENT

BLOCK TITLE: ADVANCED AIRBORNE SURVEILLANCE RADAR

OBJECTIVE: INVESTIGATE NEW AND PROMISING TECHNOLOGY IN SUPPORT OF ADVANCED AIRBORNE SURVEILLANCE RADAR

TECHNICAL APPROACH: ESTABLISH BASELINE RADAR DESIGN. DEVELOP-EXPAND HIGH RISK COMPONENTS I.E. ANT. SOLID STATE MODULES - BUILD ADVANCED DEVELOPMENT MODEL

PAY OFF: HIGH PAY OFF IN MULTI THREAT ENVIRONMENT

TPO THRUST #/TITLE: 1C TACTICAL $C^3$

SUB-SUB-THRUST #/TITLE: 2B SURVEILLANCE-ECCM/ECCM & RADAR DEVELOPMENT

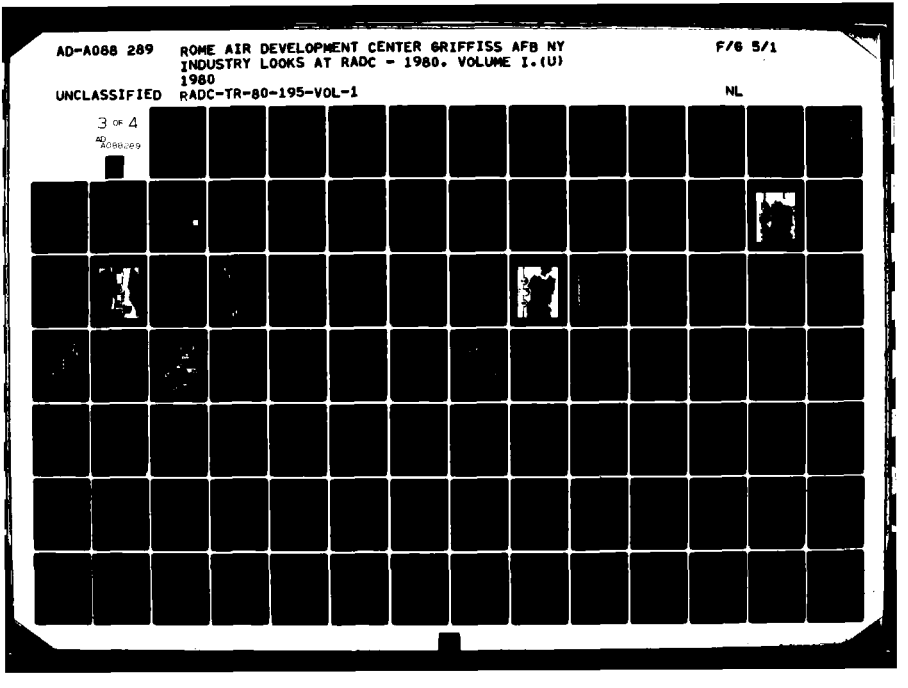
BLOCK TITLE: MULTIBAND DESIGN

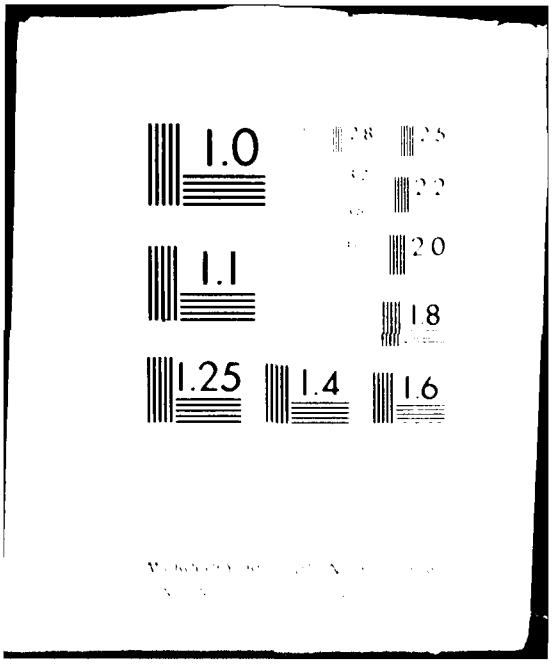
OBJECTIVE: INVESTIGATE NEW AND PROMISING TECHNOLOGY IN SUPPORT OF A MULTI BAND RADAR

TECHNICAL APPROACH: INVESTIGATE CANDIDATE LOW SIDELOBE MULTI BAND AGILE BEAM ANTENNA TECHNIQUES WITH SOLID STATE. OCTAVE BAND TRANSMITTER DEVELOPMENTS

PAY OFF: HIGH PAY OFF IN MULTI THREAT ENVIRONMENT WITH INCREASED ECCM CAPABILITY. HIGHER SEARCH AND TRACK RATES, COMM CAPABILITY, JAMMER.

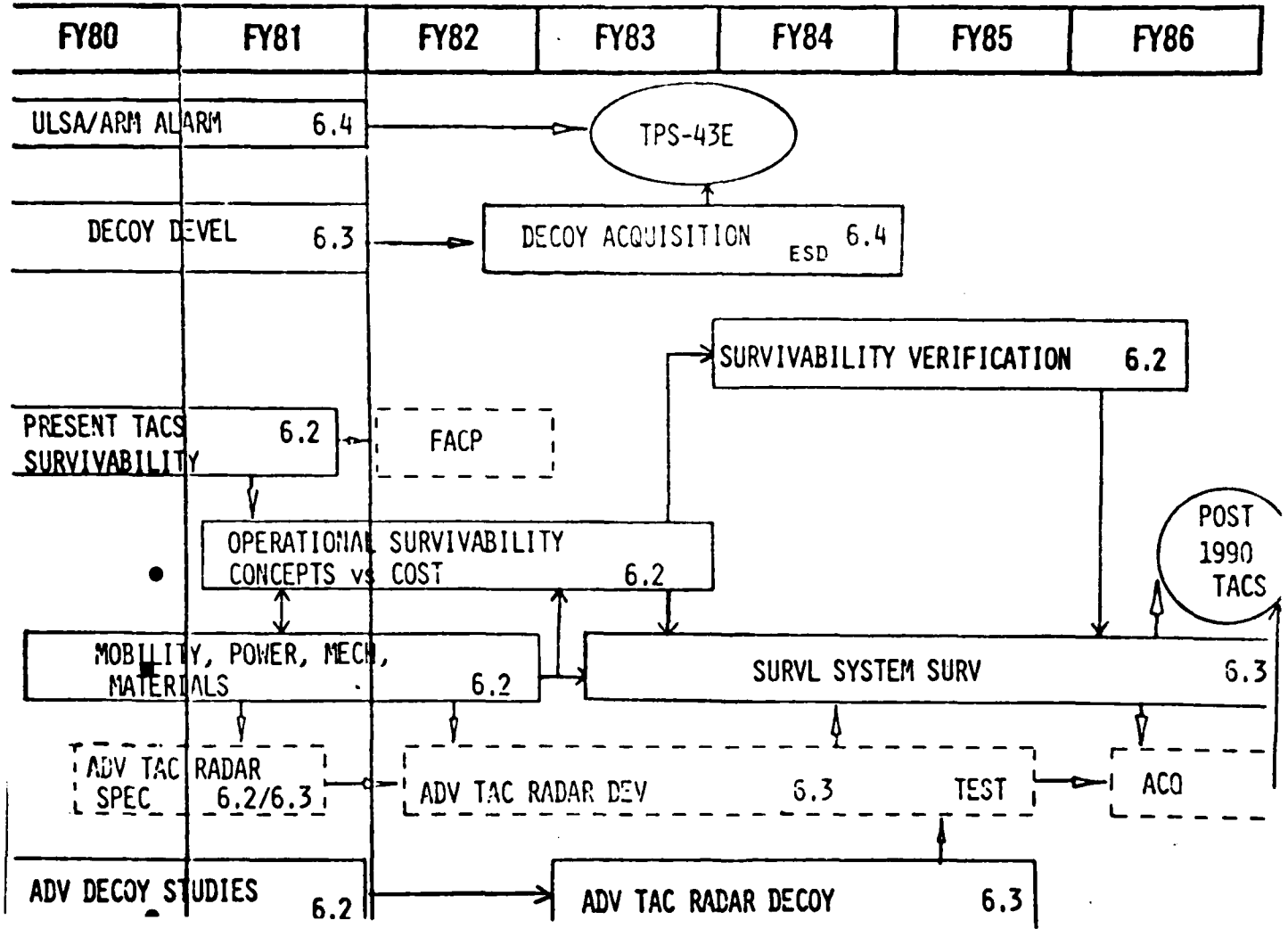
AD-A088 289 ROME AIR DEVELOPMENT CENTER GRIFFISS AFB NY F/G 5/1
INDUSTRY LOOKS AT RADC - 1980. VOLUME I.(U)
1980
UNCLASSIFIED RADC-TR-80-195-VOL-1 NL




1.0
1.1
1.25
1.4
1.6
1.8
2.0
2.2
2.5

RADC TPO

THRUST: 1 $C^3$ C2B TACTICAL $C^3$/SURVL/SURVL-ECCM/RADAR SURVIVABILITY



TPO THRUST #/TITLE: 1C TACTICAL $C^3$

SUB-SUB-THRUST #/TITLE: 2B SURVEILLANCE-ECCM/RADAR SURVIVABILITY

BLOCK TITLE: OPERATIONAL SURVIVABILITY CONCEPTS vs COST

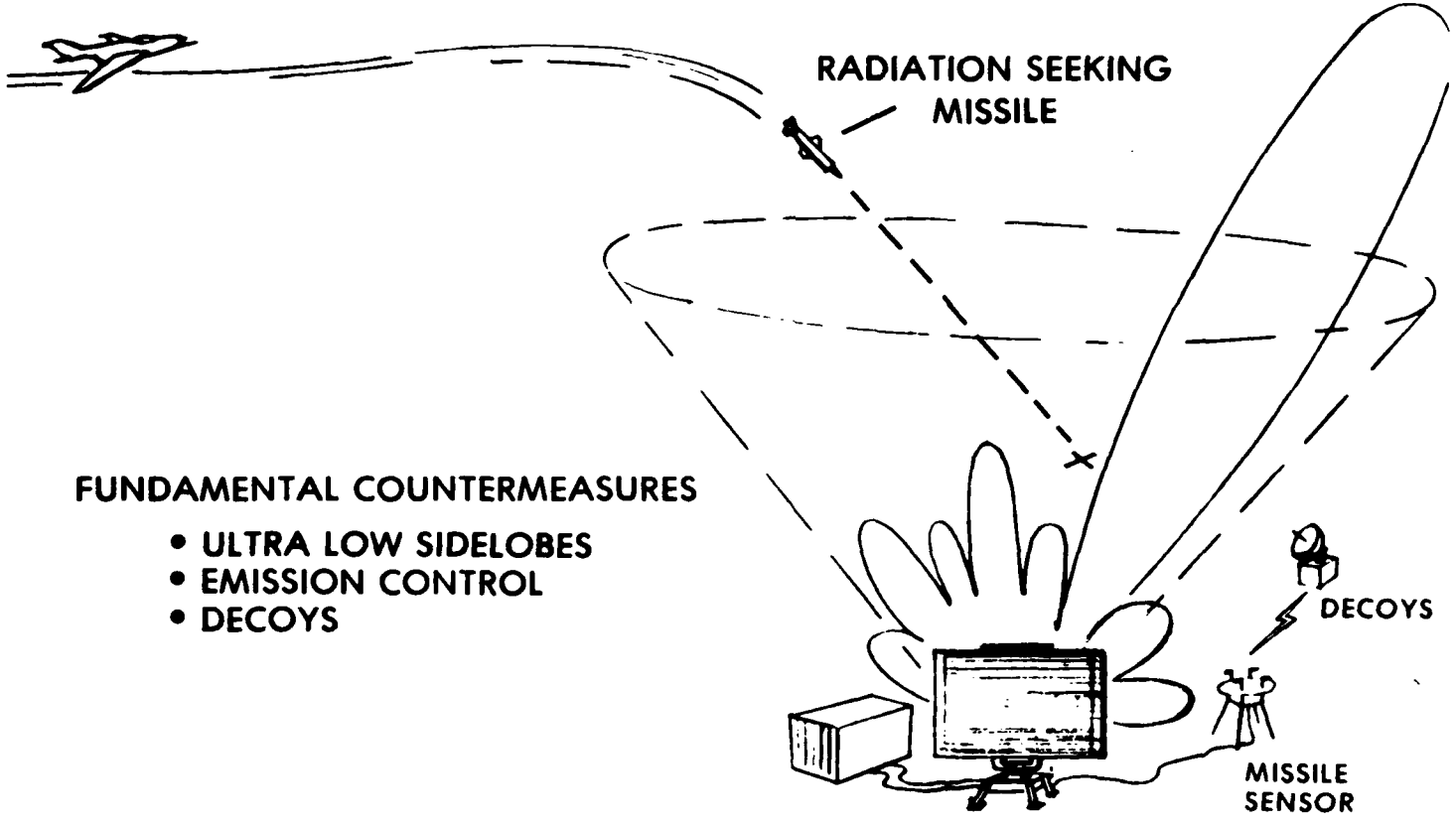
OBJECTIVE: TO DEVELOP SURVIVABILITY MODELS SUCH AS FOR THE ADVANCED TACTICAL RADAR SURVIVABILITY SPECIFICATION.

TECHNICAL APPROACH: CONDUCT A MULTIPLE THREAT ANALYSIS. I.E. ARMS. RF & IR. GUIDED BOMBS ETC. AND DERIVE SURVIVABILITY CONCEPTS. I.E. DECOYS. MOBILITY. CAMOUFLAGE. NEAR MISS HARDNESS.

DETERMINE PROBABILITY OF SURVIVAL vs COST.

PAY OFF: ENHANCED SURVIVABILITY OF FUTURE MOBILE TAC's.

# ANTI-ARM




**FUNDAMENTAL COUNTERMEASURES**

- ULTRA LOW SIDELOBES
- EMISSION CONTROL
- DECOYS

TPO THRUST #/TITLE: 1C TACTICAL $C^3$

SUB-SUB-THRUST #/TITLE: 2B SURVEILLANCE-ECCM/RADAR SURVIVABILITY

BLOCK TITLE: MOBILITY, POWER, MECHANICAL & MATERIALS

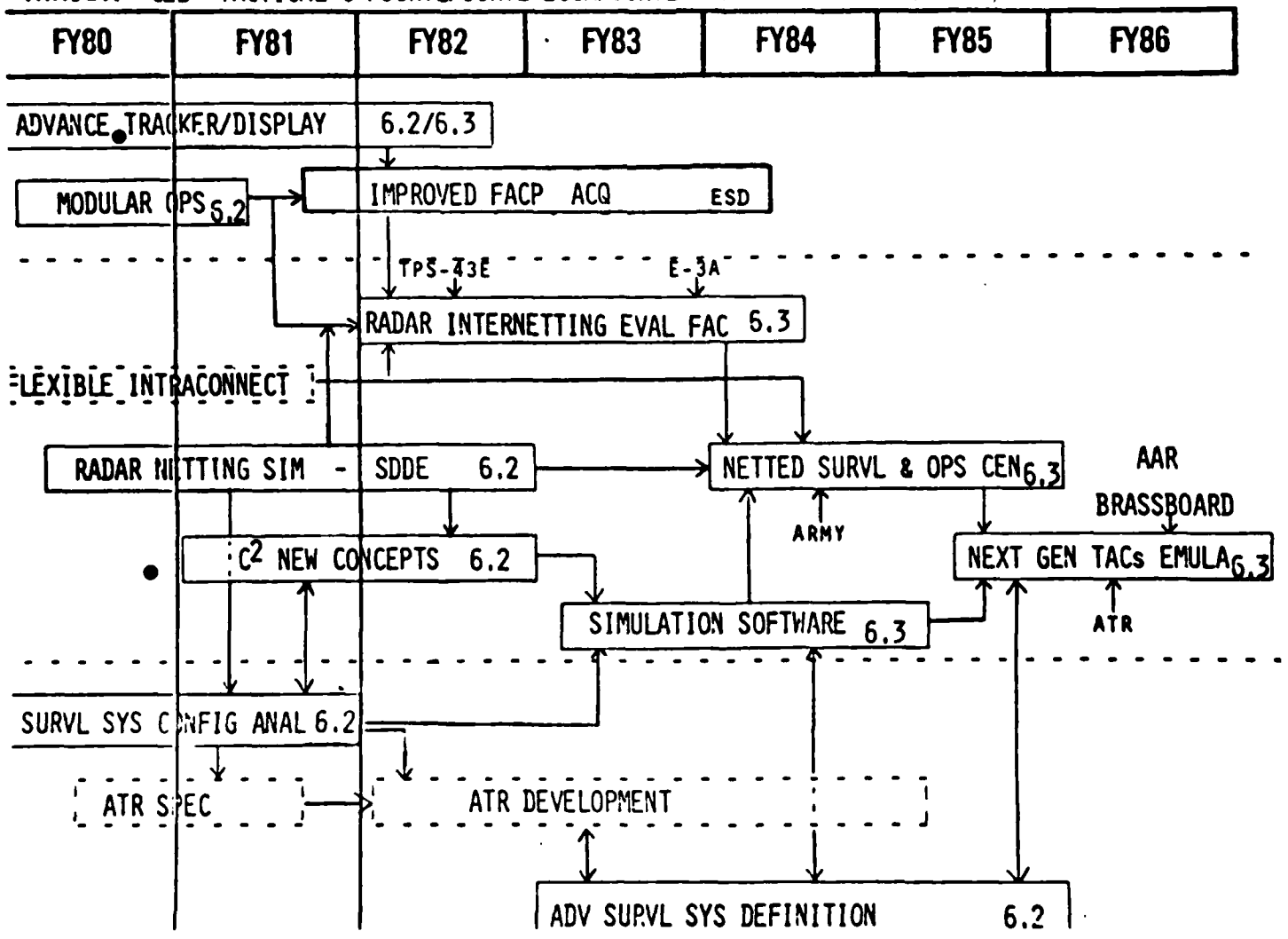
OBJECTIVE: OBTAIN LIGHT WEIGHT, EFFICIENT PRIME POWER AND ENVIRONMENTAL CONTROL UNITS FOR FULL SUPPORT OF ADVANCED TACTICAL RADAR MOBILITY REQUIREMENTS.

TECHNICAL APPROACH:
- DETERMINE THE AVAILABILITY AND CAPABILITY OF PRESENT HARDWARE
- DEVELOP A JOINT AIR FORCE/ARMY PROGRAM TO ADDRESS DEFICIENCIES AND OBTAIN DESIRED END ITEMS.

PAY OFF: HIGH. HIGH MOBILITY WILL BE ACHIEVED.

RADC TPO 1 C³

THRUST: C2B TACTICAL C³/SURVL/SURVL-ECCM/SURVL SYSTEMS TECHNOLOGY



TPO/THRUST #/TITLE: 1C TACTICAL $C^3$

SUB-SUB-THRUST #/TITLE: 2B SURVEILLANCE-ECCM/SURVL SYSTEMS TECHNOLOGY

**BLOCK TITLE:** ADVANCED TRACKER/DISPLAY

**OBJECTIVE:** TO DESIGN, DEVELOP AND TEST AN AUTOMATIC TACTICAL TARGET TRACKER/DISPLAY WHICH IS CAPABLE OF COPING WITH HIGH PERFORMANCE AIRCRAFT IN A HIGH DENSITY THREAT ENVIRONMENT.

**TECHNICAL APPROACH:** DEVELOP A BRASSBOARD FOR TESTING WITHIN RADC TEST FACILITY.

**PAYOFF:** INCREASED TRACK CAPACITY OF RADARS WITH IMPROVED OPERATIONAL FLEXIBILITY.

TPO/THRUST #/TITLE: 1C TACTICAL $C^3$

SUB-SUB-THRUST #/TITLE: 2B SURVEILLANCE-ECCM/SURVEILLANCE SYSTEM TECHNOLOGY

BLOCK TITLE: RADAR INTERNETTING EVALUATION FACILITY

OBJECTIVE: TEST NETTING, MODULAR AND NEW OPERATIONAL CONCEPTS & PROCEDURES

TECHNICAL APPROACH: PROVIDE MOCK-UP OF MODULAR OPS USING ADVANCED TRACKER DISPLAYS, FLEXIBLE INTRACONNECT FOR DATA BUS, COMM TO SENSORS FOR NETTING AND SOFTWARE.

PAY OFF: HIGH - PROVIDE INTEGRATED TESTING OF NEW TECHNOLOGY WITH NEW OPERATIONAL CONCEPTS IN AN R&D ENVIRONMENT.

TPO/THRUST #/TITLE: 1C TACTICAL $C^3$

SUB-SUB-THRUST #/TITLE: 2B SURVEILLANCE-ECCM/SURVEILLANCE SYSTEMS TECHNOLOGY

BLOCK TITLE: $C^2$ NEW CONCEPTS

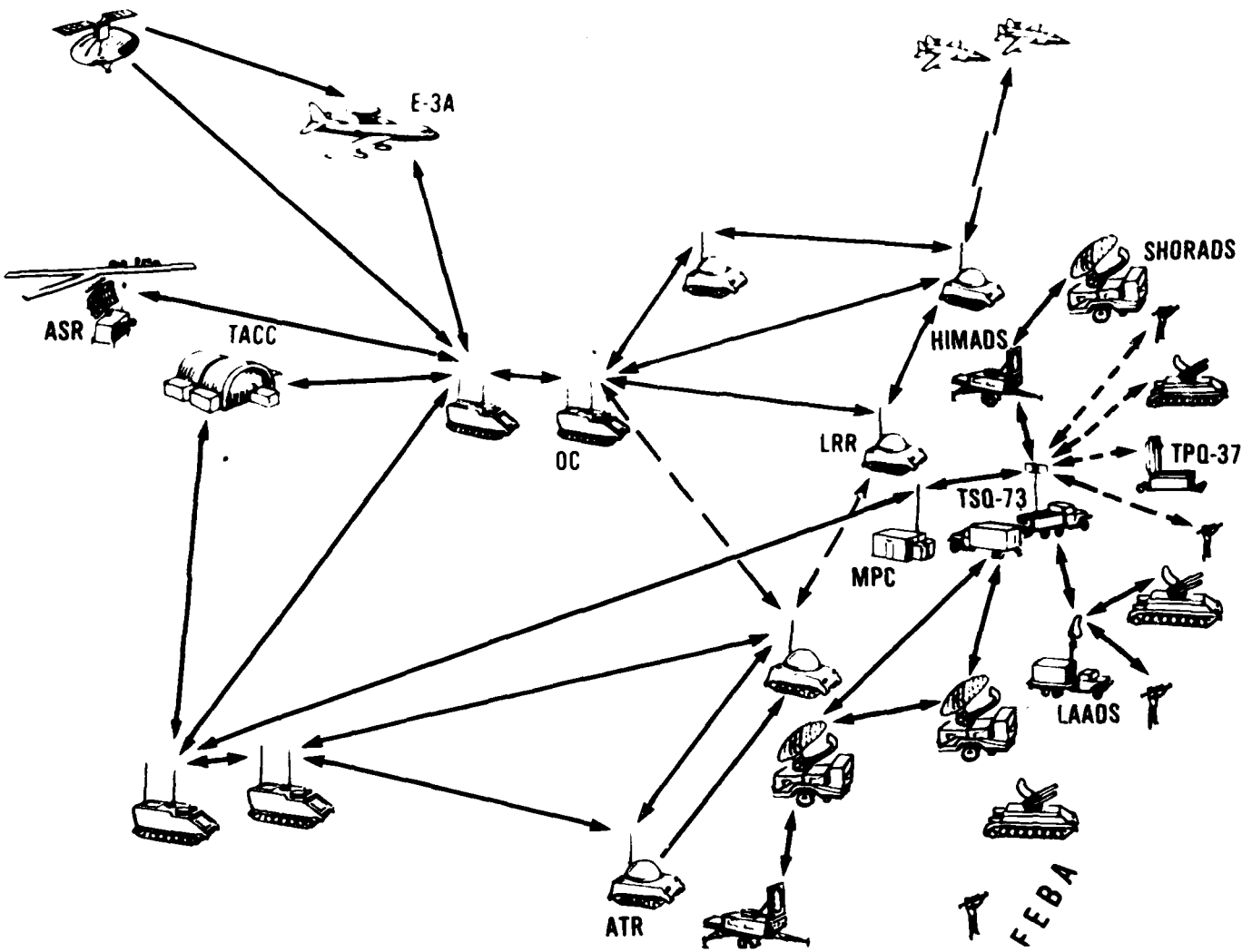
OBJECTIVE: DEVELOP THE INDIVIDUAL AND INTEGRATED CONTROL CONCEPTS FOR AN AUTOMATED SURVEILLANCE SYSTEM.

TECHNICAL APPROACH:

- APPLY MODERN PROCESSING DEVICES AND TECHNIQUES SUCH AS DISTRIBUTED PROCESSING ARRAYS AND ADAPTIVE PROBABILISTIC LOGIC TO PROVIDE AUTOMATED:
  - TARGET TRACKING AND ID
  - ECCM CONTROL
  - INTERELEMENT MESSAGE CONTROL
  - SURVIVABILITY STRATEGY
  - TIME AND ENERGY RESOURCE MANAGEMENT

PAY OFF: HIGH - ALLOWS A HIERARCHY OF CRITICAL DECISIONS TOO RAPID FOR HUMAN ACCOMPLISHMENT

# SURVEILLANCE SYSTEM INTERNETTING



SURVEILLANCE ECCM
KEY PROGRAM ENGINEERS

| | |
|---|---|
| ADVANCED TACTICAL RADAR | THOMAS SHIELDS, OCDR/7684 |
| RADAR INTERNETTING | SAM HART, OCDE/4515 |
| RADAR SURVIVABILITY | ROBERT MATHER, OCDS/4049 |
| RADAR ECCM | JOSEPH MASSOUD, OCDR/4496 |
| ADVANCED AIRBORNE SURVEILLANCE RADAR | RICHARD ACKLEY, OCDE/4441 |
| SIMULATION | GEORGE ELLIS, OCDE/4496 |
| TACTICAL RADAR ANTENNAS | DONALD HILDEBRAND, OCDR/4496 |

SURVEILLANCE DIVISION
MINI-SESSION PRESENTATIONS
TUESDAY, 3 JUNE 1980

RADC - BLDG 106 - AUDITORIUM

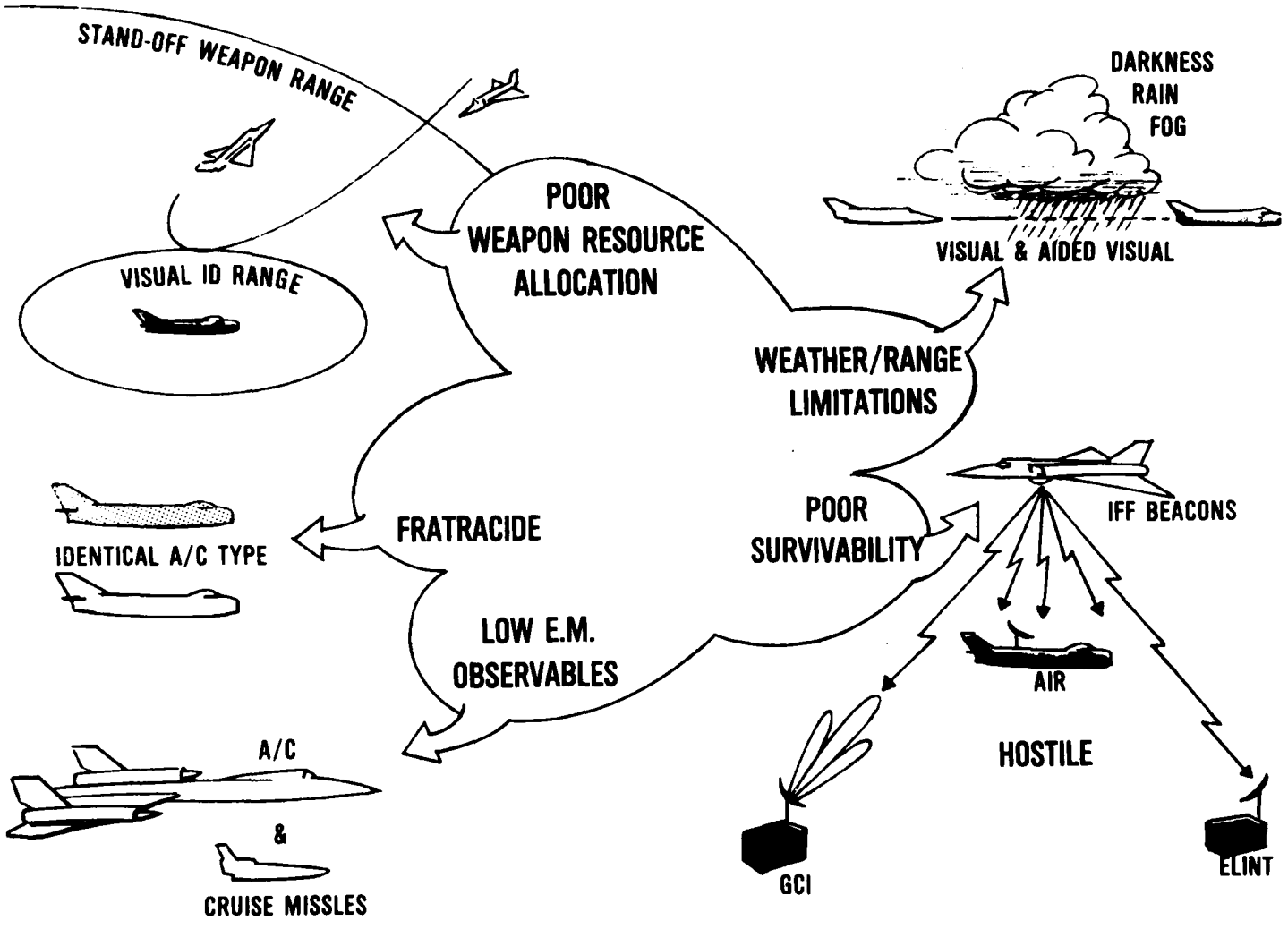
1:45 PM SURVEILLANCE ECCM - MR. SHIELDS

- AIR CRAFT IDENTIFICATION - MR. WOLF

3:15 PM SPACE BASED RADAR - MR. SIMONS

CRUISE MISSILE SURVEILLANCE - MR. OGRODNIK

# ASSESSMENT OF AIRCRAFT IDENTIFICATION PROBLEM



TPO/THRUST: 1C/TACTICAL $C^3$

SUB-THRUST/SUB SUB-THRUST: 2A/SURVEILLANCE AIRCRAFT IDENTIFICATION

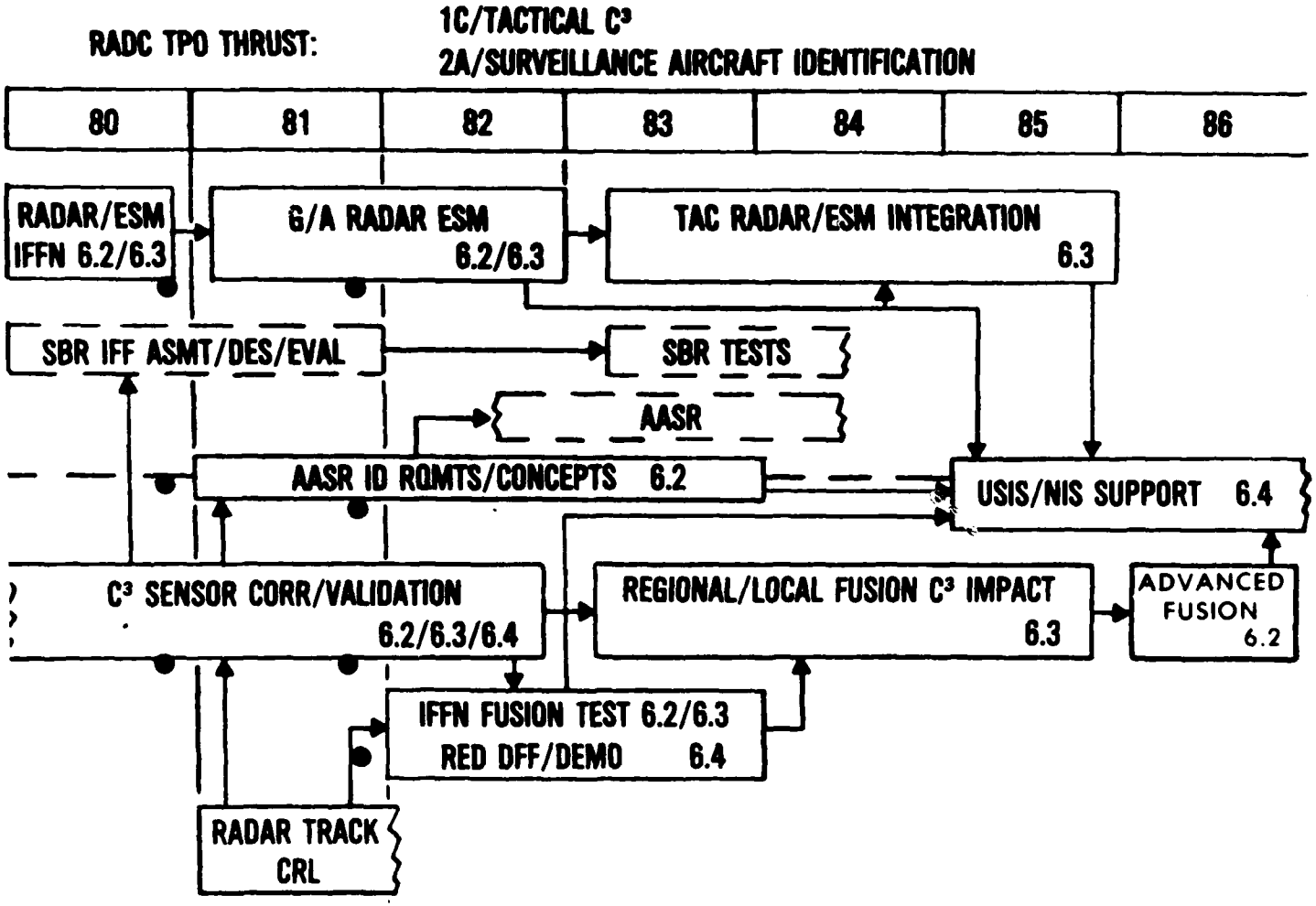
PROGRAM GOALS:

- PROVIDE LONG RANGE, ALL WEATHER, REAL-TIME IDENTIFICATION OF FRIENDLY, HOSTILE & NEUTRAL AIRCRAFT

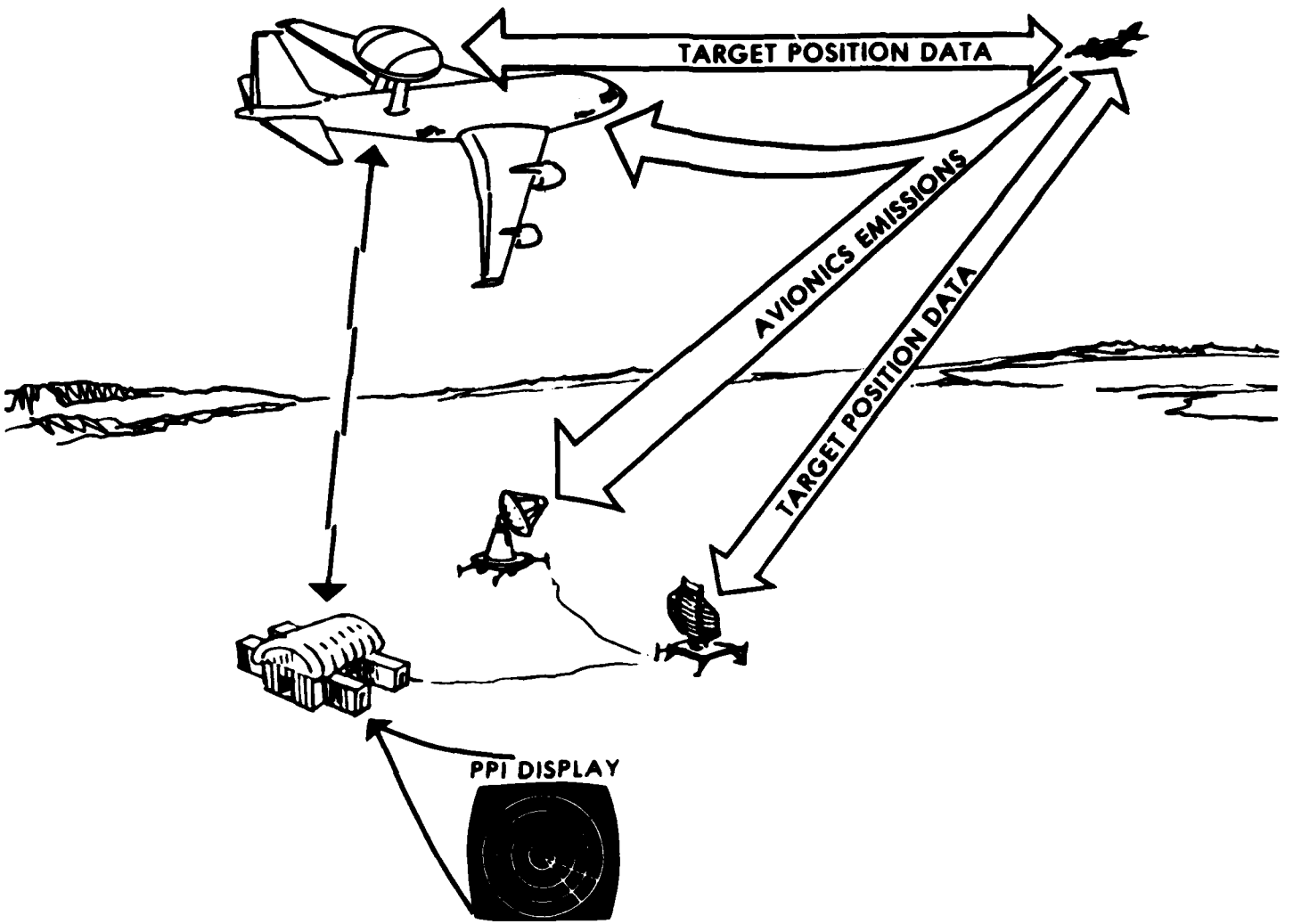
TECHNICAL AREAS:

- RADAR/ESM CORRELATION TEST & EVALUATION
- $C^3$ ID DATA CORRELATION/VALIDATION

TOTAL FUNDS FY80-83 12.5M - 13.1M


RADC TPO THRUST:
1C/TACTICAL C³
2A/SURVEILLANCE AIRCRAFT IDENTIFICATION
80
81
82
83
84
85
86
RADAR/ESM IFFN 6.2/6.3
G/A RADAR ESM 6.2/6.3
TAC RADAR/ESM INTEGRATION 6.3
SBR IFF ASMT/DES/EVAL
SBR TESTS
AASR
AASR ID RQMTS/CONCEPTS 6.2
USIS/NIS SUPPORT 6.4
C³ SENSOR CORR/VALIDATION 6.2/6.3/6.4
REGIONAL/LOCAL FUSION C³ IMPACT 6.3
ADVANCED FUSION 6.2
IFFN FUSION TEST 6.2/6.3
RED DFF/DEMO 6.4
RADAR TRACK CRL

# G/A RADAR ESM


TARGET POSITION DATA
AVIONICS EMISSIONS
TARGET POSITION DATA
PPI DISPLAY

**TPO/THRUST:** 1C/TACTICAL $C^3$

**SUB-THRUST/SUB SUB-THRUST:** 2A/SURVEILLANCE AIRCRAFT IDENTIFICATION

**BLOCK TITLE:** G/A RADAR ESM

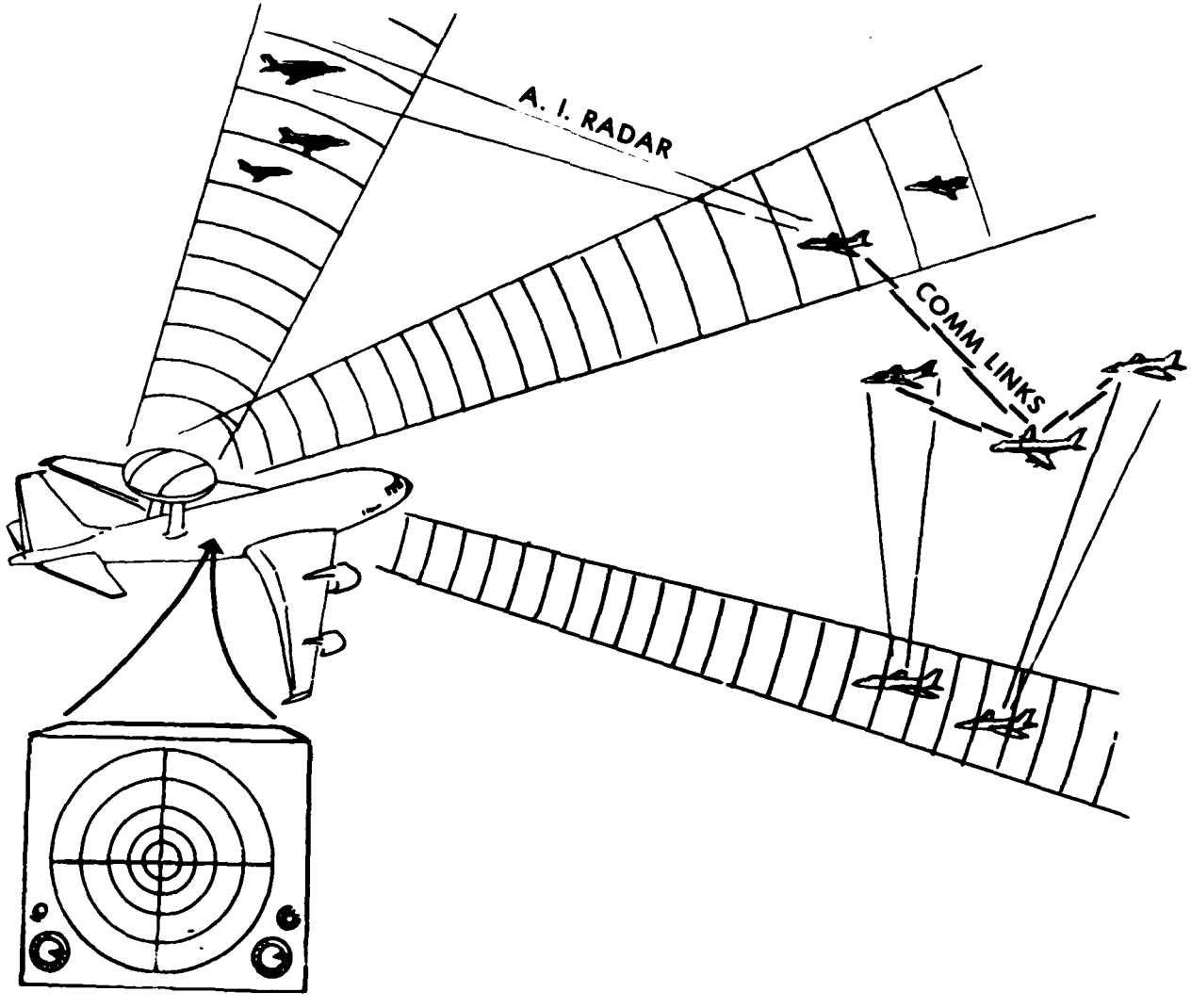
**OBJECTIVE:** OBTAIN LONG RANGE ID THROUGH CORRELATED RADAR & ESM SENSOR DATA

**TECHNICAL APPROACH:**

- INTEGRATION OF A/B RADAR/SIGINT WITH G/B RADAR ESM DATA
- EVALUATION OF REAL-TIME IFF CAPABILITY
- DETERMINATION OF DEGREE OF CORROBORATION
- EVALUATION OF EARLY WARNING CUEING OF GROUND ASSETS & POTENTIAL SORTING PAYOFFS
- POTENTIAL DEMONSTRATION OF A/B DATA AUGMENTING GROUND EXPERIMENT

**PAYOFF:** NEAR TERM ENHANCED ID CAPABILITY FOR $C^3$ SYSTEM

# AASR ID REQUIREMENTS/CONCEPTS



**TPO/THRUST:** 1C TACTICAL $C^3$

**SUB-THRUST/SUB SUB-THRUST:** 2A/SURVEILLANCE AIRCRAFT IDENTIFICATION

**BLOCK TITLE:** ADVANCED AIRBORNE SURVEILLANCE RADAR ID REQUIREMENTS

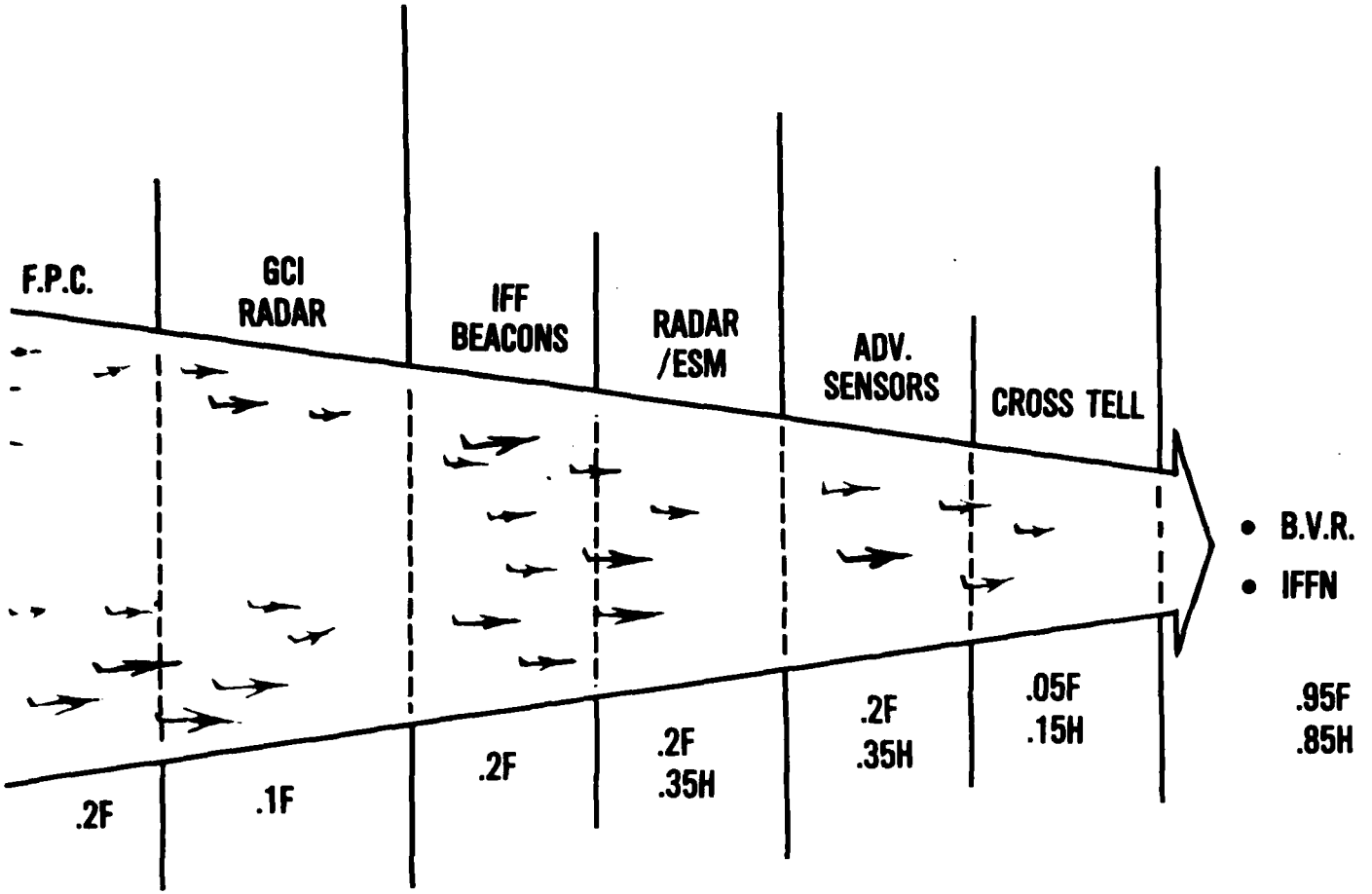
**OBJECTIVE:** ASSESS REQUIREMENTS & FORMULATE ID CONCEPTS FOR ADVANCED AIRBORNE SURVEILLANCE RADAR

**TECHNICAL APPROACH:**

- ADVANCED AIRBORNE SURVEILLANCE RADAR ID REQUIREMENTS ANALYSIS
- TECHNOLOGY ASSESSMENTS
- SYSTEM IMPACT

**PAYOFF:** LONG RANGE ID CAPABILITY FOR ADVANCED AIRBORNE SURVEILLANCE RADAR

# RATIONALE FOR MULTI-SENSOR APPROACH



**TPO/THRUST:** 1C TACTICAL $C^3$

**SUB-THRUST/SUB SUB-THRUST:** 2A/SURVEILLANCE AIRCRAFT IDENTIFICATION

**BLOCK TITLE:** $C^3$ SENSOR CORRELATION/VALIDATION

**OBJECTIVE:** ANALYSIS, SIMULATION & VALIDATION OF INDIRECT ID SUBSYSTEM

**TECHNICAL APPROACH:**

- SIMULATION & ANALYSIS OF INTEGRATED $C^3I$ CONCEPT FOR FUSING ID INFORMATION FROM DISTRIBUTED SENSORS & SOURCES
  - SENSORS INCLUDE E-3A, TPS-43E, & SIGINT
- DEVELOP DATA MANAGEMENT REQUIREMENTS
- DEVELOP FUSION ALGORITHMS
- VALIDATE THROUGH DEMONSTRATION

**PAYOFF:** HIGHLY EFFICIENT AIR SPACE MANAGEMENT CAPABILITY IN MULTI-NATIONAL ENVIRONMENT WITH ADVERSE FORCE RATIOS

TPO/THRUST: 1C/TACTICAL $C^3$

SUB-THRUST/ SUB SUB-THRUST: 2A/SURVEILLANCE AIRCRAFT IDENTIFICATION

BLOCK TITLE: IFFN FUSION TEST BED DEF/DEMO

OBJECTIVE: DEVELOPMENT OF EMULATION & HARDWARE TEST BED FOR VALIDATION OF MULTI-SENSOR DATA CORRELATION TECHNOLOGIES



TECHNICAL APPROACH:

- INTEGRATION OF CURRENT TAC SENSOR & DATA PROCESSING HARDWARE INTO SURVEILLANCE SYSTEMS SIMULATION/ EMULATION CAPABILITY
- BRASSBOARD DEVELOPMENT OF PROPOSED SYSTEMS CONCEPTS FOR TESTING & ANALYSIS

PAYOFF:

- REDUCES COSTS/RISKS IN DEVELOPMENT OF FUTURE SYSTEMS CONCEPTS
- DATA BASE FOR DEVELOPMENT & VALIDATION OF SYSTEM ARCHITECTURE

# AIRCRAFT IDENTIFICATION

| TITLE | PROJECT ENGINEER | SYMBOL | EXT |
|---|---|---|---|
| AIR AUGMENTED GROUND RADAR ESM DEMO | D. TAURONEY | OCTM | 4433 |
| MULTIPLE SENSOR DATA CORRELATION | W. WOLF | OCTM | 4432 |
| ADVANCED ID ASSESSMENT FOR AASR | W. WOLF | OCTM | 4432 |
| TTI SIMULATION PROGRAM UPGRADE | R. WOOD | OCTM | 4434 |
| TAC RADAR/ESM REQUIREMENTS SPECIFICATION | D. TAURONEY | OCTM | 4433 |
| MULTIPLE SENSOR FUSION TEST BED DEF. | W. WOLF | OCTM | 4432 |
| AASR REQUIREMENTS DEF. | W. WOLF | OCTM | 4432 |
| SENSOR FUSION VALIDATION | W. WOLF | OCTM | 4432 |

MINI SESSION ON

SWITCHING

SYSTEM CONTROL

DISTRIBUTED $C^3$



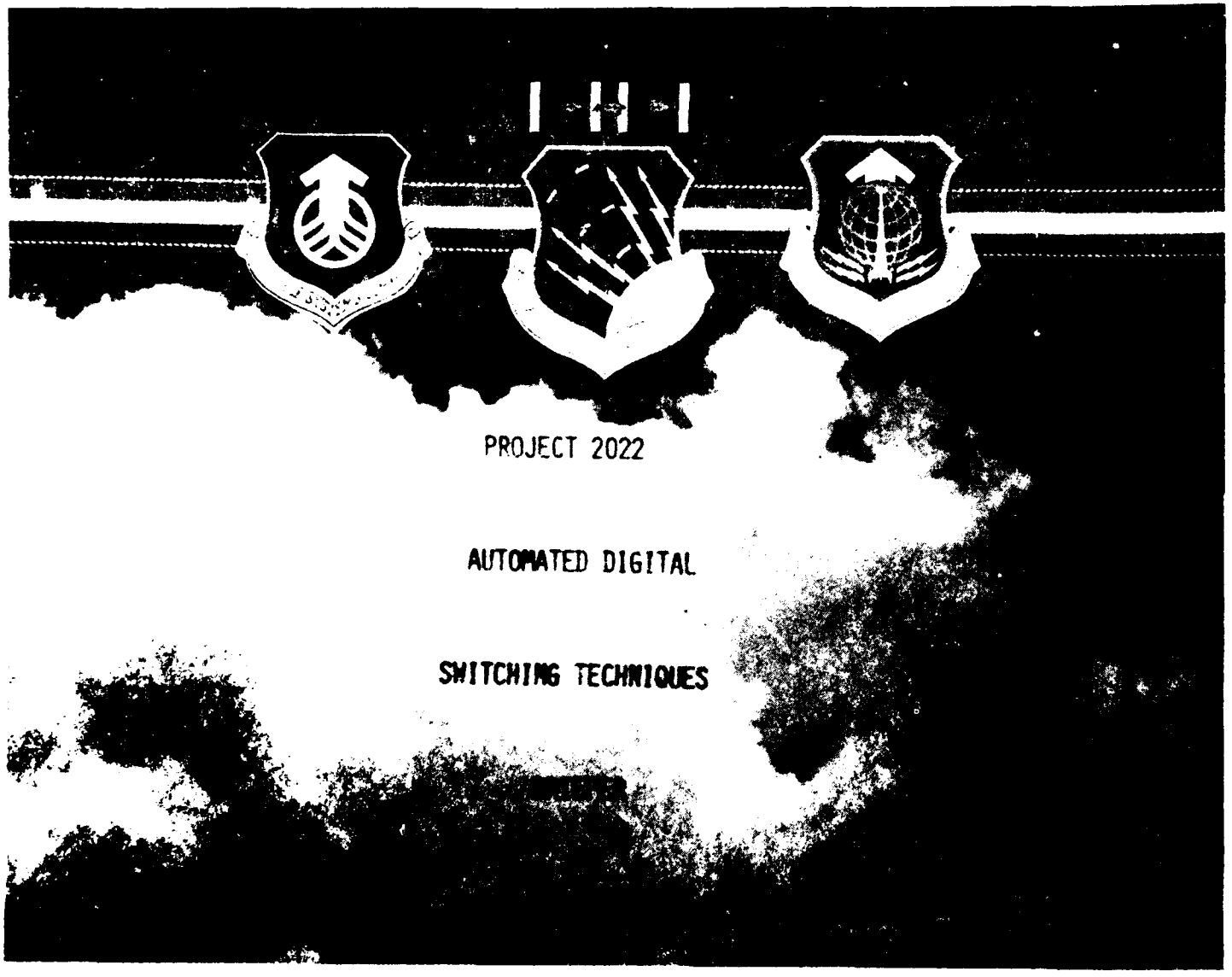
HOSTED BY: RADC/DC

## BRIEFERS

SWITCHING AND ROUTING - NEIL S. MARPLES

SYSTEM CONTROL - DONALD SPECTOR

DISTRIBUTED $C^3$ - LT. DAVID SCHMITT


PROJECT 2022
AUTOMATED DIGITAL
SWITCHING TECHNIQUES

IPO/THRUST: 1A/SUPPORT $C^3$

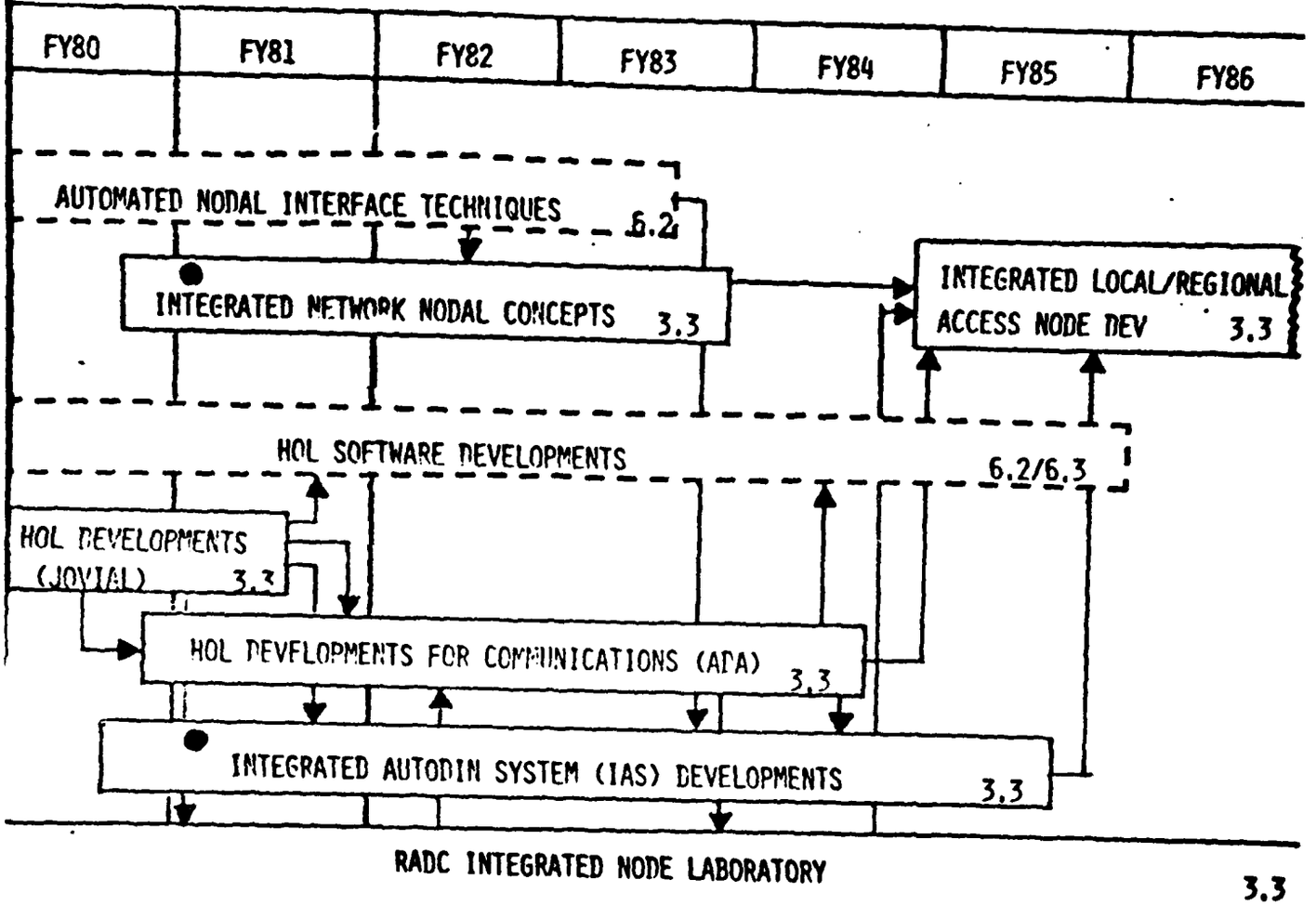
SUB-SUB-THRUST: 1A/SWITCHING AND ROUTING

PROGRAM GOALS: DEVELOP AN INTEGRATED SWITCHED SYSTEM FOR THE DEFENSE COMMUNICATIONS SYSTEM (DCS III).

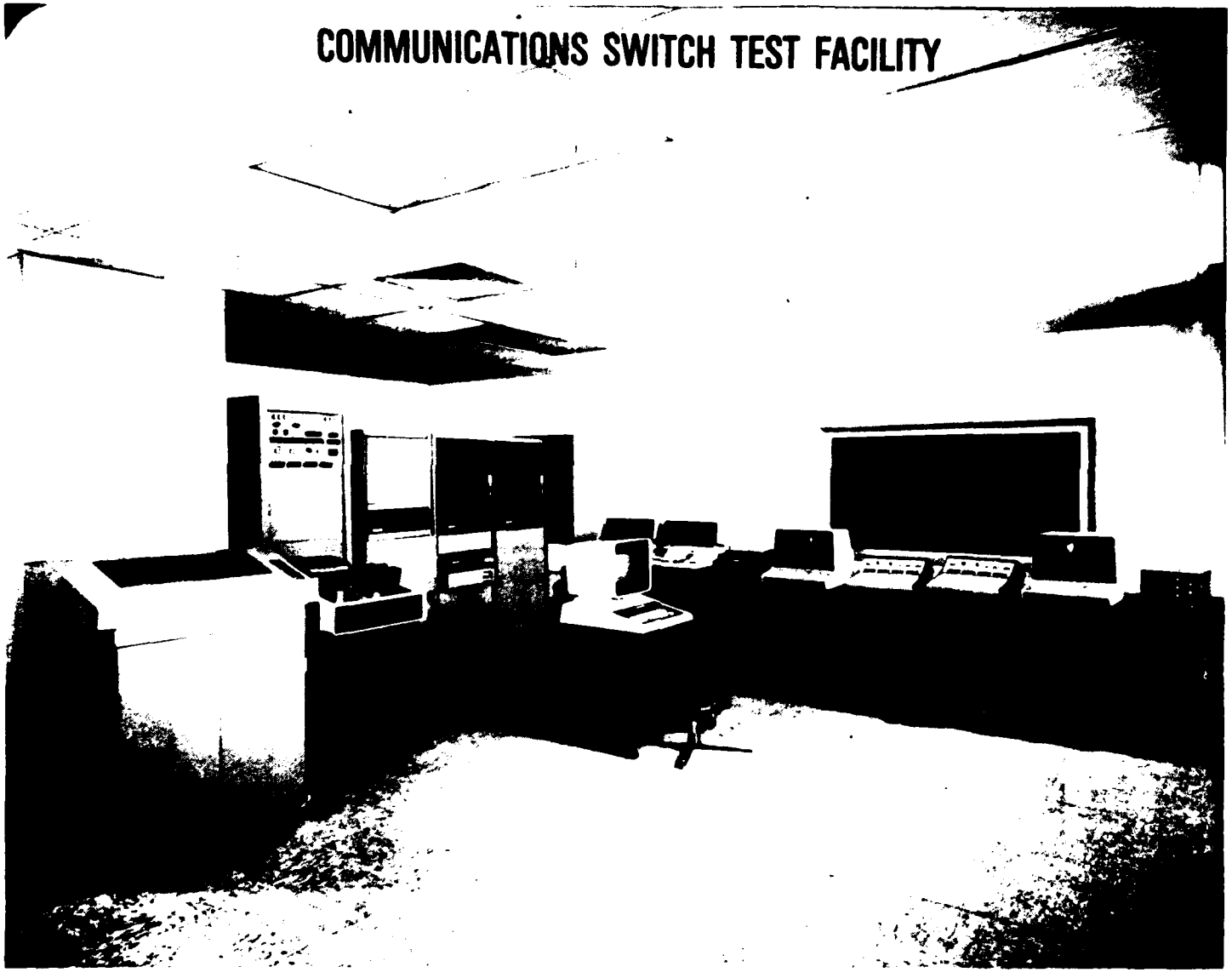
TECHNICAL AREAS:
- IMPROVEMENTS/SUPPLEMENTS TO THE AUTODIN II PACKET SWITCH NETWORK
- DEVELOP AND EVALUATE ARCHITECTURAL CANDIDATES FOR POST-1990 THIRD GENERATION DEFENSE COMMUNICATION SYSTEM (DCS III).

RADC IPO/THRUST: 1A/SUPPORT $C^3$

SUB-SUB-THRUST: 1A. SWITCHING AND ROUTING



# COMMUNICATIONS SWITCH TEST FACILITY



TPO/THRUST: 1A/SUPPORT $C^3$

SUB-SUB-THRUST: 1.A / SWITCHING AND ROUTING

BLOCK TITLE: INTEGRATED NETWORK NODAL CONCEPTS

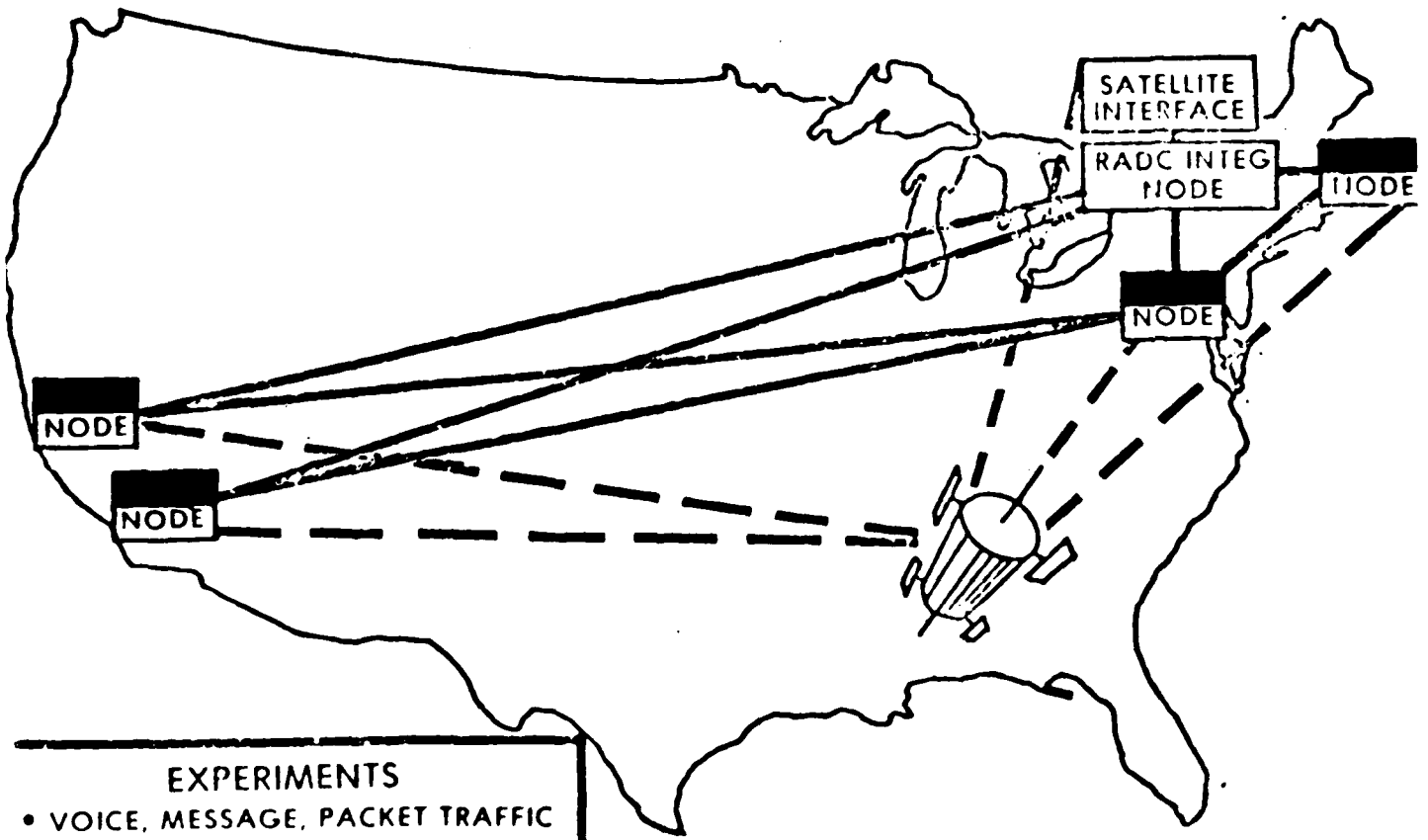
OBJECTIVE: DEVELOP AND EVALUATE CANDIDATE ARCHITECTURES FOR DCS III SWITCH

TECHNICAL APPROACH: ESTABLISH EXPERIMENTAL NETWORK UTILIZING THE RADC INTEGRATED NODE TO CONFIGURE & EVALUATE CANDIDATE ARCHITECTURES

PAYOFF: USE OF THIS EXPERIMENTAL NODAL CONFIGURATION WILL DEMONSTRATE FEASIBILITY AND REVEAL SHORTCOMINGS OF PROPOSED NODAL ARCHITECTURES

RISK: LOW. MOST SIGNIFICANT AREA OF RISK WILL BE THE GENERALIZATION OF THIS NETWORK CONFIGURATION TO THE OVERALL DCS III.

# EXPERIMENTAL INTEGRATED SWITCH NETWORK (EISN)



TPO/THRUST: 1A/SUPPORT $C^3$

SUB-SUB-THRUST: 1.A / SWITCHING AND ROUTING

BLOCK TITLE: INTEGRATED AUTODIN SYSTEM (IAS) DEVELOPMENTS

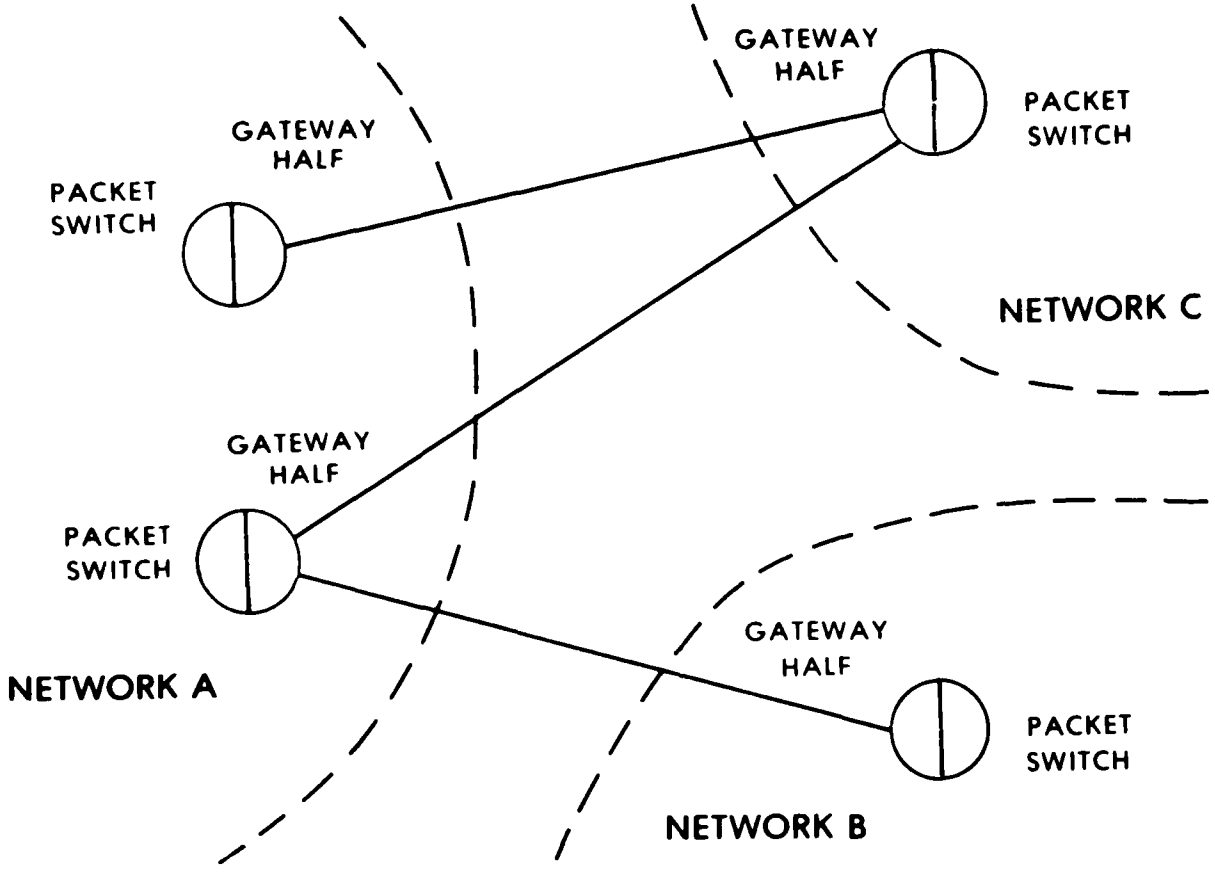
OBJECTIVE: IMPLEMENT NEW DIGITAL TELECOMMUNICATIONS SERVICES ON THE AUTODIN PACKET SWITCH NETWORK

TECHNICAL APPROACH:
- DEVELOP HARDWARE/SOFTWARE MODULES TO ACCOMMODATE NEW SERVICES
- FIELD TEST WITH A SELECT GROUP OF USERS
- GENERATE INTERFACE STANDARDS FOR FUTURE ACQUISITION

PAYOFF: COST EFFECTIVE, EFFICIENT STANDARDIZED IMPLEMENTATION OF NEW TELECOMMUNICATIONS SERVICES

RISK: LOW. TECHNOLOGY EXISTS BUT MUST BE IMPLEMENTED IN AUTODIN II

# GATEWAY CONCEPT



## IAS PILOT DEMONSTRATION PROGRAM

.IMPLEMENT SELECTED NEW DIGITAL TELECOMM SERVICES UTILIZING THE AUTODIN PACKET SWITCH NETWORK AS A BACKBONE

- . DIGITAL FACSIMILE
- . SECURE ELECTRONIC MAIL

.PROGRAM OUTPUT WILL BE A STANDARD FOR IMPLEMENTATION OF THESE NEW SERVICES FOR AUTODIN II (DOD) USERS

## POINTS OF CONTACT

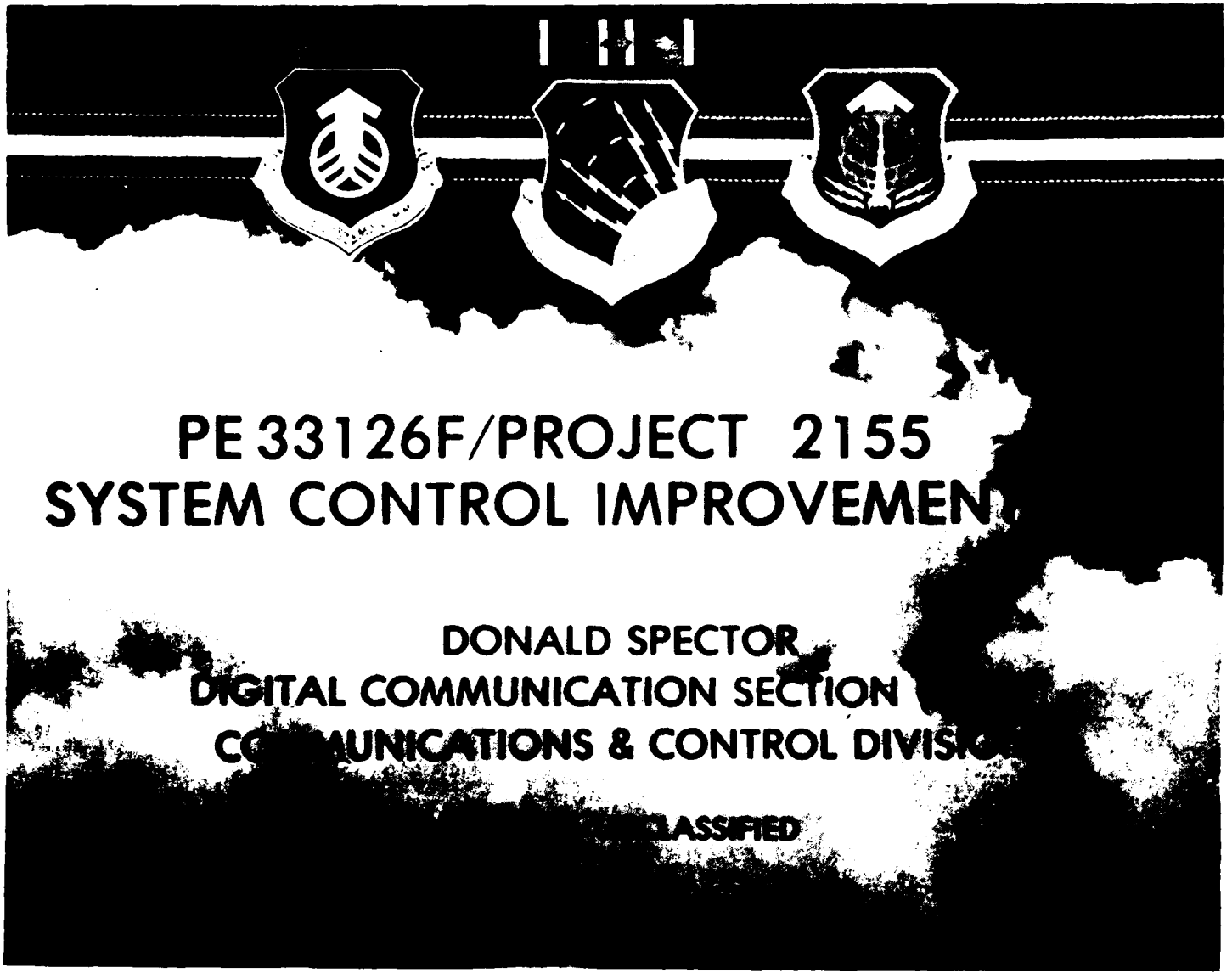
EISN - Capt. Joseph DeGroat X4567

MULTINET GATEWAY - Julian Gitlin X7751

PILOT DEMONSTRATIONS - Neil S. Marples X7751

VON 587 -

COML 315-330-



# PE 33126F/PROJECT 2155
# SYSTEM CONTROL IMPROVEMEN

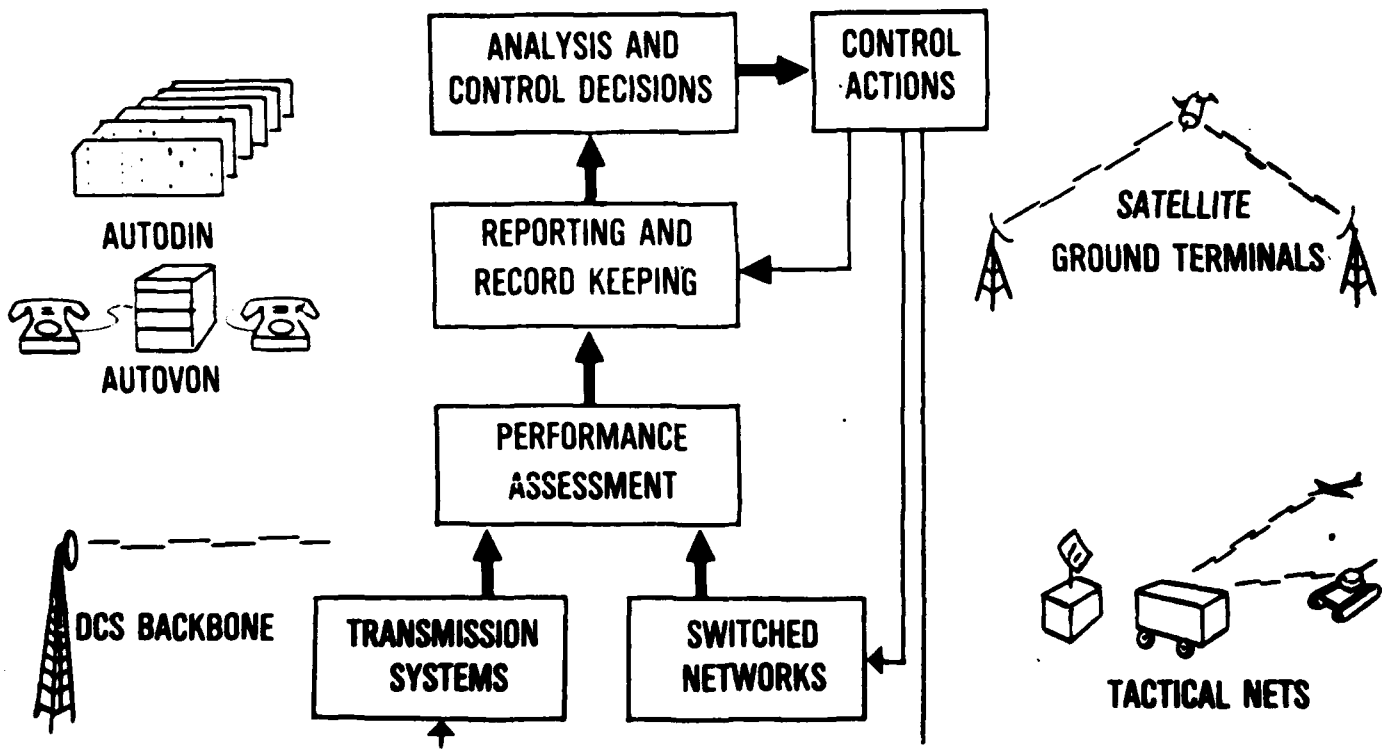
DONALD SPECTOR
DIGITAL COMMUNICATION SECTION
CO MUNICATIONS & CONTROL DIVISI

LASSIFIED

# SYSTEM CONTROL [illegible] FOR THE DCS

ATEC

- PERFORMANCE ASSESSMENT FOR:
  - DCS DIGITAL COMM UPGRADES
  - SATELLITE TERMINALS
  - AUTOVON / AUTODIN
- COMPUTER ASSISTED NETWORK MANAGEMENT
  - TRAFFIC CONTROL
  - AUTOMATIC ROUTING / RECONFIGURATION
- DCS-TRI-TAC INTEROPERABILITY



TPO/THRUST: 1A/SUPPORT $C^3$

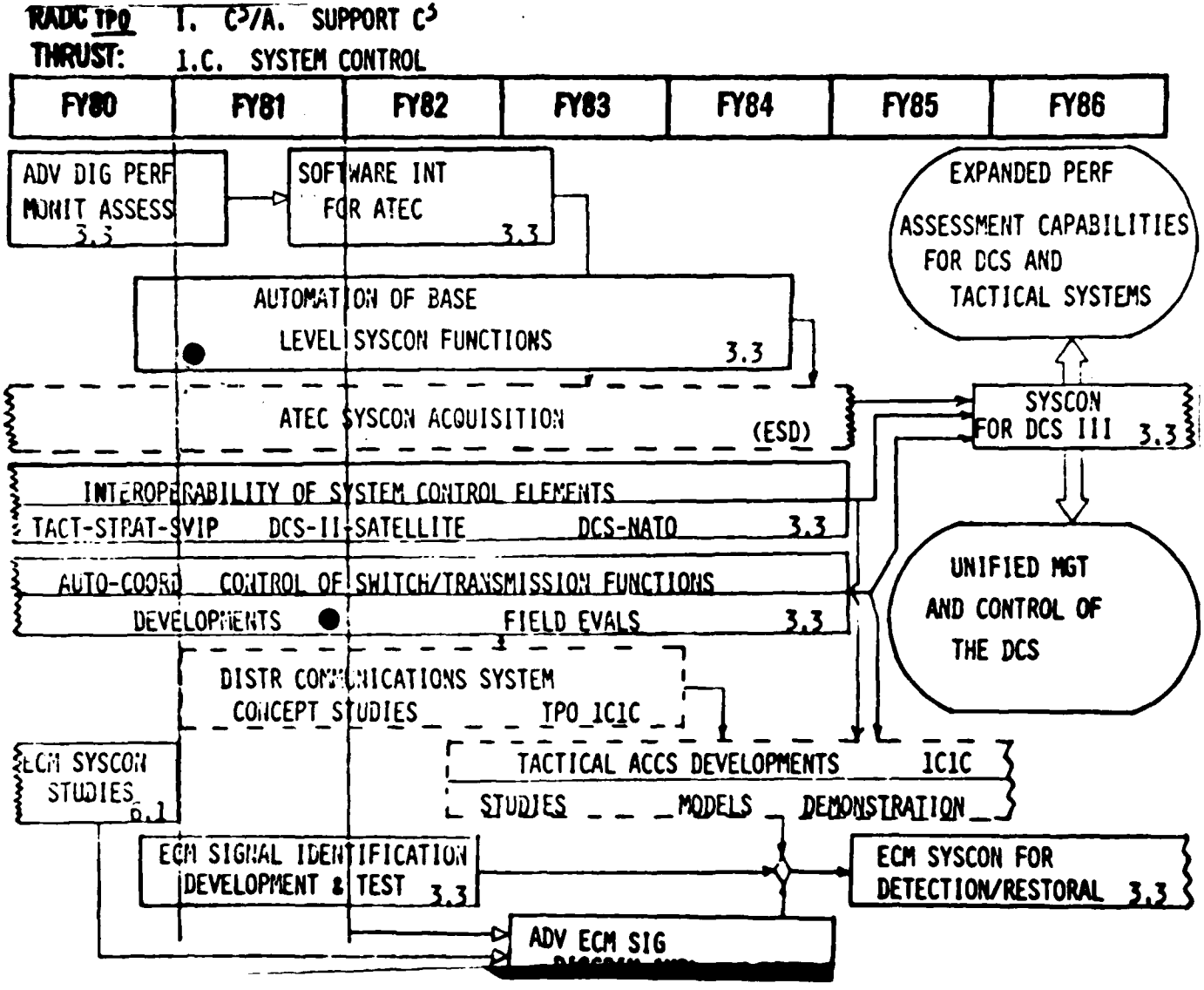
SUB-SUB-THRUST: 1C/SYSTEM CONTROL

PROGRAM GOALS: EXPAND EXISTING SYSTEM CONTROL SUBSYSTEMS TO PROVIDE:

- ENHANCED PERFORMANCE ASSESSMENT
- COORDINATED RESTORAL & ALLOCATION OF NETWORK RESOURCES
- INTEROPERABILITY & SURVIVABILITY OF SYSTEM CONTROL ELEMENTS

TECHNICAL AREAS:

- COMM NETWORK ASSESSMENT
- ECM SIG DET, ISOLATION & CHARACTERIZATION
- CHANNEL RECONFIGURATION
- INTEROPERABILITY OF SYSTEM CONTROL ELEMENTS
- INFORMATION PROCESSING & DISPLAYS


RADC TPO I. C³/A. SUPPORT C³
THRUST: I.C. SYSTEM CONTROL
FY80
FY81
FY82
FY83
FY84
FY85
FY86
ADV DIG PERF MONIT ASSESS 3.3
SOFTWARE INT FOR ATEC 3.3
EXPANDED PERF ASSESSMENT CAPABILITIES FOR DCS AND TACTICAL SYSTEMS
AUTOMATION OF BASE LEVEL SYSCON FUNCTIONS 3.3
ATEC SYSCON ACQUISITION (ESD)
SYSCON FOR DCS III 3.3
INTEROPERABILITY OF SYSTEM CONTROL ELEMENTS
TACT-STRAT-SVIP DCS-II-SATELLITE DCS-NATO 3.3
AUTO-COORD CONTROL OF SWITCH/TRANSMISSION FUNCTIONS
DEVELOPMENTS FIELD EVALS 3.3
UNIFIED MGT AND CONTROL OF THE DCS
DISTR COMMUNICATIONS SYSTEM CONCEPT STUDIES TPO ICIC
ECM SYSCON STUDIES 6.1
TACTICAL ACCS DEVELOPMENTS ICIC
STUDIES MODELS DEMONSTRAITION
ECM SIGNAL IDENTIFICATION DEVELOPMENT & TEST 3.3
ECM SYSCON FOR DETECTION/RESTORAL 3.3
ADV ECM SIG

TPO/THRUST: 1. $C^3$/A. SUPPORT $C^3$

SUB-SUB-THRUST: 1.C. SYSTEM CONTROL

BLOCK TITLE: AUTOMATION OF BASE LEVEL SYSCON FUNCTIONS

OBJECTIVE:
- REDUCE RESPONSE & REPORTING TIME FOR RESTORAL OF SERVICE
- EXTEND ASSESSMENT/FAULT ISOLATION COVERAGE TO ADDRESS PROBLEMS BETWEEN BASE AREA & TECH CONTROL

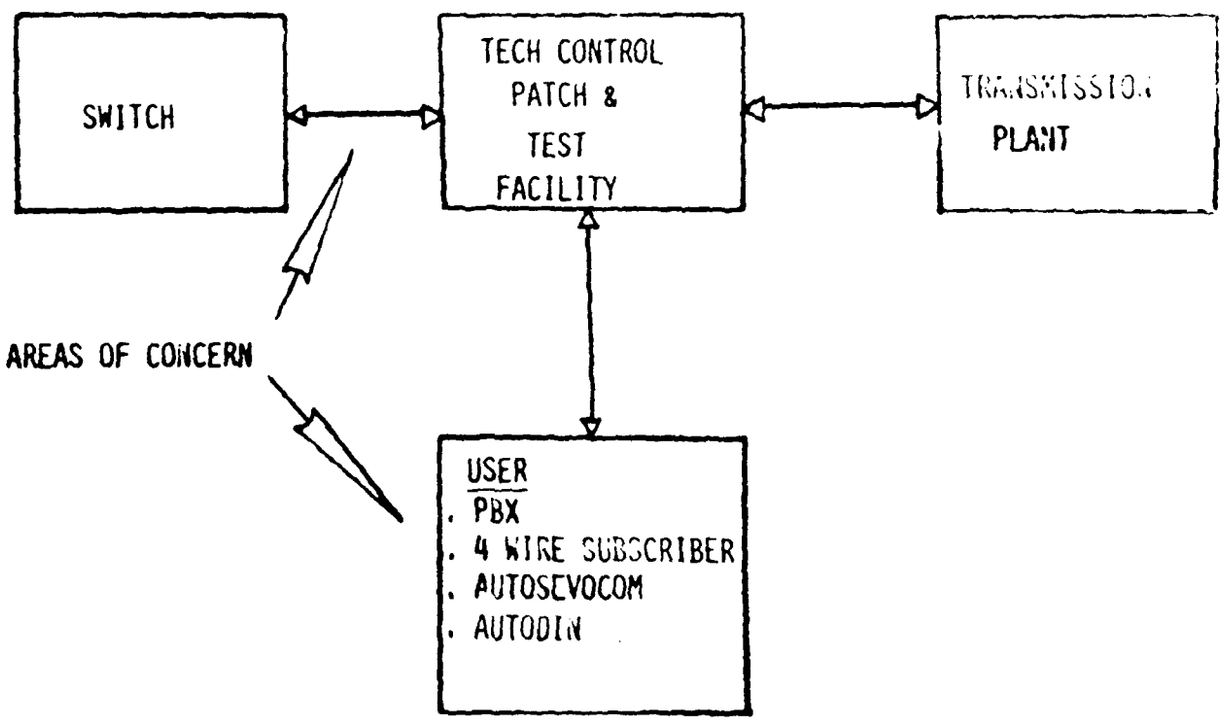
TECHNICAL APPROACH:
- DEVELOP INTEGRATED INFO REPORTING/DISPLAY SYSTEM & MAN-MACHINE INTERFACES
- EVALUATE ALTERNATIVE MONITORING TECHNIQUES SUITABLE FOR BASE & ACCESS AREA
- DEVELOP ADV DEV MODEL OF BASE & ACCESS AREA FAULT REPORTING SYSTEM.

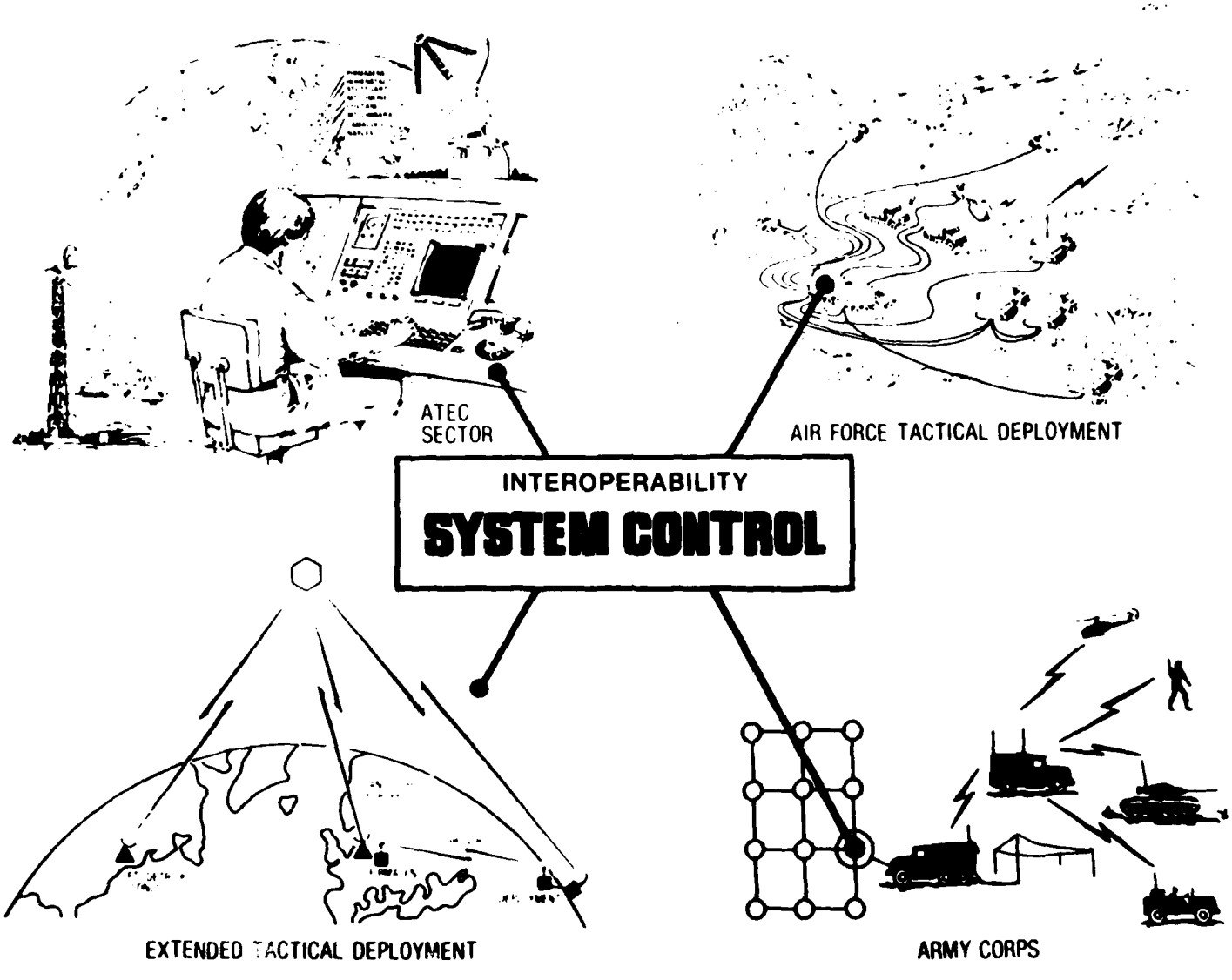
PAYOFF:
- GREATER NETWORK AVAILABILITY THROUGH MORE COMPREHENSIVE NETWORK PERFORMANCE VISIBILITY.
- RESOLUTION OF HIGHER PERCENTAGE OF NETWORK FAULTS.

RISK:
MODERATE - DISPLAYS FOR SOME SUBSYSTEMS NOT AVAILABLE
LOW - TECHNOLOGY FOR BASE LEVEL FAULT ANALYSIS EXISTS
PROBLEM IS ONE OF COST/PERFORMANCE ANALYSIS

AUTOMATED REPORTING FOR USER

AND ACCESS AREA COMMUNICATIONS




ATEC
SECTOR
AIR FORCE TACTICAL DEPLOYMENT
INTEROPERABILITY
SYSTEM CONTROL
EXTENDED TACTICAL DEPLOYMENT
ARMY CORPS

TPO/THRUST: I. $C^3$/A. SUPPORT $C^3$

SUB-SUB-THRUST: 1.C. SYSTEM CONTROL

BLOCK TITLE: AUTOMATED COORDINATION & CONTROL OF SWITCH/TRANSMISSION FUNCTIONS

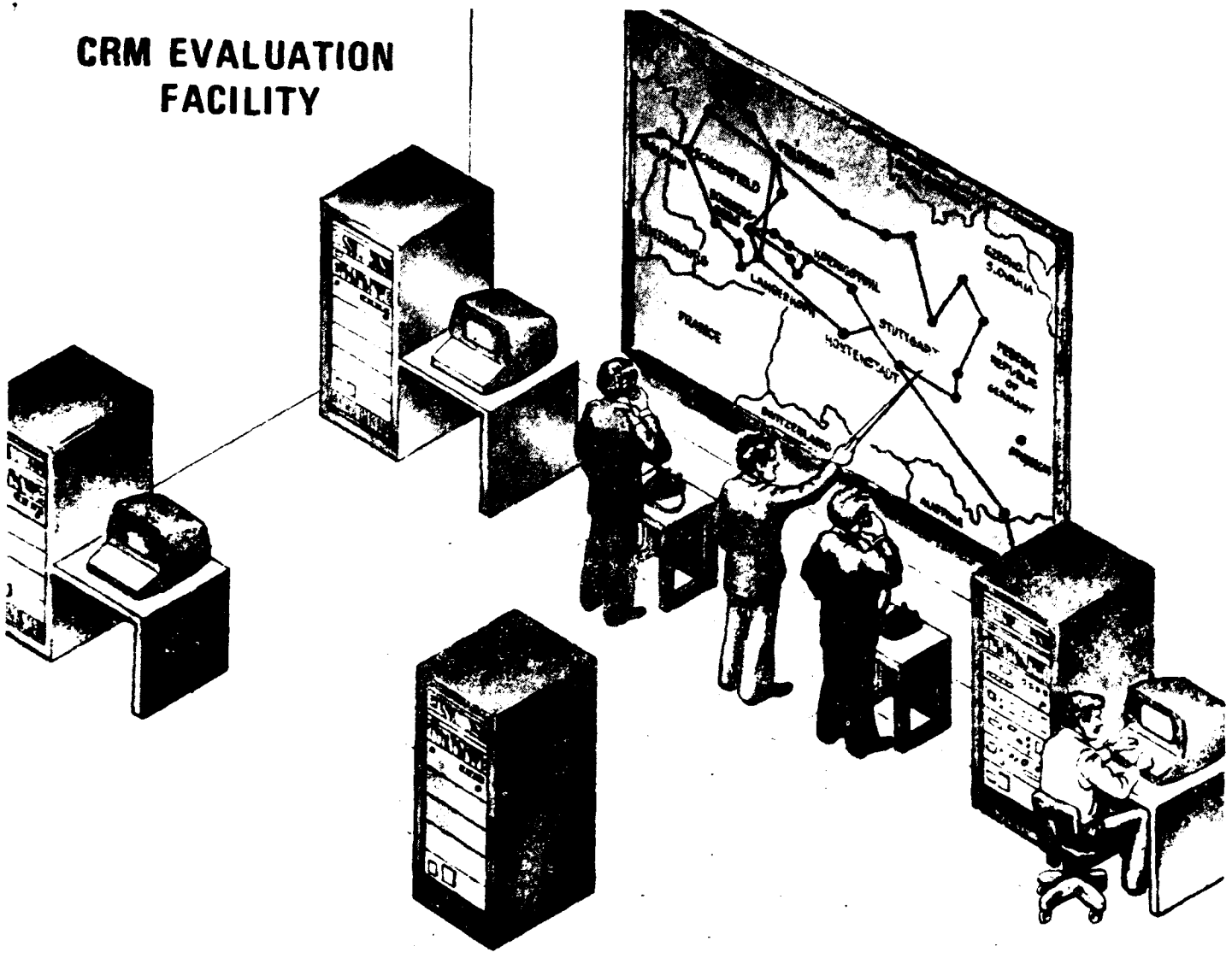
OBJECTIVE:
- DEMONSTRATE FEASIBILITY OF AUTOMATED CHANNEL RECONFIGURATION MODEL (CRM)
- DEVELOP ENHANCED, SURVIVABLE MONITORING & CONTROL CAPABILITY FOR THE OVERSEAS AUTOVON & FUTURE INTEGRATED SWITCHED NETWORKS.

TECHNICAL APPROACH:
- DESIGN, FABRICATE & TEST 3 EA CRM FEASIBILITY MODELS.
- DESIGN, FABRICATE & TEST AUTOVON NETWORK CONTROL SUBSYSTEM (ANCS)
- DEVELOP PROCEDURES & PROTOCOLS REQUIRED TO ADAPTIVELY MAINTAIN SYSTEM CONTROL IN FRAGMENTED NETWORKS.

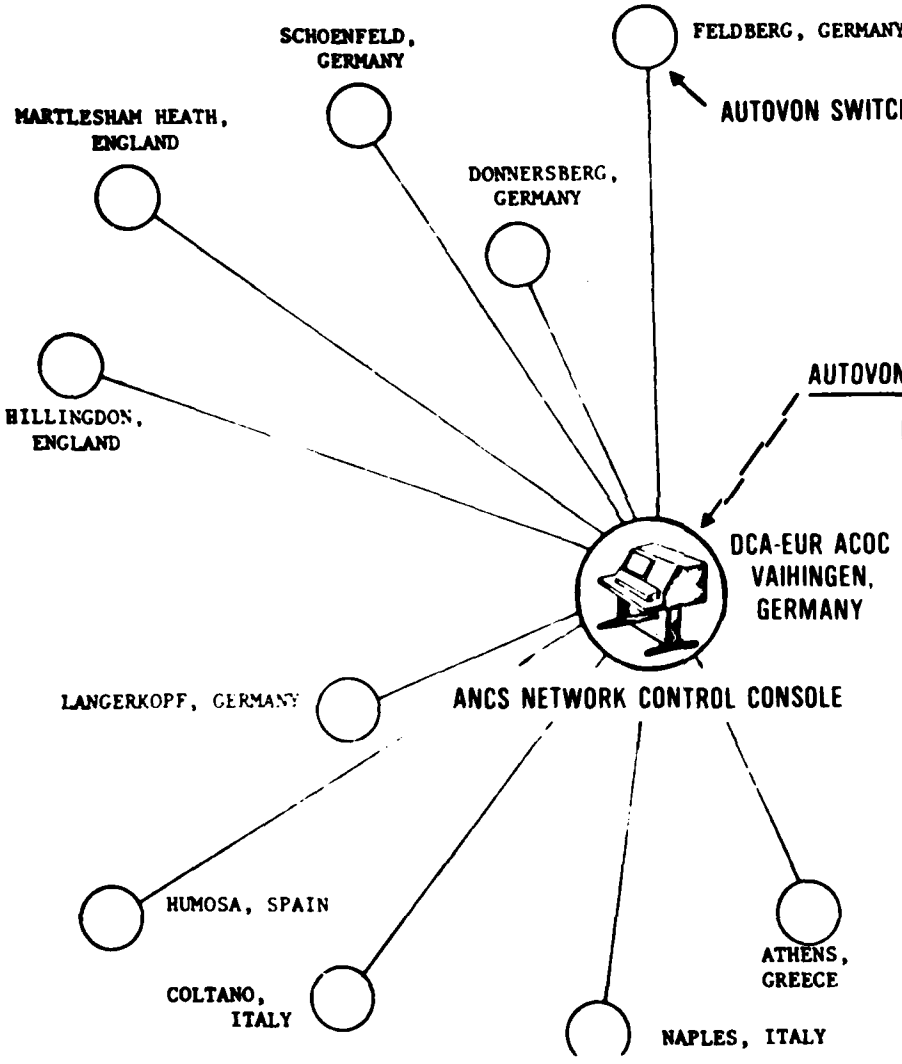
PAYOFF: IMPROVED RESTORATION, RECONFIGURATION & SURVIVABILITY OF DCS UNDER DEGRADED/CRISIS CONDITIONS.

RISK:
- CRM - MEDIUM RISK - MUST INTERFACE EXISTING & PLANNED TACTICAL & STRATEGIC SYSTEMS.
- ANCS - MODERATE RISK - SINCE SOME TECHNOLOGY AVAILABLE. MAJOR EFFORT REQUIRED TO RESOLVE MAN-MACHINE INTERFACE ISSUES.
- ADAPTIVE CONTROL - MEDIUM TO HIGH RISK - MANY UNRESOLVED ISSUES.

# CRM EVALUATION FACILITY



# SYSTEM CONTROL IMPROVEMENTS FOR THE OVERSEAS AUTOVON




AUTOVON NETWORK CONTROL SUBSYSTEM (ANCS

ENABLES NETWORK CONTROLLER TO:

- DISPLAY SWITCH STATUS & TRAFFIC DATA
- ASSESS NETWORK CONDITIONS
- APPLY TRAFFIC, ROUTING, & RESTORATION CONTROLS

## TECHNOLOGY - INTENSIVE SYSCON DEVELOPMENTS

| MAJOR AREAS OF INTEREST | TECHNOLOGY AREAS |
|---|---|
| DIGITAL PERFORMANCE MONITORING & ASSESSMENT | . RADIO LINK MONITORS<br>. SYSTEM FAULT ISOLATION ALGORITHMS<br>. TRENDING ALGORITHMS |
| AUTOMATION OF BASE LEVEL FUNCTIONS | . CORRELATION OF SWITCH & TRANS FUNCTIONS<br>. DISPLAYS FOR CONTROL OF NODAL SUBSYSTEMS<br>. LOW COST FACILITY STATUS MONITORS |
| INTEROPERABILITY OF SYSTEM CONTROL ELEMENTS | . DEVELOPMENT OF PROTOCOL & DISPLAYS FOR INTERSYSTEM MONITORING, COORDINATION, & CONTROL OF MAJOR AF SYSTEMS. |
| AUTOMATED COORDINATION & CONTROL OF SWITCH/TRANSMISSION FUNCTIONS | . DEVELOPMENT OF STATUS DISPLAYS, NETWORK CONTROLS, TRAFFIC ANALYSIS CAPABILITIES<br>. AUTOMATED DIGITAL PATCHING & NETWORK ALGORITHMS<br>. ELECTRONIC SURVIVABILITY |
| ECM SIGNAL IDENTIFICATION DEVELOPMENT & TEST | . PATTERN ANALYSIS<br>. TIME/FREQUENCY/AMPLITUDE CHARACTERIZATION TECHNIQUES |

## POINTS OF CONTACT

### SYSTEM CONTROL

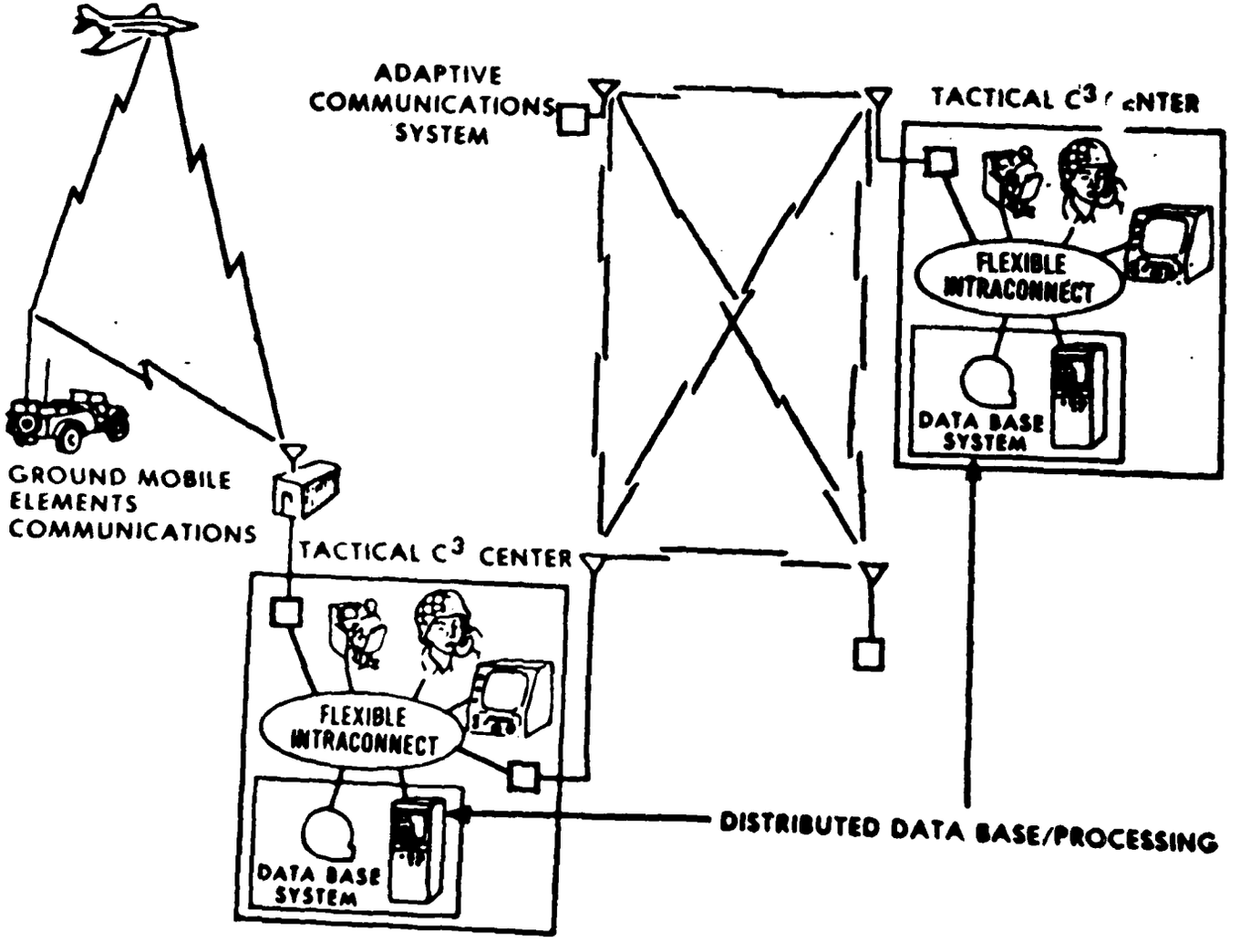
| PROGRAM TIILE | COGNIZANT ENG | TELEPHONE |
|---|---|---|
| AUTOMATED REPORTING FOR USER & ACCESS AREA COMM | MR. CHARLES MEYER/DCLD | 330-4374 |
| ADAPTIVE CONTROL FOR INTEGRATED NETWORKS | MR. DONALD SPECTOR/DCLD | 330-4374 |

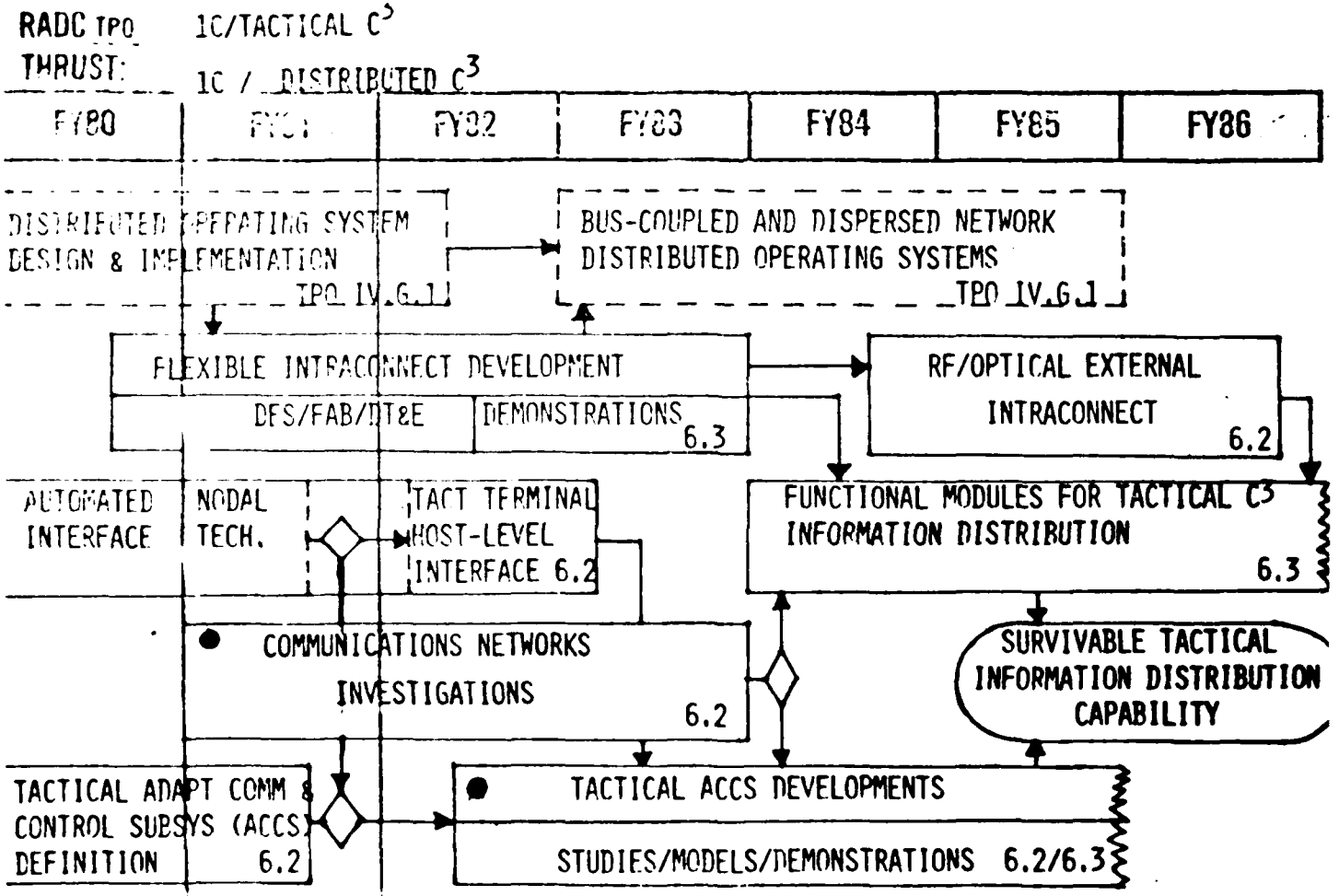
TACTICAL DISTRIBUTED C²

PRESENTED BY

LT DAVID SCHMITT

# DISTRIBUTED C³




RADC TPO
THRUST:
IC/TACTICAL C3
IC / DISTRIBUTED C3
FY80
FY81
FY82
FY83
FY84
FY85
FY86
DISTRIBUTED OPERATING SYSTEM DESIGN & IMPLEMENTATION
TPO IV.G.1
BUS-COUPLED AND DISPERSED NETWORK DISTRIBUTED OPERATING SYSTEMS
TPO IV.G.1
FLEXIBLE INTRACONNECT DEVELOPMENT
DFS/FAB/IT&E
DEMONSTRATIONS 6.3
RF/OPTICAL EXTERNAL INTRACONNECT 6.2
AUTOMATED INTERFACE
NODAL TECH.
TACT TERMINAL HOST-LEVEL INTERFACE 6.2
FUNCTIONAL MODULES FOR TACTICAL C3 INFORMATION DISTRIBUTION 6.3
COMMUNICATIONS NETWORKS INVESTIGATIONS 6.2
SURVIVABLE TACTICAL INFORMATION DISTRIBUTION CAPABILITY
TACTICAL ADAPT COMM & CONTROL SUBSYS (ACCS) DEFINITION 6.2
TACTICAL ACCS DEVELOPMENTS
STUDIES/MODELS/DEMONSTRATIONS 6.2/6.3

TPO/THRUST: I. $C^3/C$. TACTICAL $C^3$

SUB-SUB-THRUST: I.C. DISTRIBUTED $C^3$

BLOCK TITLE: TACTICAL ACCS DEVELOPMENTS

OBJECTIVE: DEVELOP AN ADAPTIVE COMMUNICATIONS AND CONTROL SUBSYSTEM TO PROVIDE SURVIVABLE, MOBILE GROUND/GROUND COMMUNICATIONS FOR THE TACTICAL AIR FORCES (TAF) FOR POST 1995

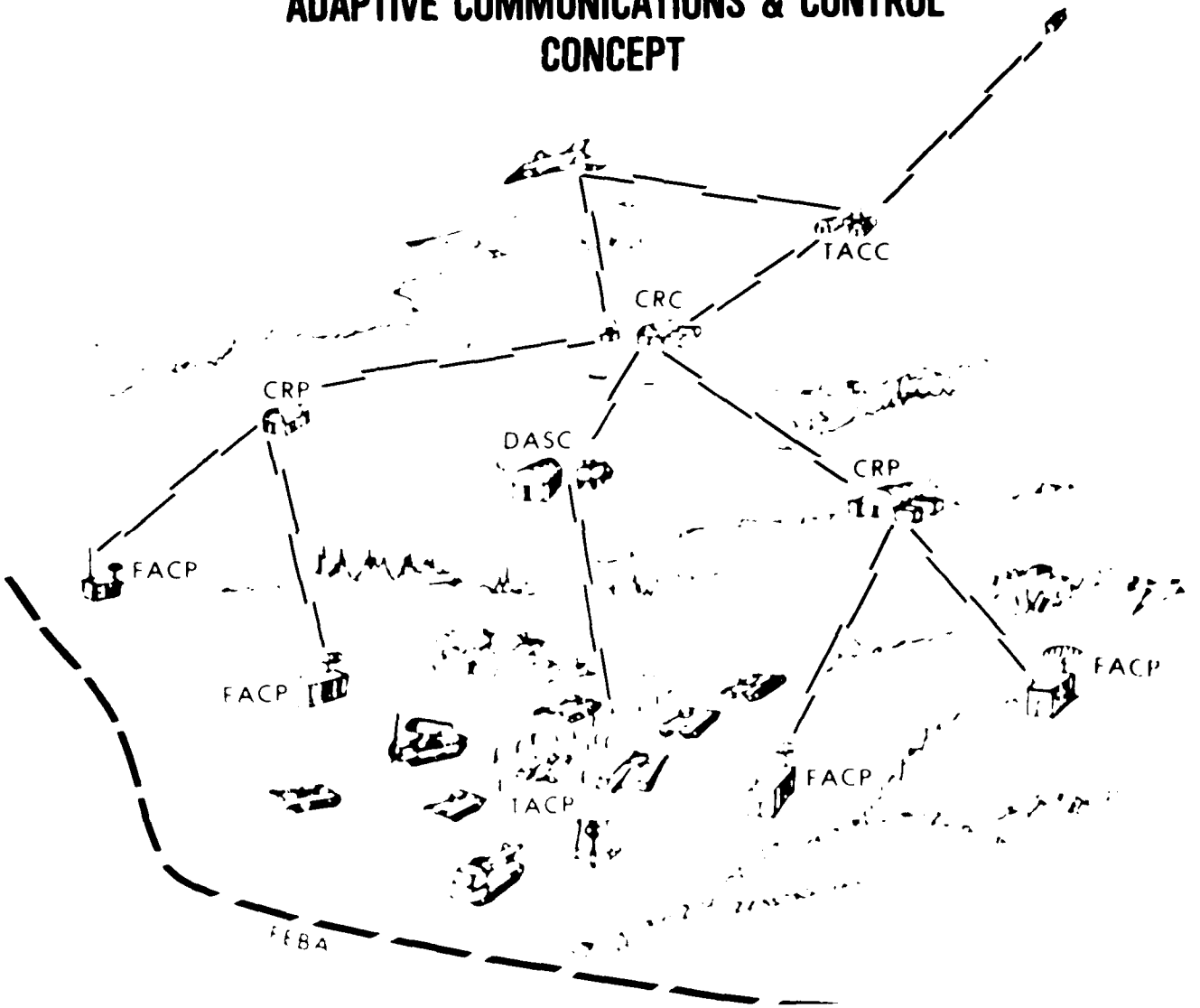
TECHNICAL APPROACH:

- EVALUATE SUBSYSTEM ALTERNATIVES RESPONSIVE TO TAFIIS
- DEVELOP ADVANCED TACTICAL COMM TRANSMISSION, SYSTEM CONTROL AND COMM PROCESSING ELEMENTS
- INTEGRATE ELEMENTS INTO SYSTEM ARCHITECUTRE

PAY OFF: ROBUST, HIGHLY MOBILE, SURVIVABLE GROUND/GROUND COMMUNICATIONS

RISK: MODERATE - DETAILED DEFINITION AND MODELING REDUCE RISK

# ADAPTIVE COMMUNICATIONS & CONTROL CONCEPT



**TPO/THRUST:** 1C/TACTICAL $C^3$

**SUB-SUB-THRUST:** 1C/DISTRIBUTED $C^3$

**BLOCK TITLE:** COMMUNICATIONS NETWORKS INVESTIGATIONS

**OBJECTIVE:** DEVELOP ADAPTIVE COMMUNICATIONS CONTROL AND DISTRIBUTION TECHNIQUES FOR INTELLIGENCE DATA DISTRIBUTION AND LOCAL AREA APPLICATIONS.

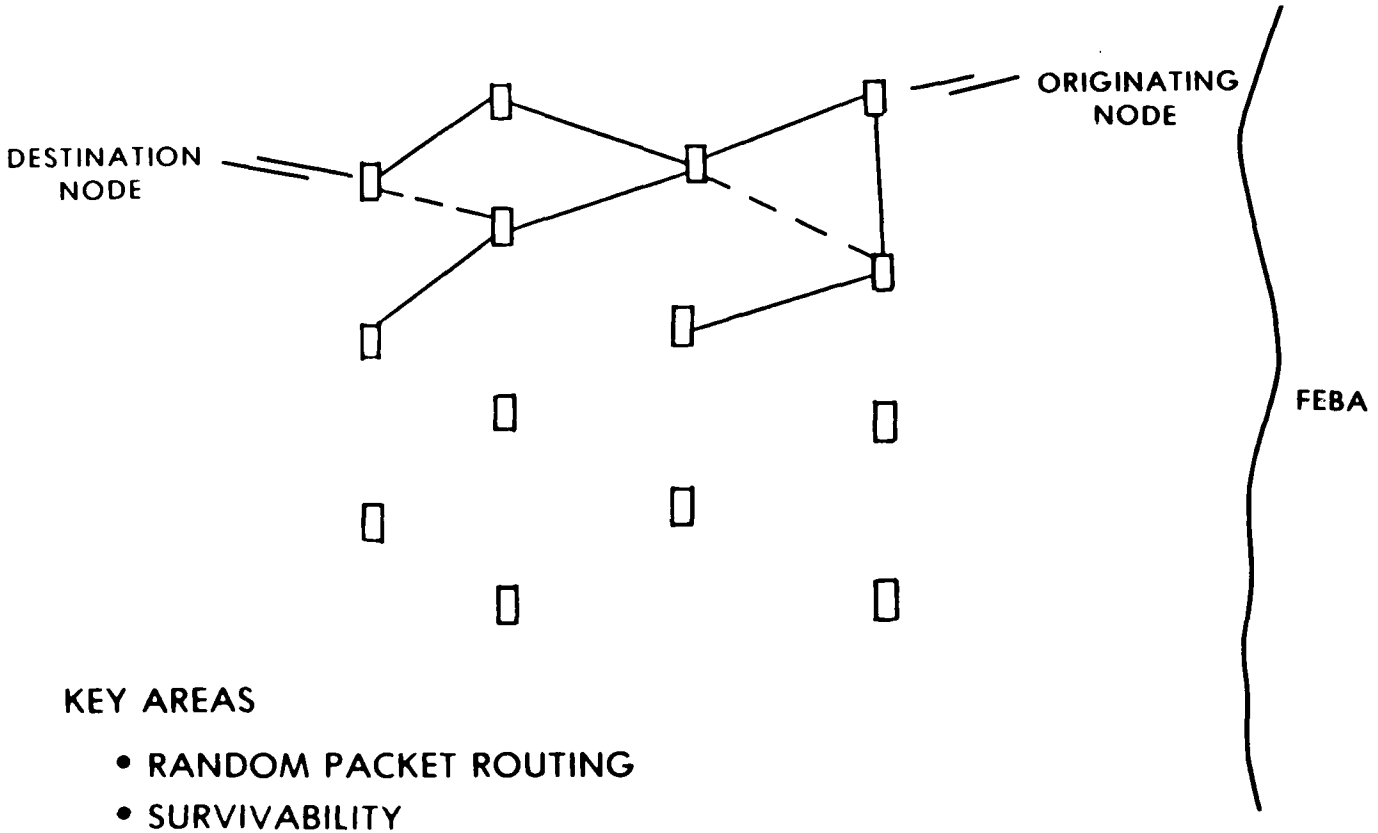
**TECHNICAL APPROACH:** STUDY/ANALYZE/DEVELOP PROCESSOR CONTROLLED ADAPTIVE DATA ROUTING AND SYSTEM CONTROL:

- INTELLIGENCE ANALYST
- TACTICAL FORWARD AREA PACKET COMM

**PAY OFF:** HIGHLY SURVIVABLE COMM DISTRIBUTION FOR INTELLIGENCE AND FORWARD AREA APPLICATIONS.

**RISK:** LOW - INTELLIGENCE ANALYST
MODERATE - PACKET COMMUNICATION

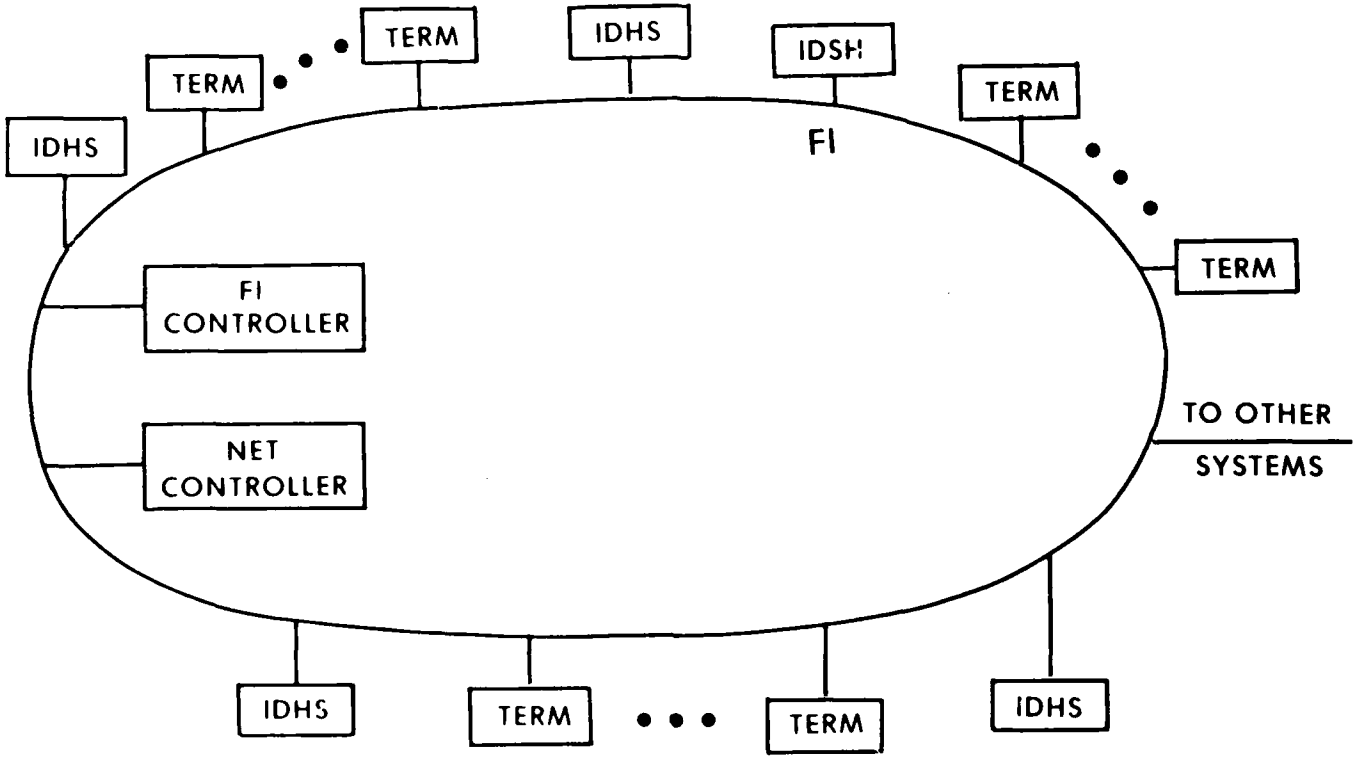
# PACKET RADIO NETWORK




KEY AREAS

- RANDOM PACKET ROUTING
- SURVIVABILITY

# INTELLIGENCE COMMUNICATIONS DISTRIBUTION SYSTEM (ICDS)




FI - FLEXIBLE INTRACONNECT

IDHS - INTELLIGENCE DATA HANDLING SYSTEMS

TERM TERMINALS

## CONTACT POINTS

INTELLIGENCE COMMUNICATIONS DISTRIBUTION SYSTEM - - - LT DAVID R. SCHMITT
DCLF/X4567

PACKET RADIO NETWORK - - - - - - - - - - - - - - - - - - MR DANIEL McAULIFFE
DCLF/X4567

TACTICAL ADP DEVELOPMENTS - - - - - - - - - - - - - - - CAPT EMANUEL R. SIVE
DCLF/X4567

# ANTENNAS

JOHN McILVENNA

ELECTROMAGNETIC SCIENCES DIVISION

RADC/EE

HANSCOM AFB, MA 01731

TPO/THRUST: 4C ELECTROMAGNETICS

SUB/THRUST: 1 ANTENNAS

PROGRAM GOALS:
- DEVELOP ADVANCED ANTENNA TECHNOLOGY FOR GROUND BASED, SPACE BASED AND AIRCRAFT APPLICATIONS

PROGRAMS: 6.1, 6.2, 6.3

FRACTION OF TOTAL EFFORT: 1/3, 2/3, SMALL BUT GROWING

TECHNICAL AREAS:
- ARRAY AND REFLECTOR STUDIES — 6.1, 6.2
- DETERMINISTIC AND ADAPTIVE RADIATION PATTERN CONTROL — 6.1, 6.2
- LOW PROFILE AND CONFORMAL AIRCRAFT ANTENNAS 6.1, 6.2, 6.3
- LONG WAVE ANTENNAS

## 6.1 TASK AREAS

PHASED ARRAY ANTENNAS

CONFORMAL ANTENNAS

REFLECTOR/APERTURE ANTENNAS

13 WORK UNITS,

- 4 IN-HOUSE
- 9 UNIVERSITY CONTRACT

## 6.1 EFFORTS

## PHASED ARRAY ANTENNAS

- ARRAY TECHNIQUES
  - WIDEBAND, WIDE-ANGLE SCAN
    - OVERLAPPED SUBARRAYS
    - MICROWAVE LENS
  - LIGHTWEIGHT ARRAY ELEMENTS
    - METAL FILM DIPOLES
- NONUNIFORM GROUND SYSTEMS FOR HF ARRAYS
  - THEORY FOR ARBITRARY VERTICAL ARRAYS
- RADIATING ELEMENTS FOR MILLIMETER REGION
  - ELEMENTS COMPATIBLE WITH VARIOUS LOW-LOSS, HIGH POWER TRANSMISSION LINE FEEDS

## 6.1 EFFORTS

## CONFORMAL ANTENNAS

- MICROSTRIP ANTENNAS
  - BASIC RADIATION MECHANISM FOR VARIOUS CANONICAL SHAPES
  - OPTICAL DESIGN METHODS FOR MILLIMETER WAVES
  - MULTIPLE FREQUENCY OPERATION VIA MULTIPLE FEED POINTS
  - ELEMENTS OF ARBITRARY SHAPE VIA SURFACE PATCH METHOD
- SLOTTED WAVEGUIDE ARRAYS
  - MUTUAL COUPLING/FEED STRUCTURE

## 6.1 EFFORTS

## REFLECTOR/APERTURE ANTENNAS

- LARGE SATELLITE ANTENNAS WITH LOW SIDELOBES
  - CLUSTER OFFSET FEEDS, REFLECTOR/LENS SURFACE SHAPING, FRESNEL-ZONE CALCULATIONS
- SURFACE-PATCH MODELING FOR RADIATION/SCATTERING
  - ANALYSIS FOR CONDUCTORS OF ARBITRARY SHAPE

BLOCK TITLE: VLF ANTENNA STUDIES

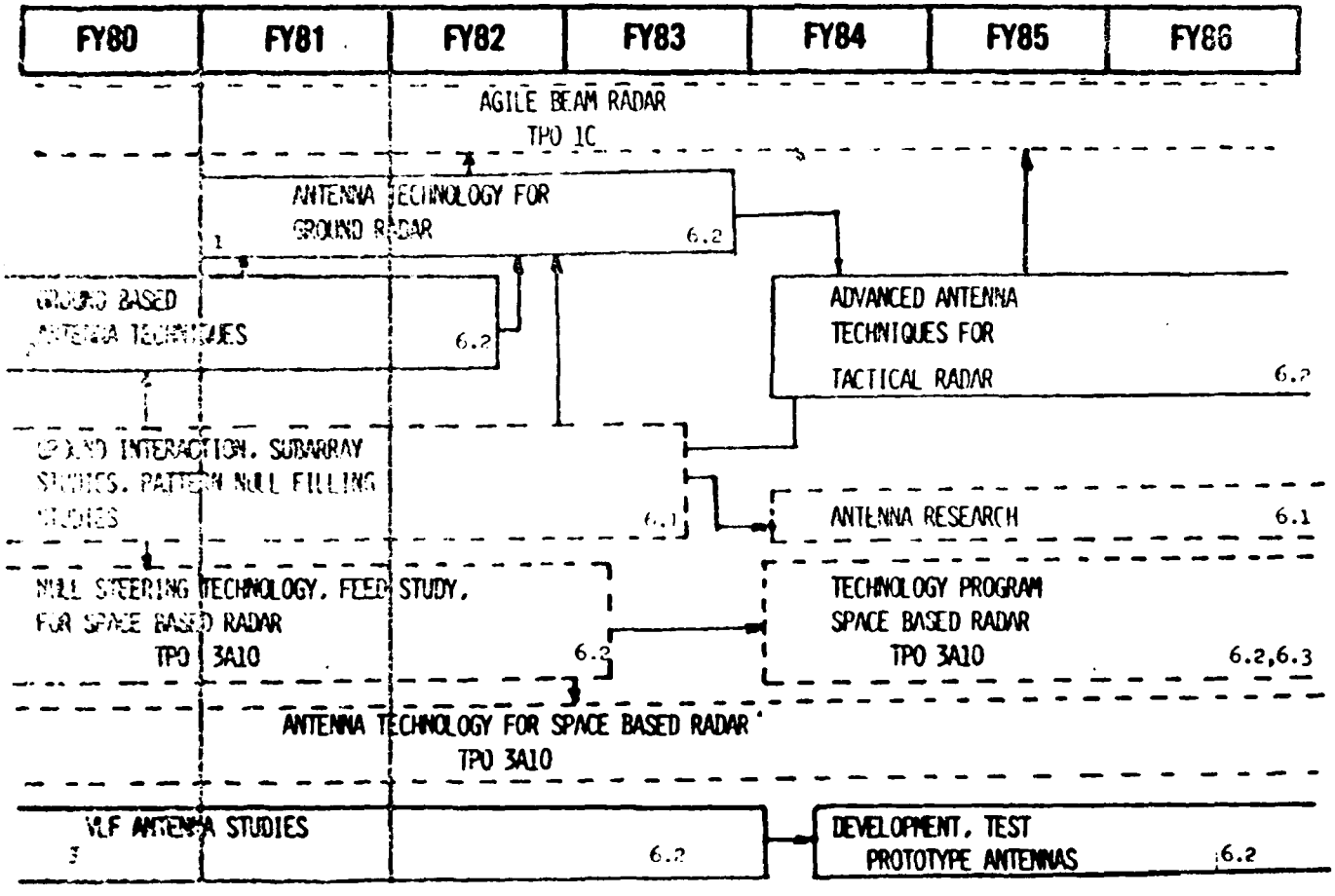
OBJECTIVE: FURNISH AF C3 MISSION WITH NEW ANTENNA TECHNOLOGY FOR VLF EMERGENCY COMMUNICATIONS/JAM RESISTANT COMMUNICATION MODES

TECHNICAL APPROACH: EXAMINE RADIATION AND EFFICIENCY OF VLF LOOP AND GROUND BASED TE ANTENNAS. ANALYZE DISPERSIBLE ANTENNA AND POTENTIAL SUB-CUTOFF FREQUENCY ANTENNAS

PAY OFF: EXTENSION OF VLF COMMUNICATIONS RANGE, RELIABILITY, AND SURVIVABILITY

BASIC TPO 4. TECHNOLOGY

THRUST: 4C ELECTROMAGNETICS SUB-THRUST: 4C10 ANTENNAS (ANTENNA PATTERN CONTROL)

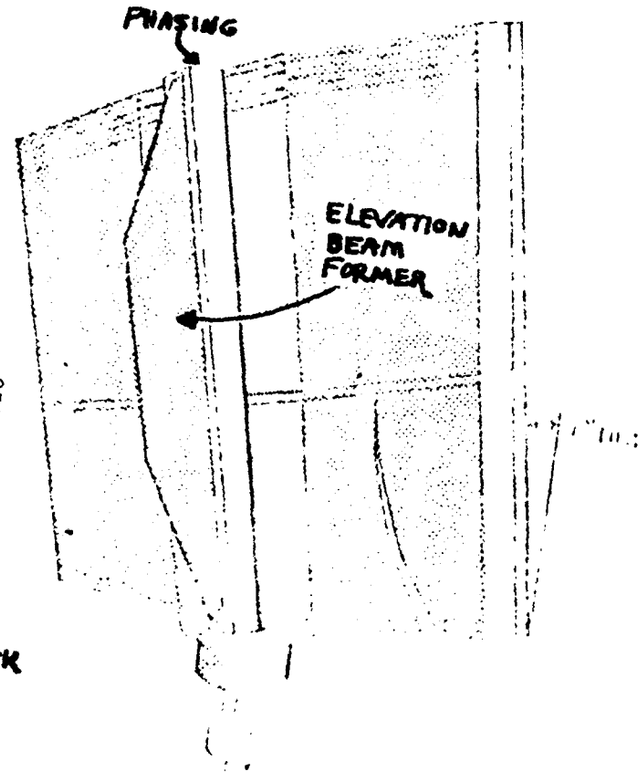


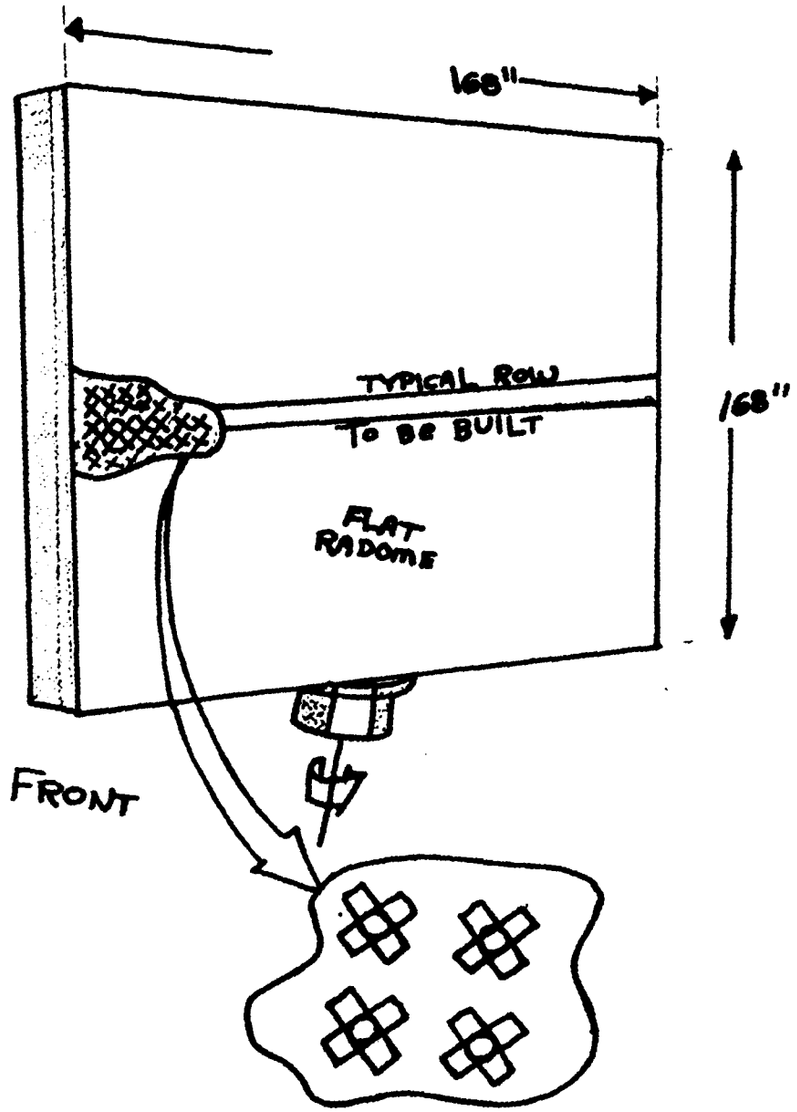
EFFORT BLOCK TITLE: GROUND BASED ANTENNA TECHNIQUES

OBJECTIVE: DEVELOP NEW ANTENNA TECHNOLOGY FOR GROUND BASED RADAR

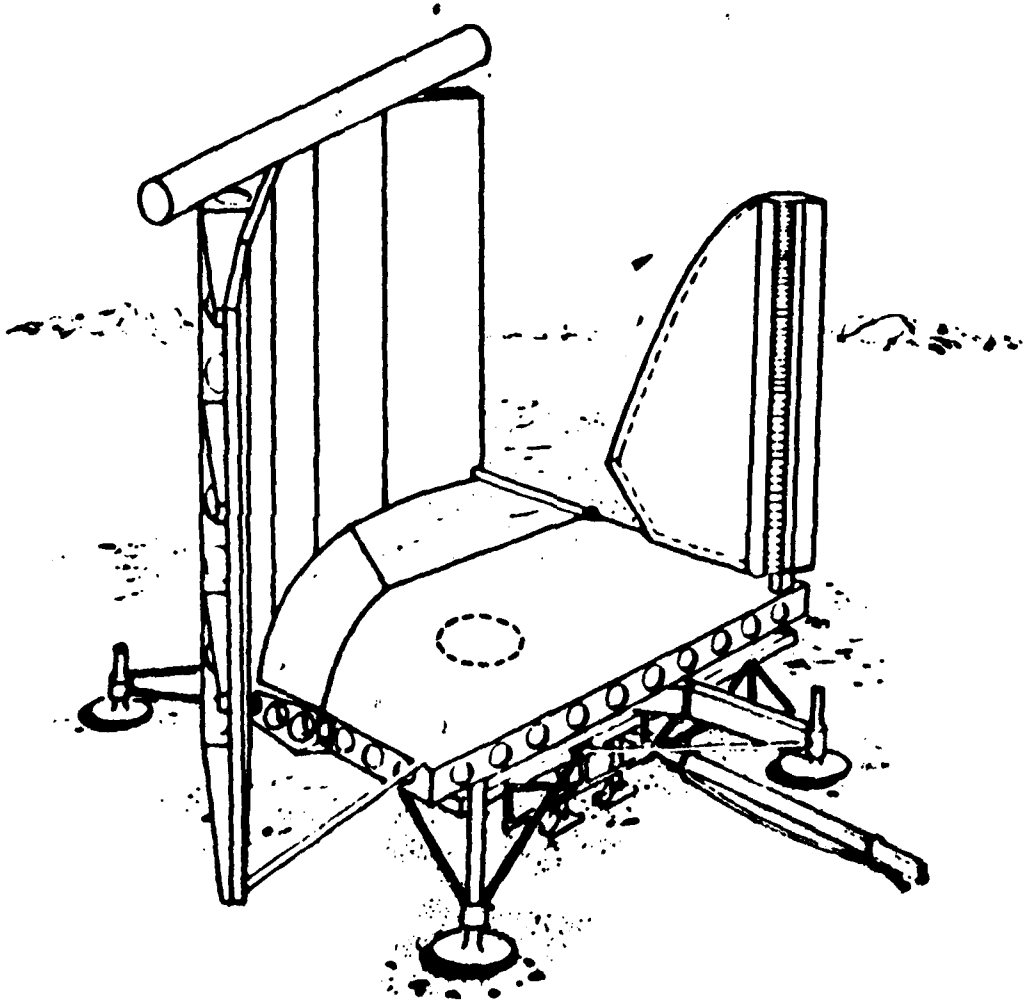
TECHNICAL APPROACH:
- DIGITAL BEAM STEERING
- ANGULAR FILTER
- LOW SIDELOBE LINE SOURCE FEED
- LOW SIDELOBE PARABOLIC CYLINDER ANTENNA
- CIRCULAR ARRAY DESIGNS
- WIDEBAND LENS AND SUBARRAY STUDIES

PAYOFF: LOW SIDELOBE ANTENNAS FOR GROUND RADAR

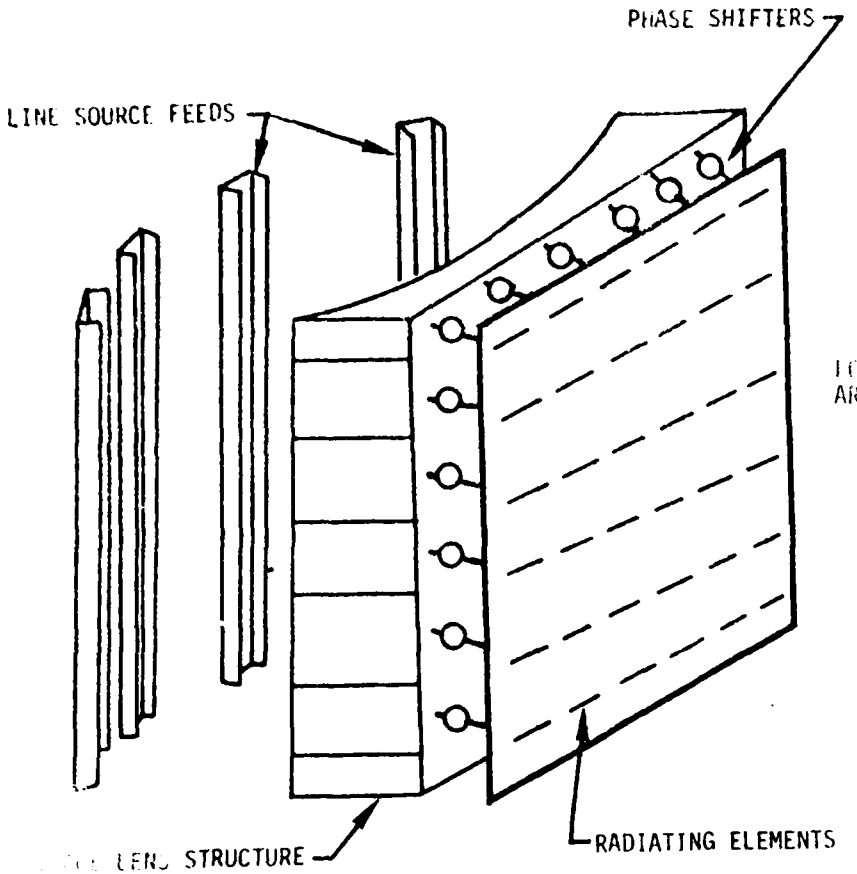

PHASING
ELEVATION BEAM FORMER
BACK


168"
168"
TYPICAL ROW
To be BUILT
FLAT RADOME
FRONT

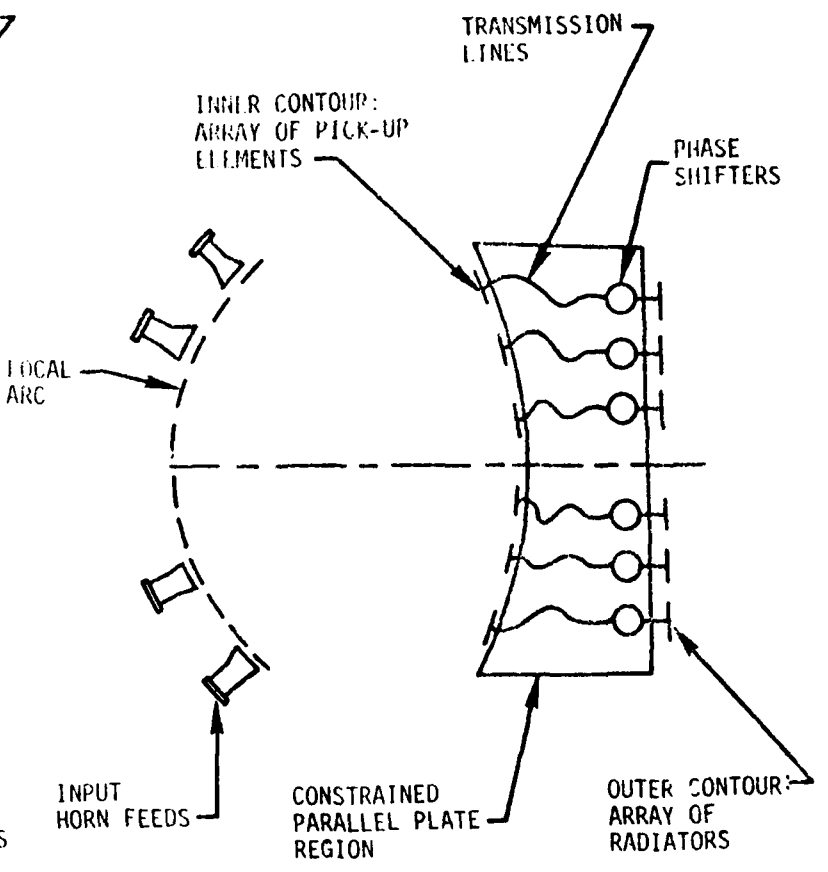
# PARABOLIC CYLINDER



# 3D CYLINDRICAL CONSTRAINED LENS




A) 3D MODEL




B) 2D COUNTERPART

## DIGITAL BEAM STEERING

- DIGITAL TECHNIQUES FOR ALL PHASED ARRAY BEAM FUNCTIONS.
  - STEERING
  - NULLING - MAINBEAM AND SIDELOBES
  - SIDELOBE CONTROL
  - TIME VARYING APERTURE WEIGHTING
- STUDY AND EXPERIMENT
- EVALUATE BANDWIDTH AND PROCESSING TIME CONSTRAINTS
- COST AND PRACTICALITY

## FY 81 STARTS

EFFORT BLOCK TITLE: ANTENNA TECHNOLOGY FOR GROUND RADAR

OBJECTIVE: DEVELOP NEW ANTENNA TECHNOLOGY WITH IMPROVED ECCM FEATURES FOR GROUND BASED RADAR

TECHNICAL APPROACH:
- CONSTRAINED FEED SUBARRAY
- DUAL BAND ARRAY FOR TAC RADAR
- ADAPTIVE SPACE FED ANTENNA SYSTEM

PAYOFF: ANTENNA TECHNIQUES FOR RADAR SYSTEMS

LOW COST, HIGH PERFORMANCE RADAR SYSTEMS

TITLE: CONSTRAINED FEED OVERLAPPED SUBARRAY ANTENNA

OBJECTIVE: DEVELOP COMPACT BROADRAND SCANNING ARRAY ANTENNAS WITH SIDELOBE AND MAINLOBE NULLING AS ECCM FEATURES.

APPROACH:

- INVESTIGATE CONSTRAINED FEED-OVERLAPPED SUBARRAY TECHNIQUES TO COMPLEMENT EFFORTS IN SPACE-FED-OVERLAPPED SUBARRAYS.
- DESIGN APPROPRIATE COMBINATIONS OF ORTHOGONAL LENS BEAMFORMERS, BUTLER MATRICES OR SWITCHING NETWORKS TO PRODUCE PRACTICAL OVERLAPPED SUBARRAYS
- CONSTRUCT AND TEST A PART OF SUCH AN ARRAY DESIGN

PROPOSED EFFORT: OPEN-BID, 2 YRS, FY 81 - FY 83, ABOUT 3 MY

TITLE: ADAPTIVE SPACE-FED OVERLAPPED SUBARRAY ANTENNA

OBJECTIVE: STUDY CAPABILITIES OF SPACE-FED OVERLAPPED SUBARRAYS TO PERFORM SIDELOBE AND MAIN BEAM NULLING.

APPROACH:

- INVESTIGATE COST EFFECTIVENESS OF NULL PLACEMENT AT ARRAY FACE AND AT FEED.
- COMPUTER STUDY OF TRADEOFFS IN SIDELOBE LEVEL, BAND OF OPERATION, ADAPTIVE NULL DEPTH AND WIDTH, NUMBER AND BANDWIDTH OF NULLS.
- STUDY PROCESSING NEEDED TO COUNTER 1 TO 10 JAMMERS OVER 15% BANDWIDTH.

PROPOSED EFFORT: OPEN-BID, 2 YRS, FY 81 - FY 83, ABOUT 3 MY

TITLE: DUAL BAND TACTICAL RADAR ANTENNA

OBJECTIVE: DEVELOP A C AND S-BAND ANTENNA WITH AN INDEPENDENTLY SCANNED BEAM FOR EACH FREQUENCY BAND. BANDWIDTH IS 10% AT EACH CENTER FREQUENCY.

APPROACH:

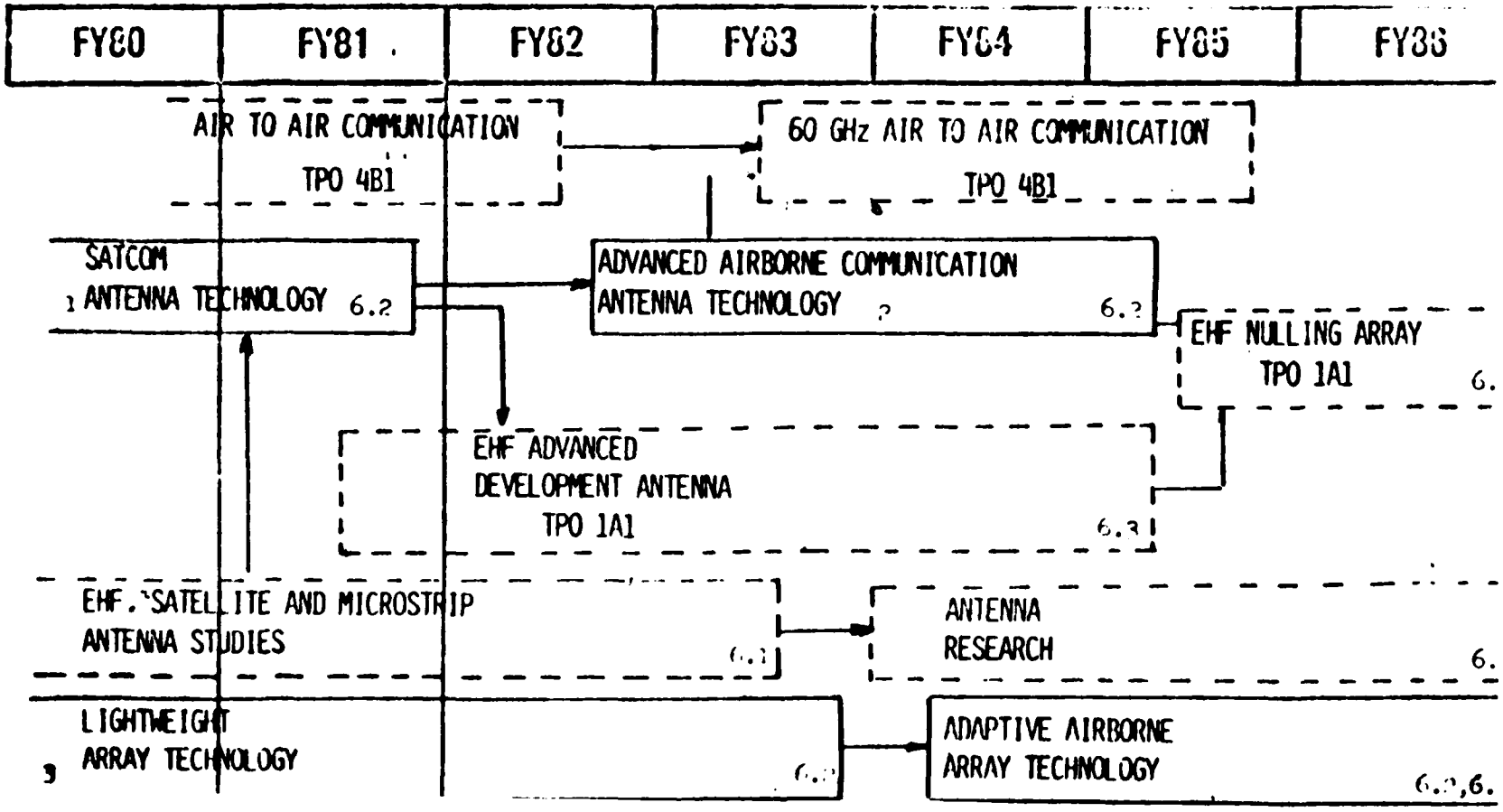
- GENERAL STUDY OF APPLICABLE DUAL BAND TACTICAL RADAR ANTENNA TECHNOLOGY.
- DESIGN PHASE WITH THREE SEPARATE APPROACHES
- SELECTION OF A WINNING APPROACH, COMPONENT AND ARRAY TEST.

PROPOSED EFFORT: OPEN-BID, 30 MOS, FY 81 - FY 83, ABOUT 3 MY.

RADC TPO

THRUST: 4C ELECTROMAGNETICS

SUB-THRUST: 4C10 ANTENNAS (CONFORMAL AND HEMI-SCAN)



SUB-THRUST: 1 ANTENNAS (CONFORMAL AND HEMISPHERICAL COVERAGE ANTENNAS)

BLOCK TITLE: SATCOM ANTENNA TECHNOLOGY

OBJECTIVE: DEVELOP LOW PROFILE, LIGHTWEIGHT ANTENNA TECHNOLOGY FOR AIRCRAFT COMMUNICATING WITH SATELLITES AT SHF AND EHF.

TECHNICAL APPROACH:

- LOW PROFILE FOUR FACED SHF ARRAY
- EHF ANTENNA TECHNOLOGY
  - HYBRID MECH/ELEC CONTROL
  - FULL ELECTRONIC CONTROL

PAYOFF: REPLACE PRESENT BULKY SHF AND EHF DISH ANTENNAS WITH CONFORMAL AND LOW PROFILE NEW TECHNOLOGY.

TITLE: EHF SATCOM TERMINAL ANTENNA

OBJECTIVE: DEVELOP A DUAL FREQUENCY, HYBRID MECHANICAL/ELECTRICAL SCAN ANTENNA FOR COMMAND POST TYPE AIRCRAFT.

APPROACH:

- ADVANCED DEVELOPMENT MODEL AT 20 GHz (Rx) AND 44 GHz (Tx) FOR C-135 AIRCRAFT
- LOW PROFILE, MINIMUM INTRUSION INTO FUSELAGE
- WIDE ANGLE UPPER HEMISPHERE COVERAGE

PROPOSED EFFORT: OPEN - BID, 2 YRS, FY 81 - 83

SUB-THRUST: 1 ANTENNAS (CONFORMAL AND HEMISPHERICAL COVERAGE ANTENNAS)

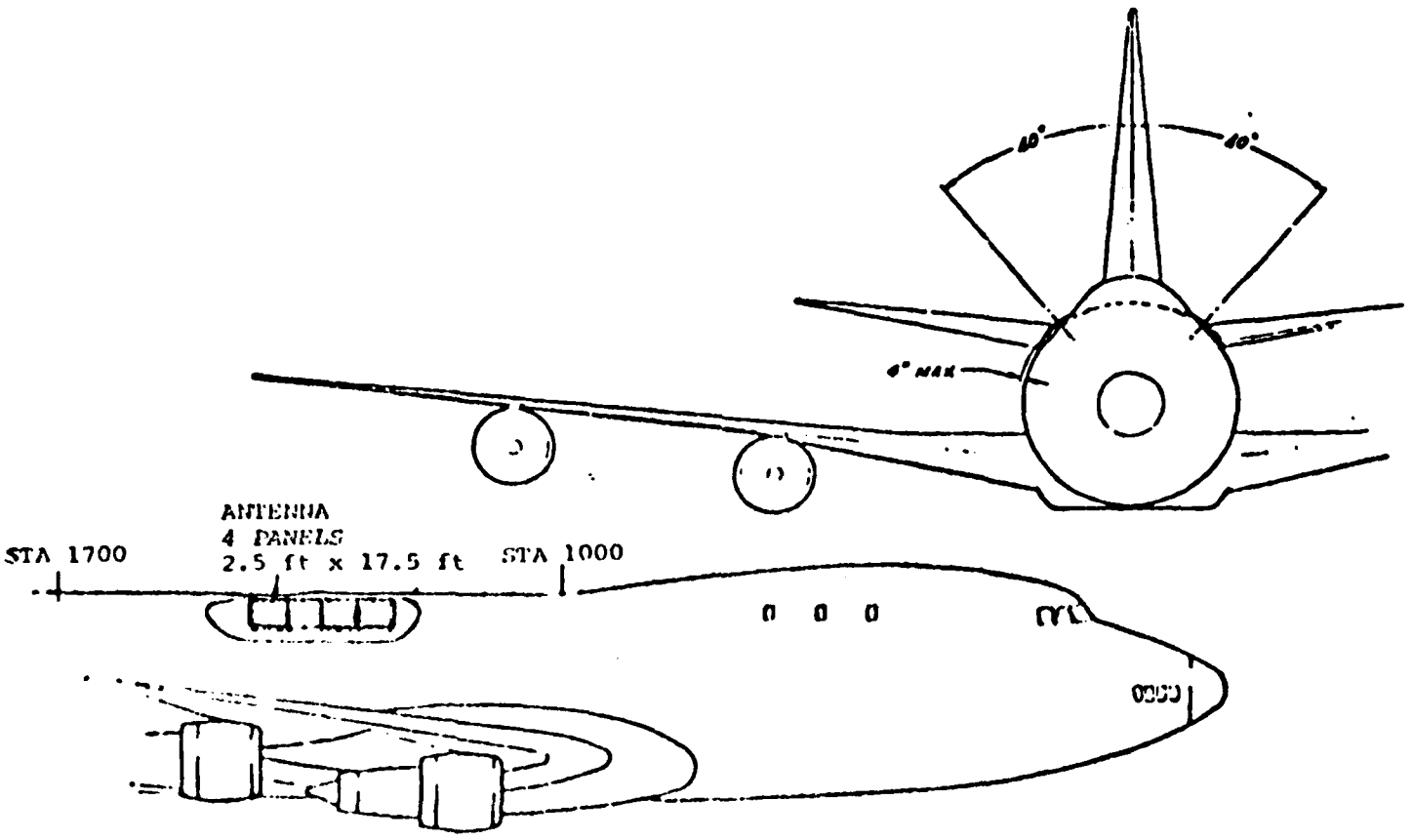
EFFORT BLOCK TITLE: LIGHTWEIGHT ARRAY TECHNOLOGY

OBJECTIVE: TO DEVELOP LIGHTWEIGHT HIGH PERFORMANCE ANTENNAS FOR AIRBORNE RADAR AND COMMUNICATIONS APPLICATIONS

TECHNICAL APPROACH:

- VERY HIGH GAIN PRINTED CIRCUIT ANTENNAS FOR SAC COMMUNICATIONS
- ADAPTIVE LOW SIDELOBE ARRAY FOR ADVANCED SURVEILLANCE RADAR

PAYOFF: LOW COST, LIGHTWEIGHT AIRCRAFT ARRAYS WOULD GREATLY INCREASE THE RANGE AND STATION TIME OF AIRBORNE SYSTEMS IN COMPARISON WITH ROTATING FIXED BEAM ANTENNAS


60°
60°
4° MAX
ANTENNA
4 PANELS
2.5 ft x 17.5 ft
STA 1700
STA 1000

TITLE: HIGH GAIN PRINTED CIRCUIT ANTENNAS FOR SAC COMMUNICATIONS

OBJECTIVE: DEVELOP ULTRA LOW LOSS PRINTED CIRCUIT ANTENNAS AT 2.25 GHz FOR AIRCRAFT USE.

APPROACH:

- INVESTIGATE LOSS REDUCTION METHODS FOR LARGE, HIGH GAIN, AIRBORNE PHASED ARRAY ANTENNAS
- ANALYZE EFFECTS OF INCORPORATING AMPLIFICATION AT THE ELEMENT OR SUB-ARRAY LEVEL
- CONSTRUCT AND DELIVER A TEST SECTION OF ARRAY

PROPOSED EFFORT: OPEN - BID, 2 YRS, FY 81 - 83, 4 MY.

TITLE: ADAPTIVE LOW SIDELOBE ARRAY FOR ADVANCED AIRBORNE SURVEILLANCE RADAR

OBJECTIVE: DEVELOP LIGHTWEIGHT, THIN PHASED ARRAYS FOR CONFORMAL MOUNTING ON AN AIRBORNE PLATFORM.

APPROACH:

- EXTREMELY LOW SIDELOBE LEVELS
- SELF - SURVEYING TECHNIQUES TO AUTOMATICALLY COMPENSATE FOR ELEMENT SHIFTS DUE TO AIRFRAME FLEXING
- NULL PLACEMENT, ADAPTIVE AND OPEN LOOP
- BROADBAND OPERATION

PROPOSED EFFORT: OPEN -BID, 2 YRS, FY 81 - 83, ABOUT 3 MY

SUB-THRUST: 1 ANTENNAS (CONFORMAL AND HEMISPHERICAL COVERAGE ANTENNAS)

BLOCK TITLE: ADVANCED AIRBORNE COMMUNICATIONS ANTENNA TECHNOLOGY

OBJECTIVE: DEVELOP LOW COST LIGHTWEIGHT CONFORMAL ARRAY TECHNOLOGY WITH ADVANCED ECCM FEATURES FOR SATELLITE COMMUNICATION

TECHNICAL APPROACH:

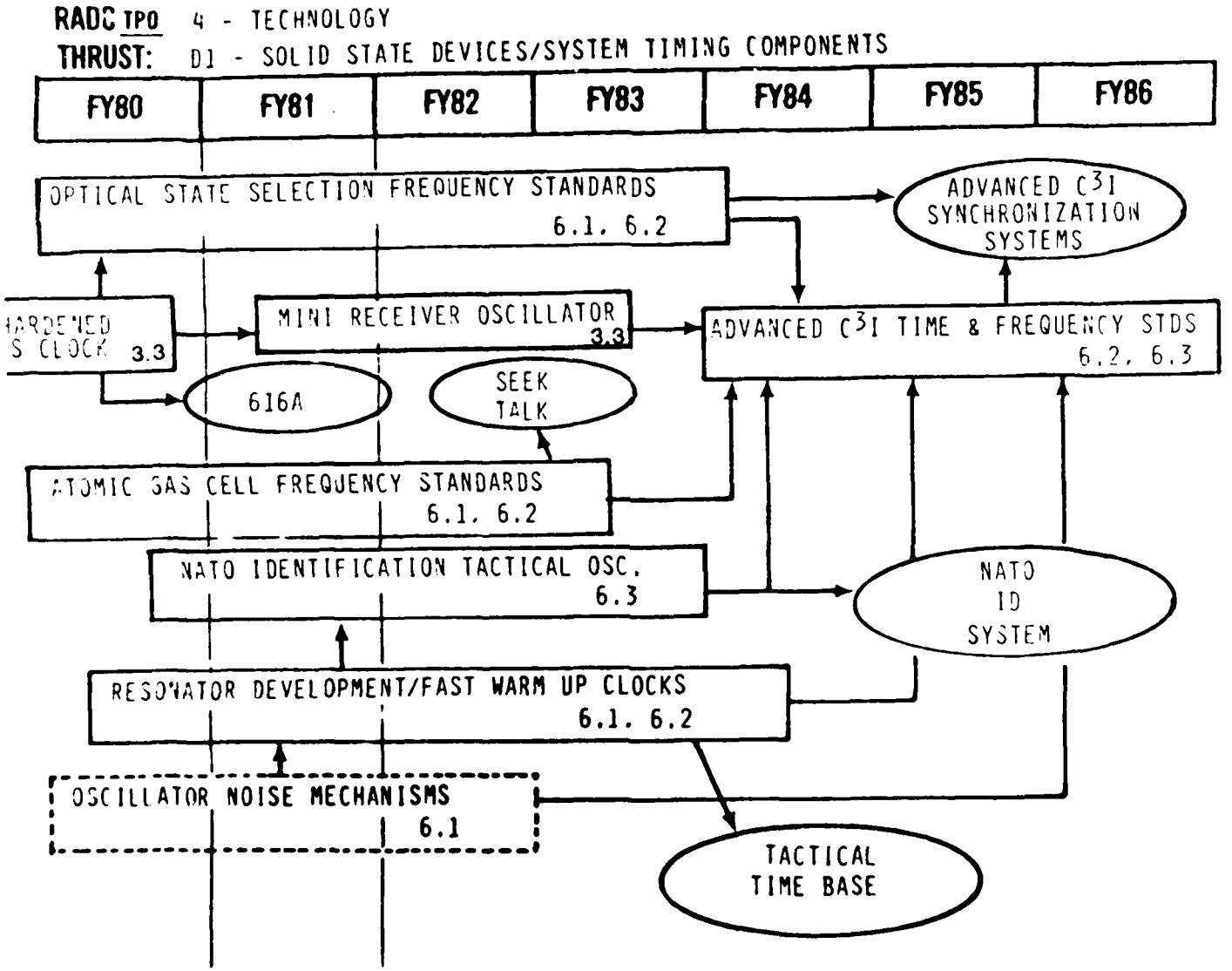
- EXTEND PRINTED CIRCUIT ARRAY TECHNOLOGY TO EHF FREQUENCIES
- INVESTIGATE USE OF ADVANCED MEANS OF NULLING, SIDELOBE CONTROL AND MULTIPLE FREQUENCY OPERATION.
- DEVELOP 60 GHz ANTENNA TECHNIQUES.

PAYOFF: SUBSTANTIAL INCREASE IN SATCOM AND AIR-AIR PERFORMANCE THROUGH WIDEBAND NULL STEERING AND MULTIPLE FREQUENCY FEEDS.

# INDUSTRY LOOKS AT RADC

# SYSTEM TIMING COMPONENTS

3 JUNE 1980
RADC-GRIFFISS AFB
DR. NICHOLAS F. YANNONI
(617) 861-3295


RADC TPO 4 - TECHNOLOGY
THRUST: D1 - SOLID STATE DEVICES/SYSTEM TIMING COMPONENTS
FY80
FY81
FY82
FY83
FY84
FY85
FY86
OPTICAL STATE SELECTION FREQUENCY STANDARDS
6.1, 6.2
ADVANCED C3I SYNCHRONIZATION SYSTEMS
HARDENED S CLOCK 3.3
MINI RECEIVER OSCILLATOR 3.3
ADVANCED C3I TIME & FREQUENCY STDS
6.2, 6.3
616A
SEEK TALK
ATOMIC GAS CELL FREQUENCY STANDARDS
6.1, 6.2
NATO IDENTIFICATION TACTICAL OSC.
6.3
NATO ID SYSTEM
RESONATOR DEVELOPMENT/FAST WARM UP CLOCKS
6.1, 6.2
OSCILLATOR NOISE MECHANISMS
6.1
TACTICAL TIME BASE

## TASK AREAS

- QUARTZ OSCILLATOR RESEARCH
- ATOMIC FREQUENCY STANDARDS

## FREQUENCY STANDARDS

- ATOMIC BEAM RESONATORS
- GAS CELLS
- MASERS
- CRYSTAL OSCILLATORS

TPO THRUST #/TITLE: 4D / SOLID STATE DEVICES

SUB-THRUST #/TITLE: 1 / SYSTEM TIMING COMPONENTS

MAJOR NON-DL PROGRAMS SUPPORTED

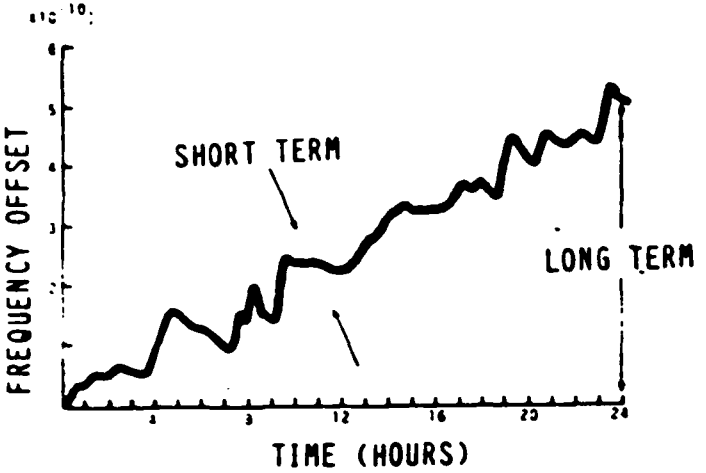
| NON-DL PROGRAM | SUPPORT PROVIDED | CUSTOMER |
|---|---|---|
| 616A/AF SUPPORT TO MEECN | DEVELOPMENT OF PORTABLE REAL-TIME CLOCK (CESIUM) | ESD |
| NIS/NATO IDENTIFICATION SYSTEM | TEST/EVALUATION OF CANDIDATE TIME BASE, QUARTZ OSCILLATOR DEVELOPMENT | ASD |
| SEEK TALK | DEVELOPMENT OF SMALL MILITARIZED RUBIDIUM STANDARD AND NEW DESIGN RUBIDIUM STANDARD | RADC/ESD |

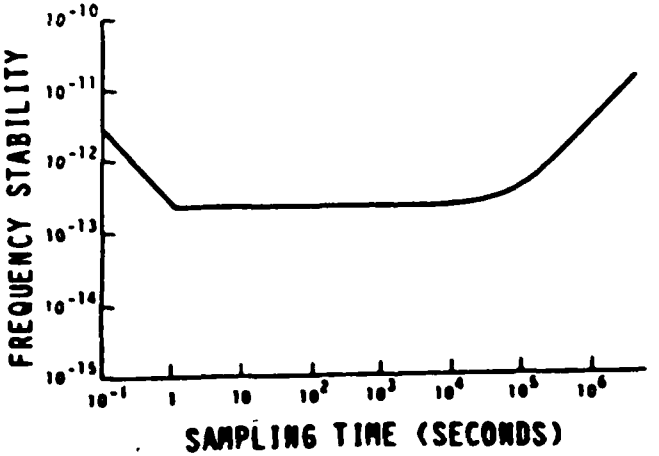
## TIME AND FREQUENCY CHARACTERIZATION

- ACCURACY
- PRECISION
- STABILITY
  - SHORT-TERM
  - LONG-TERM

1ms
100μs
10μs
1μs
100ns
10ns
1ns
100ps
10ps
1ps
TIME ACCURACY
1
1
10
10²
10³
10⁴
10⁵
10⁶
10⁷
1 HOUR
t, TIME AFTER SYNCHRONIZATION (SECONDS) ⟶
10⁻⁸
10⁻⁹
10⁻¹⁰
10⁻¹¹
10⁻¹²
10⁻¹³
10⁻¹⁴
R₀=Δν/ν, FRACTIONAL FREQUENCY OFFSET ⟵
OR
σy/ν(T-t), FRACTIONAL FREQUENCY STABILITY

# STABILITY CHARACTERIZATION



## TIME/FREQUENCY DEVICE SELECTION CRITERIA

- PERFORMANCE

  STABILITY, PHASE NOISE, ACCURACY

- SYSTEM LIMITATIONS

  SIZE, WEIGHT, POWER

- COST

  INITIAL AND/OR LIFE CYCLE

- OPERATIONAL REQUIREMENTS

## MILITARY APPLICATIONS OF T/F STANDARDS

- NAVIGATION, POSITIONING, AND TARGETING
- COMMUNICATIONS
  - STRATEGIC
  - TACTICAL
  - SECURE AND ANTI-JAM
- SURVEILLANCE AND RECONNAISSANCE
- IDENTIFICATION
- INTELLIGENCE

## PLATFORMS

- GROUND STATION - BENIGN ENVIRONMENT
- MOVING VEHICLE - TANK, HELICOPTER, TRUCK
  - POWER AVAILABLE
  - SEVERE ENVIRONMENTAL EFFECTS
  - RESYNCHRONIZATION PROBLEM
- HIGH PERFORMANCE AIRCRAFT
  - FAST WARMUP
  - SYNCHRONIZATION
- MANPACK
  - POWER/SIZE/WEIGHT
  - RESYNCHRONIZATION
- SATELLITE - Thermo-Vac.

## OPERATIONAL REQUIREMENTS

- ENVIRONMENTAL SENSITIVITY
  SPACE, NUCLEAR, ATMOSPHERE
- "ILITIES"
  RELIABILITY, DURABILITY, MAINTAINABILITY, INTEROPERABILITY
- SHOCK, ACCELERATION, AND VIBRATION ON DIFFERENT PLATFORMS
- WARM UP AND TEMPERATURE FLUCTUATION
- EASE OF BATTLEFIELD DEPLOYMENT
  MAN/MACHINE INTERFACES, SIMPLICITY, AUTOMATIC OPERATION

## TIME/FREQUENCY STANDARDS PROGRAM ELEMENTS

| | | |
|---|---|---|
| MATERIAL | QUARTZ | PHYSICAL PROPERTIES |
| DEVICE | RESONATOR | Q-MEASUREMENTS |
| SUBSYSTEM | OSCILLATOR | FREQUENCY STABILITY<br>SPECTRAL PURITY |
| SYSTEM | CLOCK | PERFORMANCE |

## RADC/ES T/F PROGRAM

TECHNOLOGIES

- o QUARTZ - Materials; Resonators; Oscillators
- o RUBIDIUM - Small Militarized Unit
- o CESIUM - Portable Real Time Clock
- o HYDROGEN - Small Lightweight Maser
- o FREQUENCY/TIME TEST FACILITY

## RADC/ES T/F PROGRAM

QUARTZ:

- o GROWTH
- o SWEEPING
- o ANALYSIS
- o SC CUT
- o BVA
- o OSCILLATORS FOR ABOVE
- o NOISE STUDIES

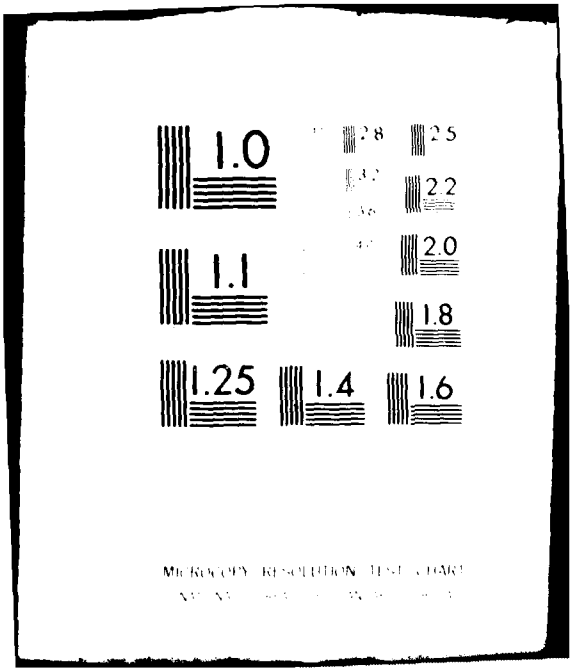
## MATERIAL PROCESSING

- SWEEPING PARAMETERS
  - TEMPERATURE
  - VOLTAGE
  - ENVIRONMENT
  - DOPANTS
  - TIME
  - ELECTRODES
  - MULTIPLE SWEEPING
- IMPURITY PEAK IDENTIFICATION

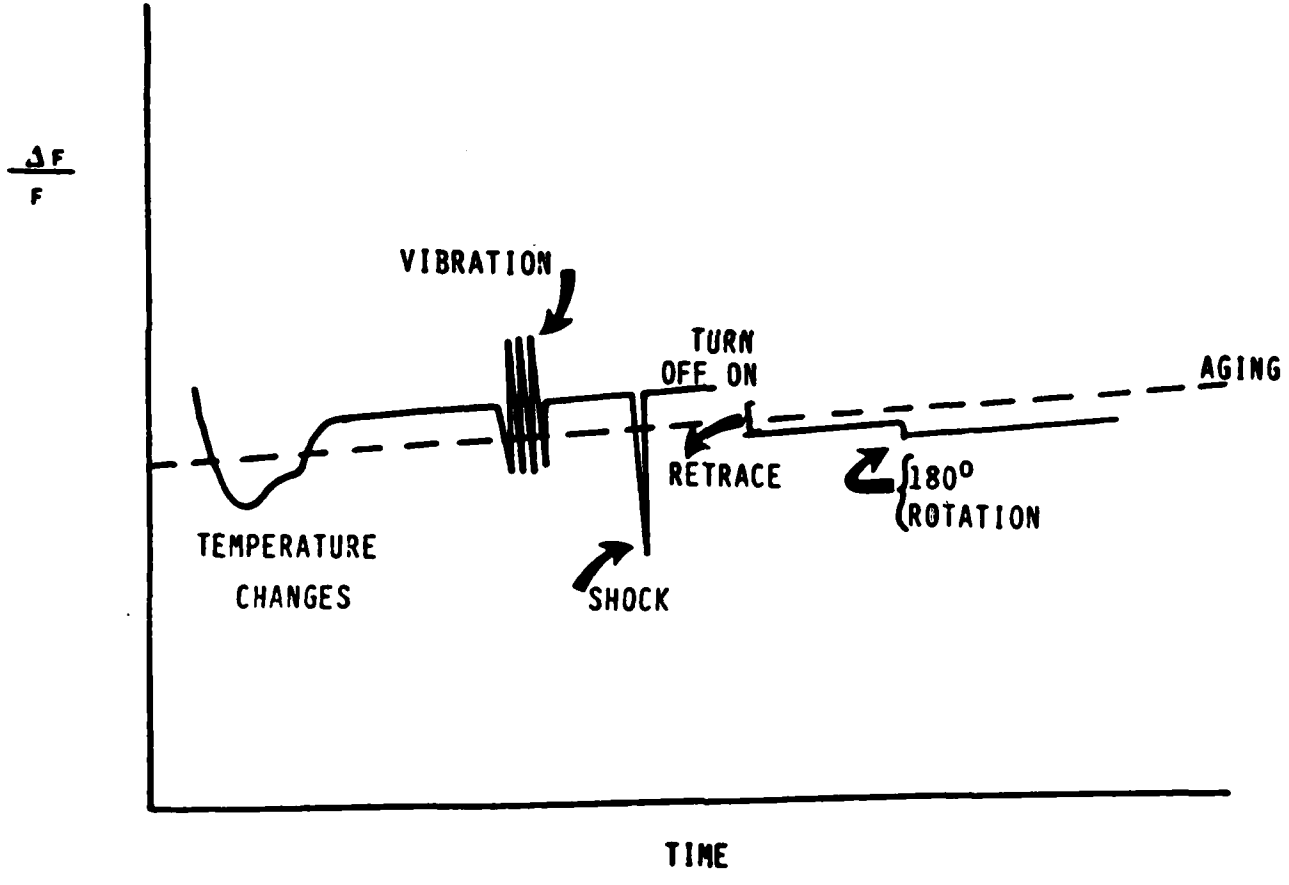
AD-A088 289 ROME AIR DEVELOPMENT CENTER GRIFFISS AFB NY F/G 5/1
INDUSTRY LOOKS AT RADC - 1980. VOLUME I.(U)
1980
UNCLASSIFIED RADC-TR-80-195-VOL-1 NL

4 OF 4
AD A088289

END
DATE FILMED
9-80
DTIC


1.0
1.1
1.25
1.4
1.6
1.8
2.0
2.2
2.5
MICROCOPY RESOLUTION TEST CHART

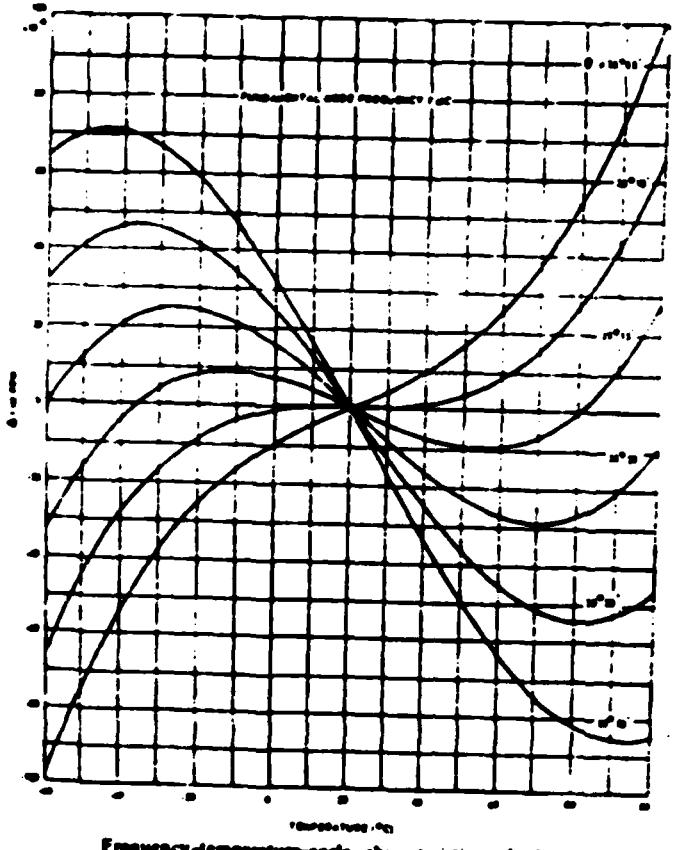
## ENVIRONMENTAL EFFECTS ON QUARTZ OSCILLATORS



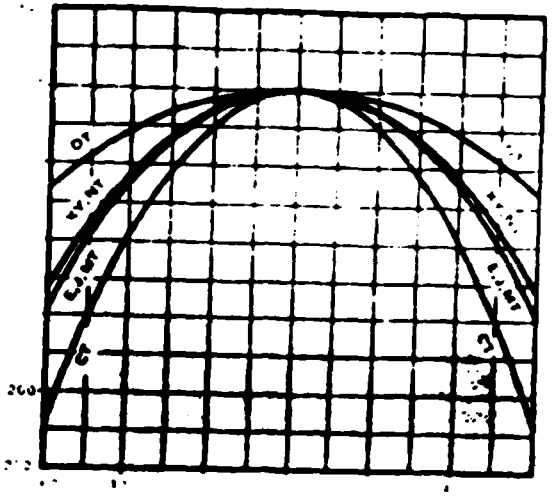
## ENVIRONMENTAL EFFECTS

- CRYSTAL — ATOMIC REARRANGEMENT
- RESONATOR — ANELASTIC LOSSES
- OSCILLATOR
  1. CESSATION OF OSCILLATION
  2. FREQUENCY OFFSET
     - A. TRANSIENT
     - B. PERMANENT

# FREQUENCY - TEMPERATURE CHARACTERISTICS

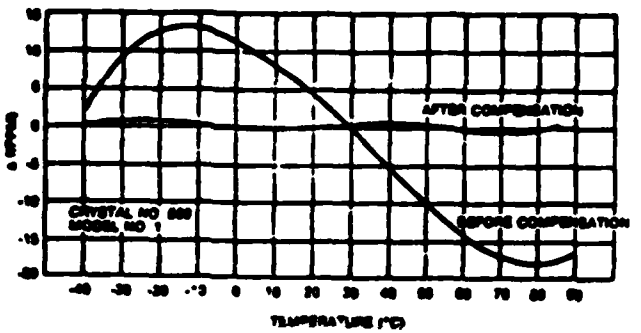


Frequency-temperature-angle characteristics of plated AT-type natural quartz crystal resonators.[6]

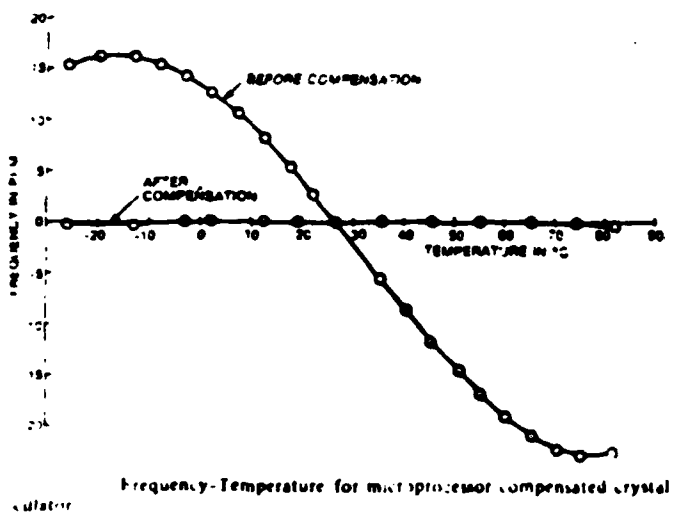


Frequency-temperature characteristics of low frequency crystal cuts (Courtesy Northern Engineering Laboratories)

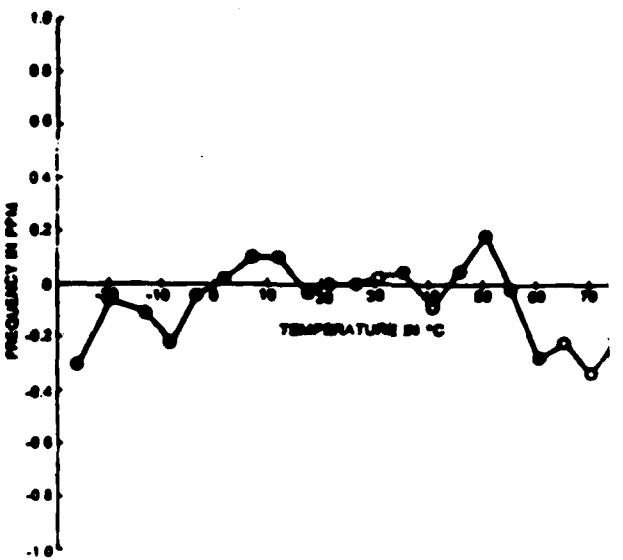
# TEMPERATURE COMPENSATION CURVES




Frequency versus temperature characteristic for a typical temperature-compensated crystal oscillator.




Frequency-Temperature for microprocessor compensated crystal oscillator




Frequency-Temperature for microprocessor compensated oscillator (expanded scale)

# Warm-up Time vs Warm-up Power: SC & BT Cuts

Warmup from still air ambient of 25°C
Warmup to within ±5 x $10^{-9}$ of 12 hour value

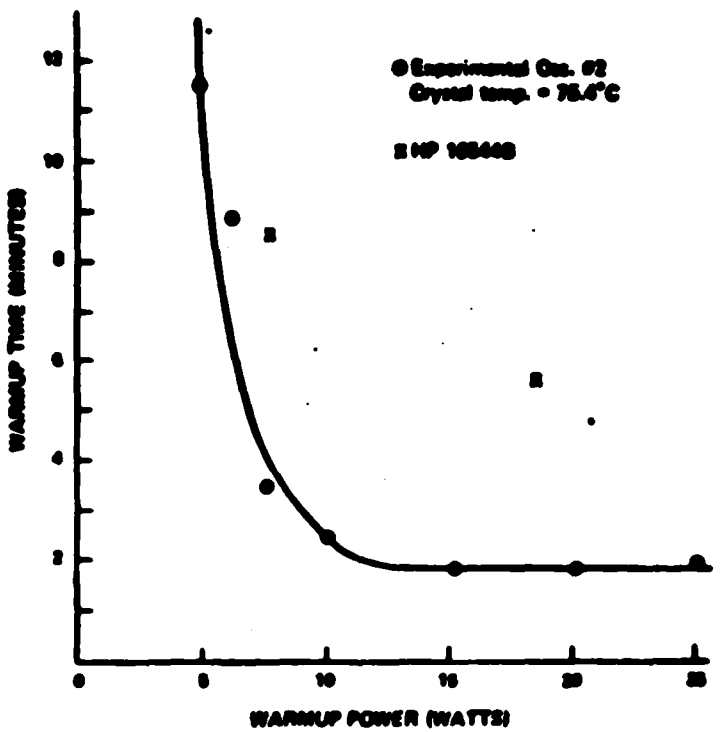
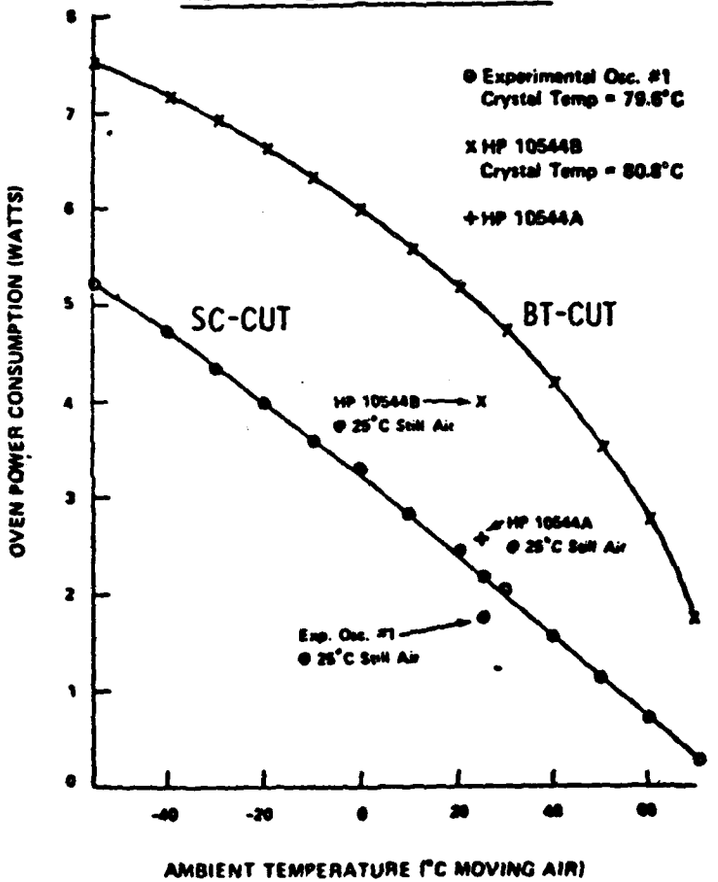
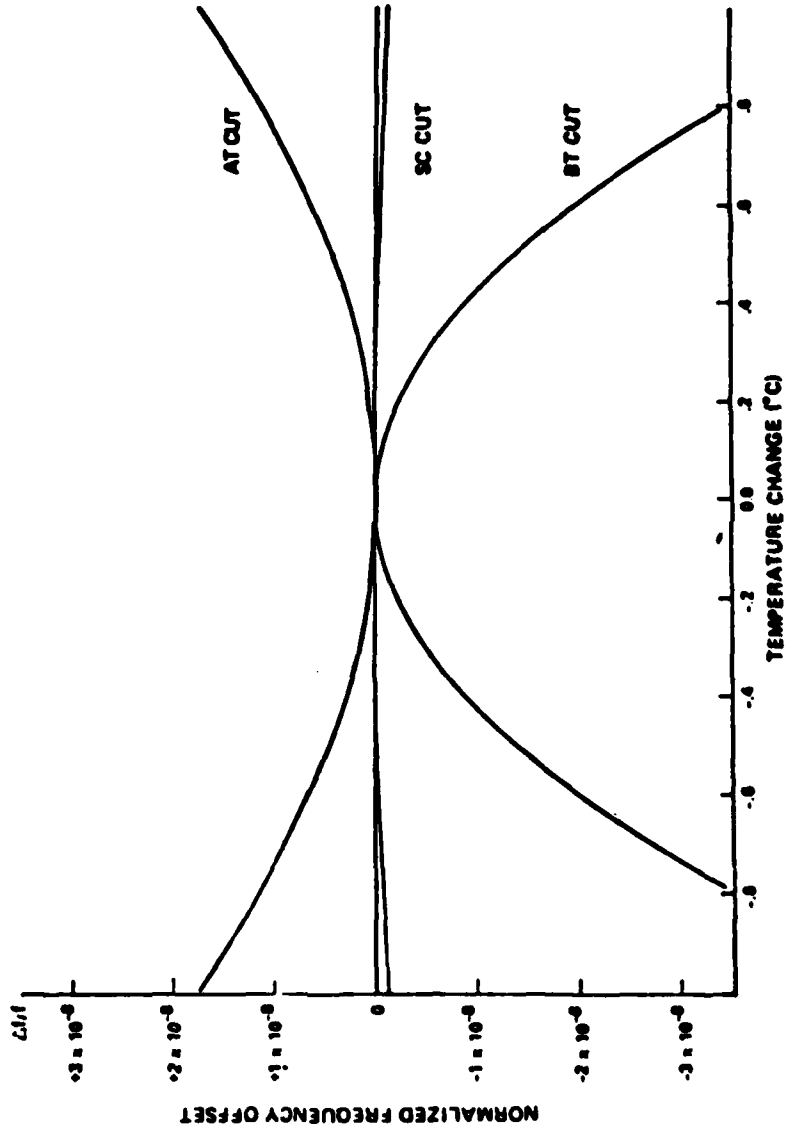



Figure 1. Warmup Time vs Warmup Power for Experimental Oscillator #2

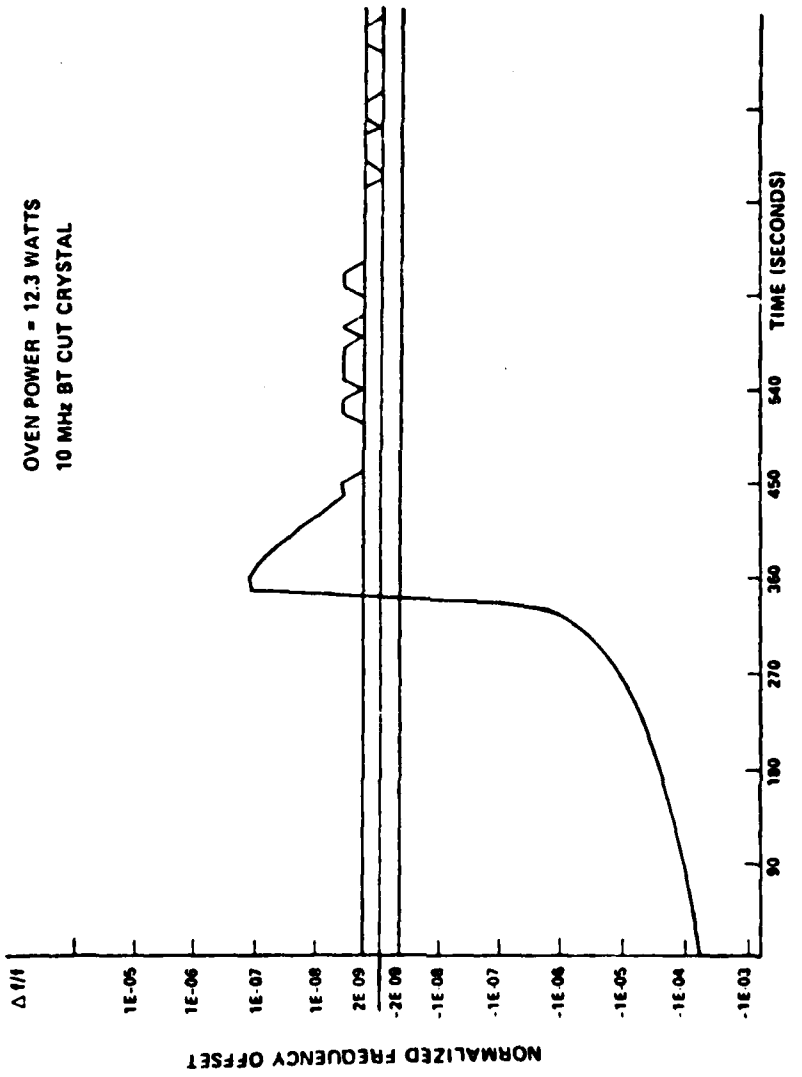
## STEADY-STATE OVEN POWER CONSUMPTION VS AMBIENT TEMPERATURE



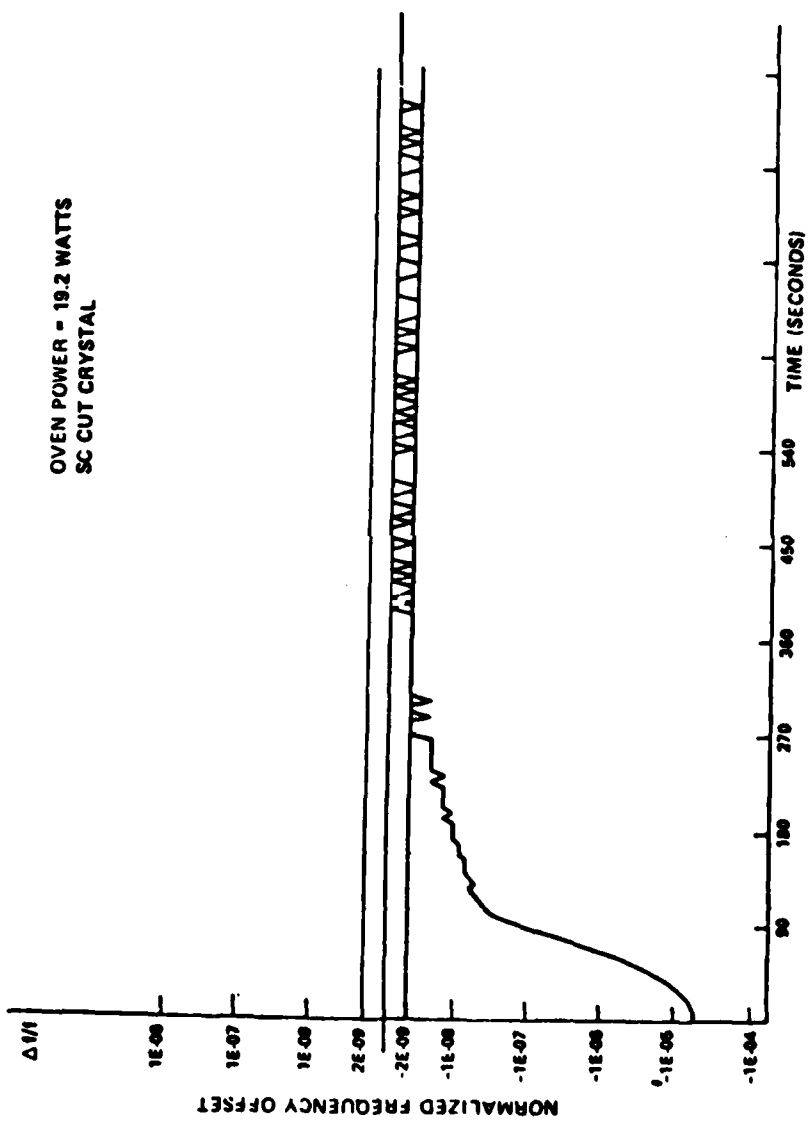
## FREQUENCY CHANGE VS. TEMPERATURE NEAR THE TURNOVER



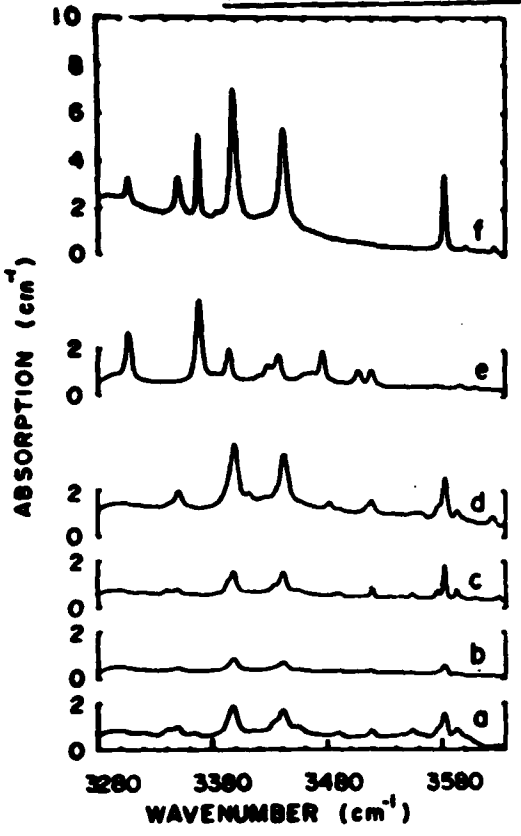
## OSCILLATOR WARMUP WITH BT-CUT CRYSTAL



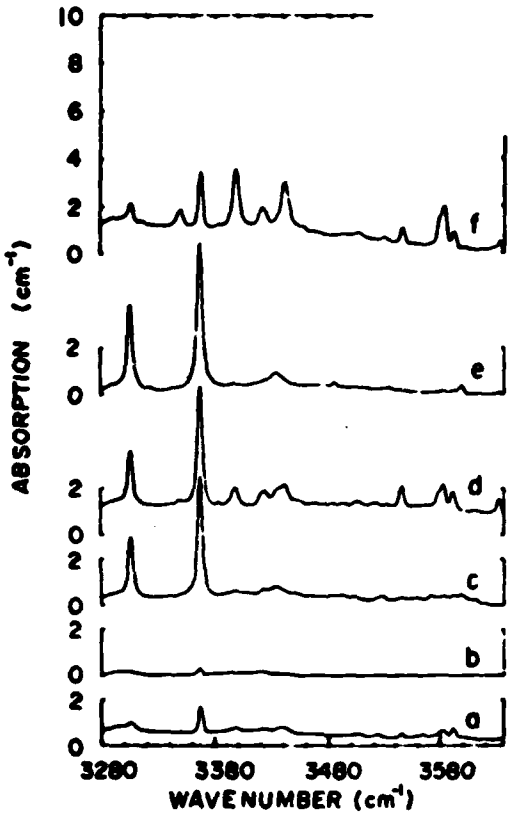
## OSCILLATOR WARMUP WITH AN SC-CUT CRYSTAL



## INFRARED ABSORPTION SPECTRA OF QUARTZ

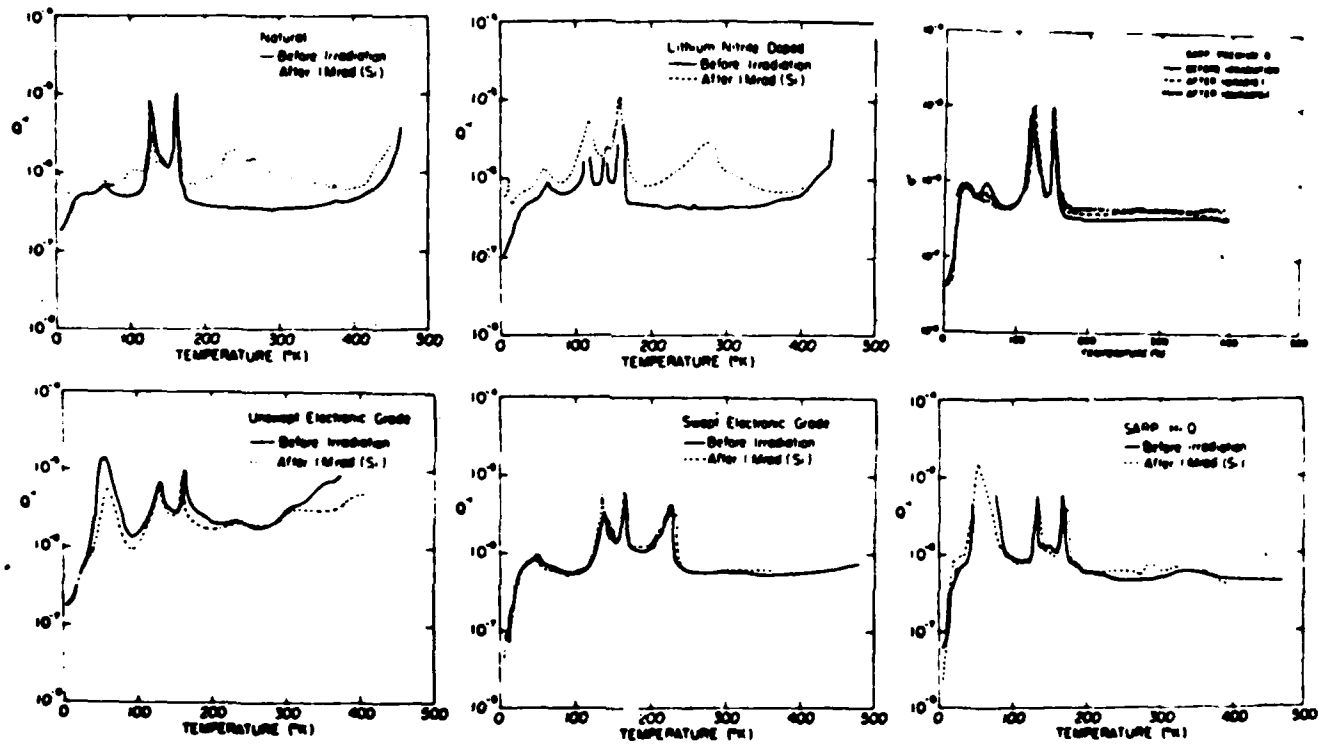



E⊥C ABSORPTION SPECTRA AT 12°K.
(a) HIGH-Q (b) PREMIUM-Q
(c) ELECTRONIC GRADE (d) Li-DOPED
(e) NATURAL (f) SWEPT ELECTRONIC




ABSORPTION SPECTRA AT 12°K AFTER A DOSE OF 6700 MRad OF 10 MeV ELECTRONS

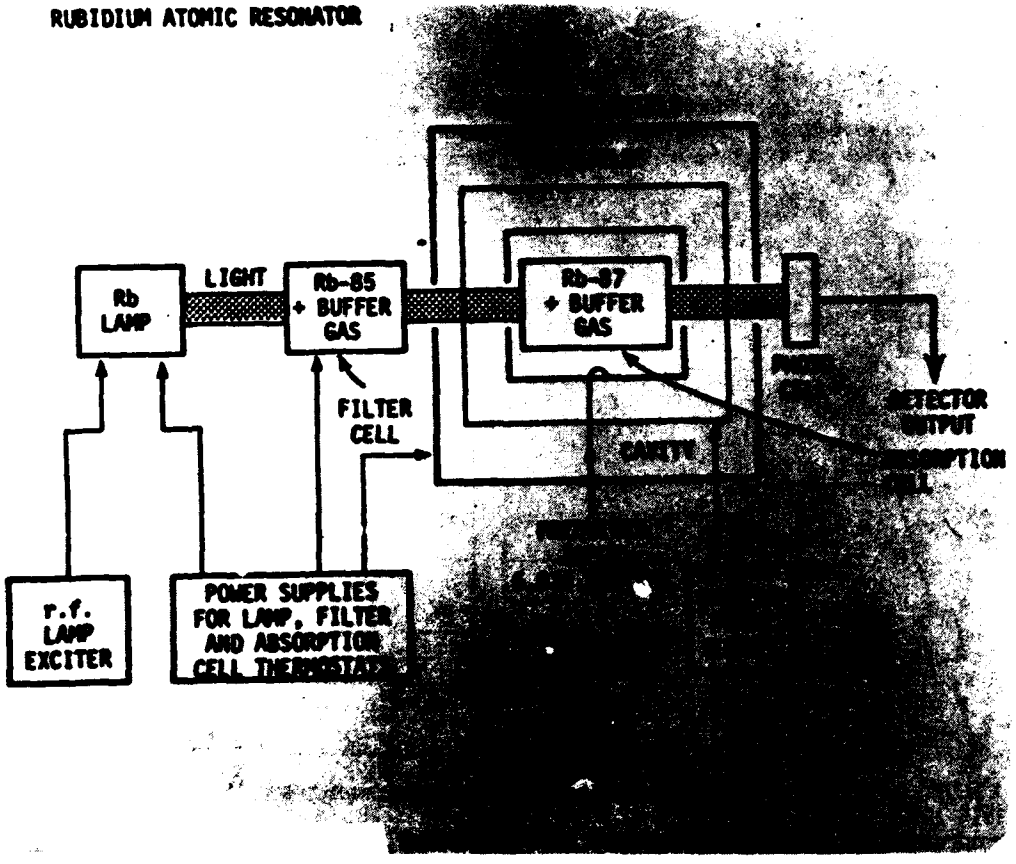
# ANELASTIC LOSS $Q^{-1}$ VS TEMPERATURE



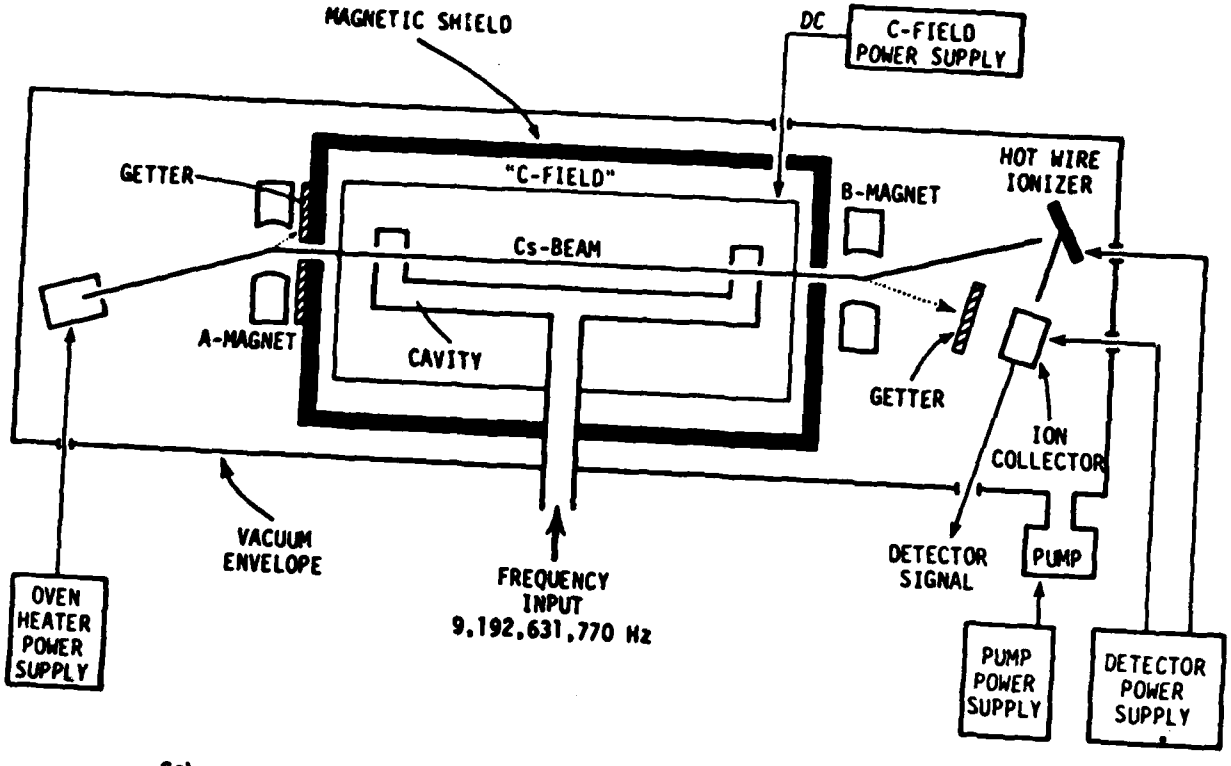
## NEW/IMPROVING TECHNOLOGIES

- SC-CUT
- BVA DESIGN
- QUARTZ GROWTH AND SWEEPING
- LOW TEMPERATURE STUDIES
- BETTER THEORETICAL UNDERSTANDING
- FABRICATION/PROCESSING
  - SURFACE CLEANING AND POLISHING
  - ULTRA-PURE (HI-VAC) FABRICATION
  - AUTOMATION OF SC-CUTS

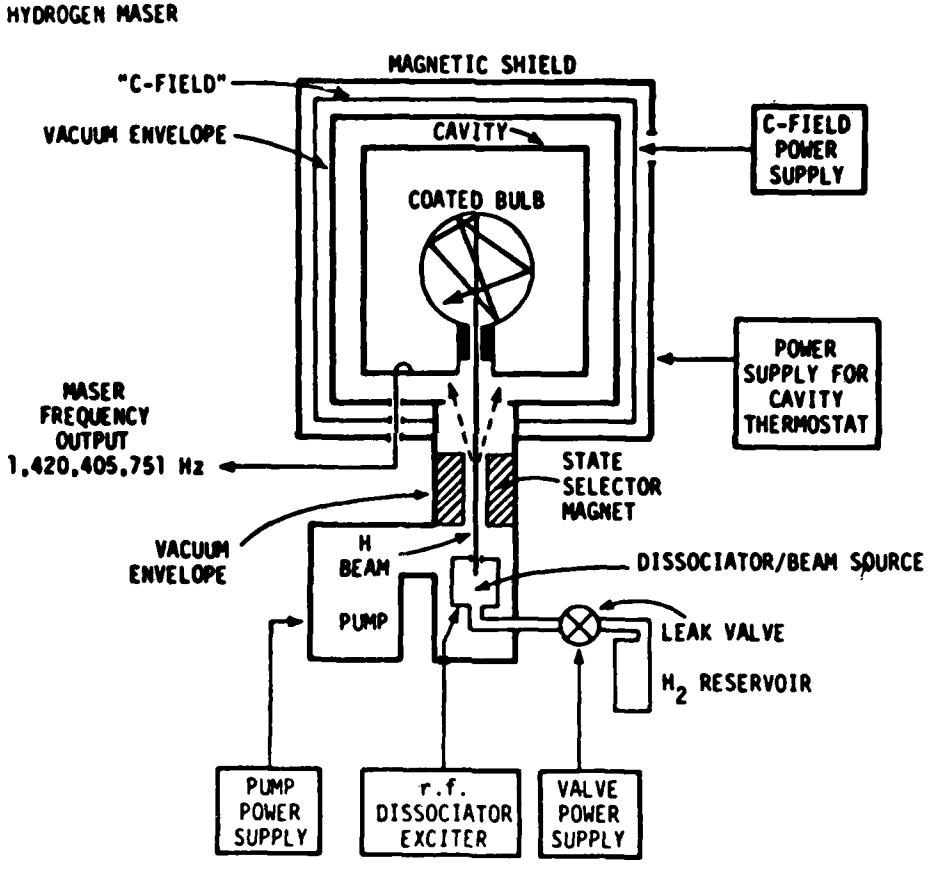
RUBIDIUM ATOMIC RESONATOR



CESIUM ATOMIC RESONATOR




Schematic of a cesium beam tube. Typically, a cavity with separated interrogation regions is used. This design offers certain advantages over a simple cavity of a length equivalent to the separation of the two regions. See Appendix II.




Schematic of a hydrogen maser oscillator.

## SUPPLIERS OF STANDARDS AND CLOCKS

QUARTZ OSCILLATORS: HP•, FEI, FTS, A AND OTHERS.

RUBIDIUM: HP, E, T

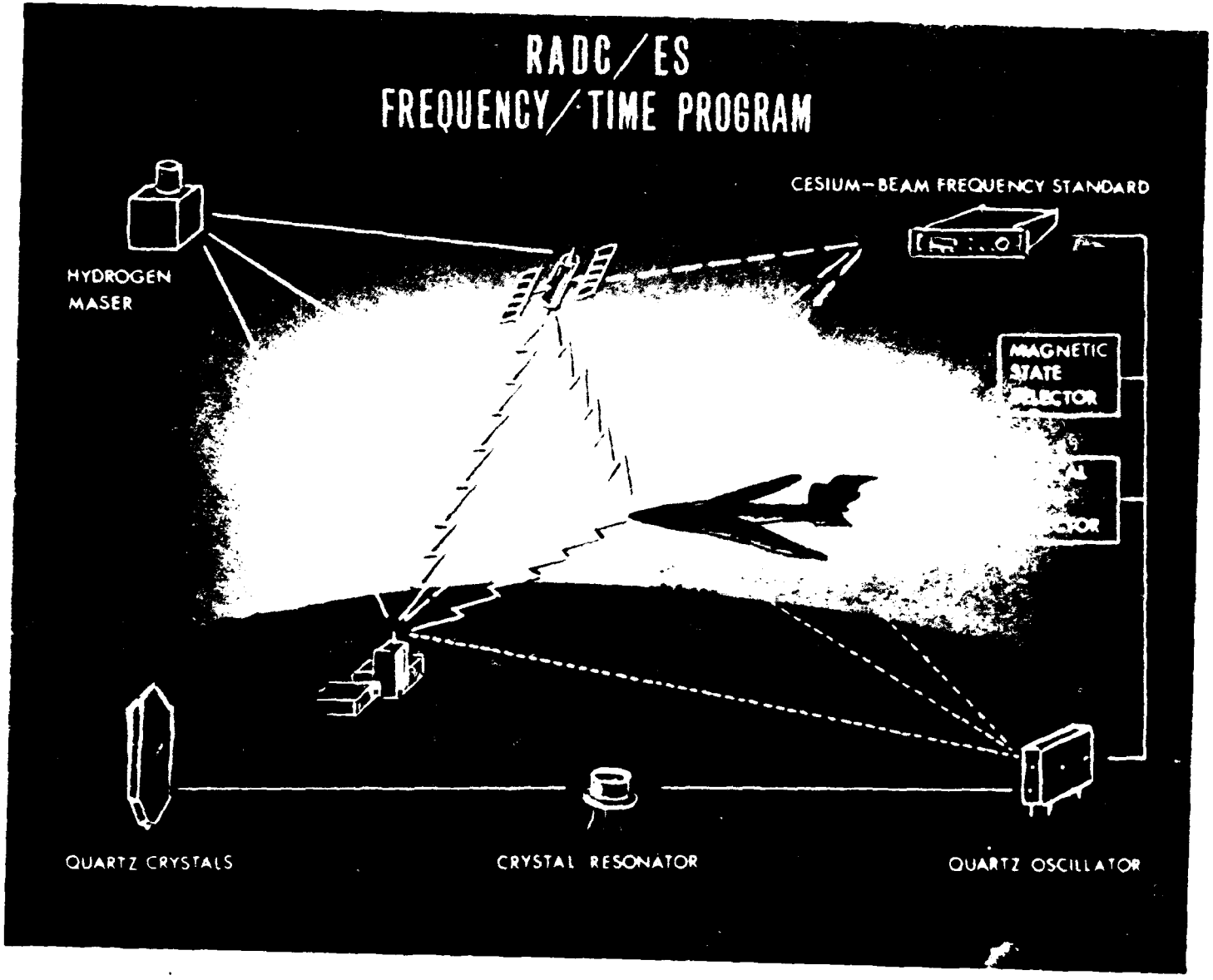
CESIUM: HP, FEI, FTS

HYDROGEN: NO COMMERCIAL VENDORS

WESTERN EUROPE:

- OSCILLOQUARTZ (SWITZERLAND)
- Q. & E. (FRANCE)
- C. E. P. E. (FRANCE)
- ROHDE & SCHWARTZ (W. GERMANY) & EFRATOM
- PLESSEY, RACAL, CATHODEON (U. K.)

• HP: HEWLETT-PACKARD
FEI: FREQUENCY ELECTRONICS, INC.
FTS: FREQUENCY & TIME SYSTEMS
E: ETRATOM
A: AUSTRON
T: TRACOR


RADC/ES
FREQUENCY/TIME PROGRAM
CESIUM-BEAM FREQUENCY STANDARD
HYDROGEN
MASER
MAGNETIC
STATE
QUARTZ CRYSTALS
CRYSTAL RESONATOR
QUARTZ OSCILLATOR

# *MISSION*
# *of*
# *Rome Air Development Center*

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