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PAXSAT BRIEFINGS



GRAPHICS

JUNE 1987

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PAXSAT BRIEFINGS



GRAPHICS

JUNE 1987

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ARMS CONTROL AND DISARMAMENT DIVISION



DEPARTMENT OF EXTERNAL AFFAIRS

CANADA

POLICY

ARMS CONTROL AND DISARMAMENT DIVISION
DEPARTMENT OF EXTERNAL AFFAIRS



CANADA AND VERIFICATION
POLICY CONSIDERATIONS



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BRIEFING CONTEXT

- 0 CANADIAN APPROACH
- 0 VERIFICATION RESEARCH
- 0 PAXSAT CONCEPT



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ARMS CONTROL

- 0 COMPLEX
- 0 SLOW
- 0 INCREMENTAL PROCESS



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VERIFICATION

0 A DETERRENT TO NON-COMPLIANCE



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VERIFICATION

0 NOT ONLY DISCOVERING NON-COMPLIANCE
BUT DEMONSTRATING COMPLIANCE



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THIRD SYSTEMS

- 0 THIRD SYSTEMS INTENDED FOR ACD
VERIFICATION
- 0 EASE PRESSURE ON EXISTING NTM'S
FOR DATA



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THIRD SYSTEMS

- 0 LESS PRESSURE
- 0 SCREEN
- 0 NOT A SUBSTITUTE FOR NTM'S
- 0 TRIGGERING MECHANISM



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EXISTING NTM'S
AND
MULTILATERAL THIRD SYSTEMS

ARE NOT ANTAGONISTIC BUT RATHER
COMPLIMENTARY CONCEPTS



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KEY THEMES

- 0 EDUCATIONAL
- 0 SCIENTIFIC & TECHNICAL
- 0 ANALYTICAL



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FOCUS

- 0 CHEMICAL WEAPONS
- 0 OUTER SPACE
- 0 CONVENTIONAL REDUCTIONS
- 0 SEISMIC MONITORING

CONCEPT

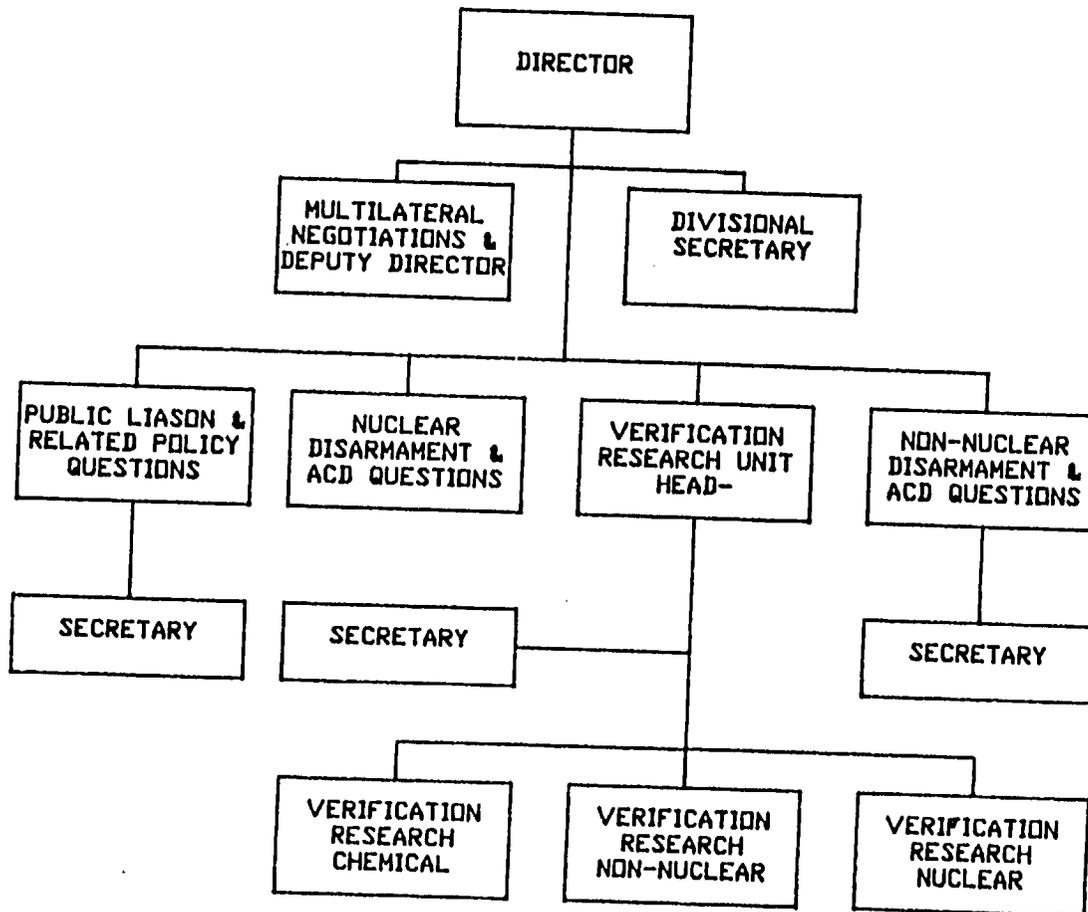
ARMS CONTROL AND DISARMAMENT DIVISION
DEPARTMENT OF EXTERNAL AFFAIRS



PAXSAT CONCEPT



ARMS CONTROL & DISARMAMENT DIVISION (IDA)





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VERIFICATION RESEARCH UNIT

RESPONSIBILITIES

1. TO PROPOSE, DEVELOP, IMPLEMENT AND MONITOR ALL ASPECTS OF THE VERIFICATION PROGRAMME
2. TO PROVIDE AN INDEPENDENT IN-HOUSE RESEARCH CAPABILITY IN SUPPORT OF ACD OBJECTIVES WITHIN THE HEADQUARTERS, AND AT OVERSEAS MISSIONS



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VERIFICATION RESEARCH PROGRAMME

GENERAL OBJECTIVE

TO CONTRIBUTE TO THE PROCESS OF ACHIEVING VERIFIABLE
ARMS CONTROL AND DISARMAMENT AGREEMENTS WHICH WILL SERVE
TO IMPROVE THE SECURITY OF CANADA AND ITS ALLIES



VERIFICATION RESEARCH PROGRAMME

OBJECTIVES

1. TO ANALYSE, ASSESS AND CLARIFY VERIFICATION ISSUES AND PROBLEMS IDENTIFIED IN ARMS CONTROL AND DISARMAMENT NEGOTIATIONS, PARTICULARLY THOSE TO WHICH CANADA IS A PARTY
2. TO ASSESS THE POLITICAL, MILITARY, LEGAL AND TECHNICAL IMPLICATIONS OF EXISTING ARMS CONTROL AND DISARMAMENT VERIFICATION PROPOSALS
3. TO ASSESS THE ADEQUACY AND NEGOTIABILITY OF EXISTING ARMS CONTROL AND DISARMAMENT VERIFICATION PROPOSALS



VERIFICATION RESEARCH PROGRAMME

OBJECTIVES (CONT'D)

4. TO RESEARCH AND ASSESS WAYS TO IMPROVE EXISTING ARMS CONTROL AND DISARMAMENT VERIFICATION TECHNIQUES AND PROPOSALS
5. TO RESEARCH AND DEVELOP NEW TECHNIQUES AND APPROACHES TO THE VERIFICATION OF COMPLIANCE WITH EXISTING OR PROSPECTIVE ARMS CONTROL AND DISARMAMENT AGREEMENTS
6. TO UNDERTAKE SUCH OTHER RESEARCH AND/OR RELATED ACTIVITY AS IS DETERMINED TO BE NECESSARY TO THE ACHIEVEMENT OF THE PROGRAMME'S GENERAL OBJECTIVE



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VERIFICATION RESEARCH PROGRAMME

PRIORITIES

1. THE ACHIEVEMENT OF A COMPREHENSIVE CONVENTION TO BAN CHEMICAL WEAPONS
2. THE NEGOTIATION OF A COMPREHENSIVE NUCLEAR TEST BAN TREATY
3. THE DEVELOPMENT OF A TREATY TO BAN WEAPONS FOR USE IN OUTER SPACE



VERIFICATION RESEARCH PROGRAMME

PRIORITIES (CONT'D)

4. THE PURSUIT OF ARMS CONTROL AND MILITARY CONFIDENCE-BUILDING IN EUROPE THROUGH THE MUTUAL AND BALANCED FORCE REDUCTION (MBFR) TALKS IN VIENNA AND THE CONFERENCE ON CONFIDENCE AND SECURITY BUILDING MEASURES AND DISARMAMENT IN EUROPE (CCSBMDE)
5. THE CONCLUSION OF A CONVENTION TO BAN RADIOLOGICAL WEAPONS
6. THE CONDUCT OF OTHER RESEARCH AS MAY BE REQUIRED FROM TIME TO TIME



VERIFICATION RESEARCH PROGRAMME PROJECTS FLOW CHART

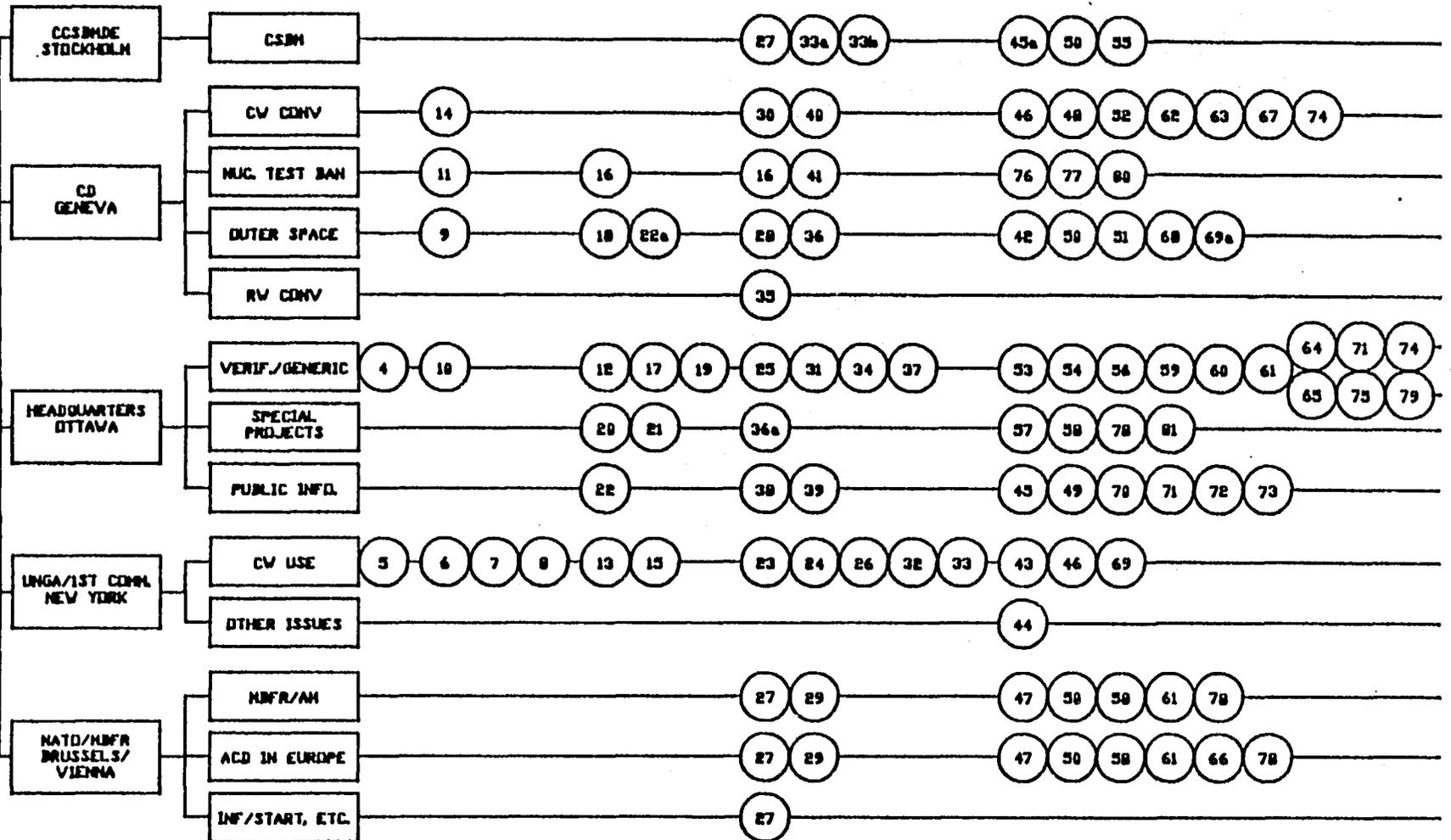
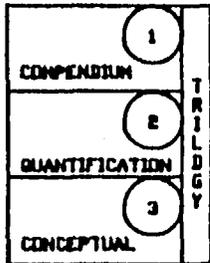
(PAST, PRESENT, PROPOSED)

BASIC RESEARCH

MISSIONS/FOIA

ACD ISSUES

APPLIED RESEARCH



VARIABLE TIME FRAME

1981 1982

1983

1984

1985

DEC 1985



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TRENDS

- 0 EMERGENCE OF MULTILATERAL ARMS CONTROL ACCORDS
- 0 RAPID EXPLOITATION OF CIVILIAN SPACE TECHNOLOGY



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BASIC ASSUMPTION

IN ANY SIGNIFICANT MULTILATERAL ACD
AGREEMENT, OVERHEAD SURVEILLANCE
TECHNIQUES ARE LIKELY TO CONSTITUTE THE
CENTRAL, BUT NOT THE ONLY MEANS, OF
VERIFICATION



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THE PAXSAT CONCEPT

THE APPLICATION OF SPACE-BASED REMOTE
SENSING TECHNIQUES TO ARMS CONTROL
VERIFICATION



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FIVE UNDERLYING PRINCIPLES

1. MULTILATERAL AGREEMENT
2. PARTICIPATION OPTION
3. NEITHER ADVERSARY NOR UMPIRE
4. SOVEREIGN AUTHORITY
5. TECHNOLOGY COLLECTIVISM



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TECHNOLOGY BASIS

THE CONCEPT IS PREDICATED ON EMPLOYING
TECHNOLOGY AVAILABLE TO NATIONS OTHER
THAN THE TWO SUPERPOWERS

ERS-1	ESA
SPOT	FRANCE
JERS-1	JAPAN
RADARSAT	CANADA



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PAXSAT FEASIBILITY STUDIES

PAXSAT "A" : SPACE-TO-SPACE

PAXSAT "B" : SPACE-TO-GROUND



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PAXSAT "A" CONCEPT
FOR
ARMS CONTROL VERIFICATION
IN
OUTER SPACE



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CONTEXT

0 UN OR OTHER SUITABLE FORUM

FORM

0 COLLECTIVE APPLICATION OF REMOTE SENSING
IN A SPECIFIC TREATY CONTEXT



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PAXSAT "B" CONCEPT
FOR
ARMS CONTROL VERIFICATION
FROM
OUTER SPACE



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CONTEXT

0 CCSBMDE AND MBFR

FORM

0 EXTENSION OF ANY NATIONAL TECHNICAL
MEANS

0 APPLICATION OF REMOTE SENSING IN A
SPECIFIC TREATY CONTEXT

0 COLLECTIVE NATIONAL TECHNICAL MEANS

PAXSAT 'A'

ARMS CONTROL AND DISARMAMENT DIVISION
DEPARTMENT OF EXTERNAL AFFAIRS



TECHNICAL DISCUSSIONS

PAXSAT "A" CONCEPT
FOR
ARMS CONTROL VERIFICATION
IN
OUTER SPACE

THE PAXSAT "A" CONCEPT

CAN A SPACE-BASED OBSERVATION SYSTEM
DETERMINE THE FUNCTION OF AN OBJECT IN
SPACE FOR THE PURPOSES OF VERIFYING AN
OUTER SPACE ARMS CONTROL REGIME?

TWO FUNDAMENTAL QUESTIONS POSED

1. "CAN OBSERVATIONS OF AN OBJECT IN SPACE DETERMINE THE FUNCTION OF THE OBJECT - PARTICULARLY IN REFERENCE TO A WEAPONS SYSTEM ?"
 2. "WOULD THE OBSERVATIONAL REQUIREMENTS PERMIT A VIABLE SPACECRAFT DESIGN FOR THE OPERATIONAL MISSION ?"
-

TWO FUNDAMENTAL QUESTIONS ANSWERED

1. "CAN OBSERVATIONS OF AN OBJECT IN SPACE DETERMINE THE FUNCTION OF THE OBJECT - PARTICULARLY IN REFERENCE TO A WEAPONS SYSTEM ?"

PRELIMINARY STUDIES INDICATE A TENTATIVE "YES"

2. "WOULD THE OBSERVATIONAL REQUIREMENTS PERMIT A VIABLE SPACECRAFT DESIGN FOR THE OPERATIONAL MISSION ?"

PRELIMINARY STUDIES INDICATE A TENTATIVE "YES"

FUNDAMENTAL CONSIDERATIONS

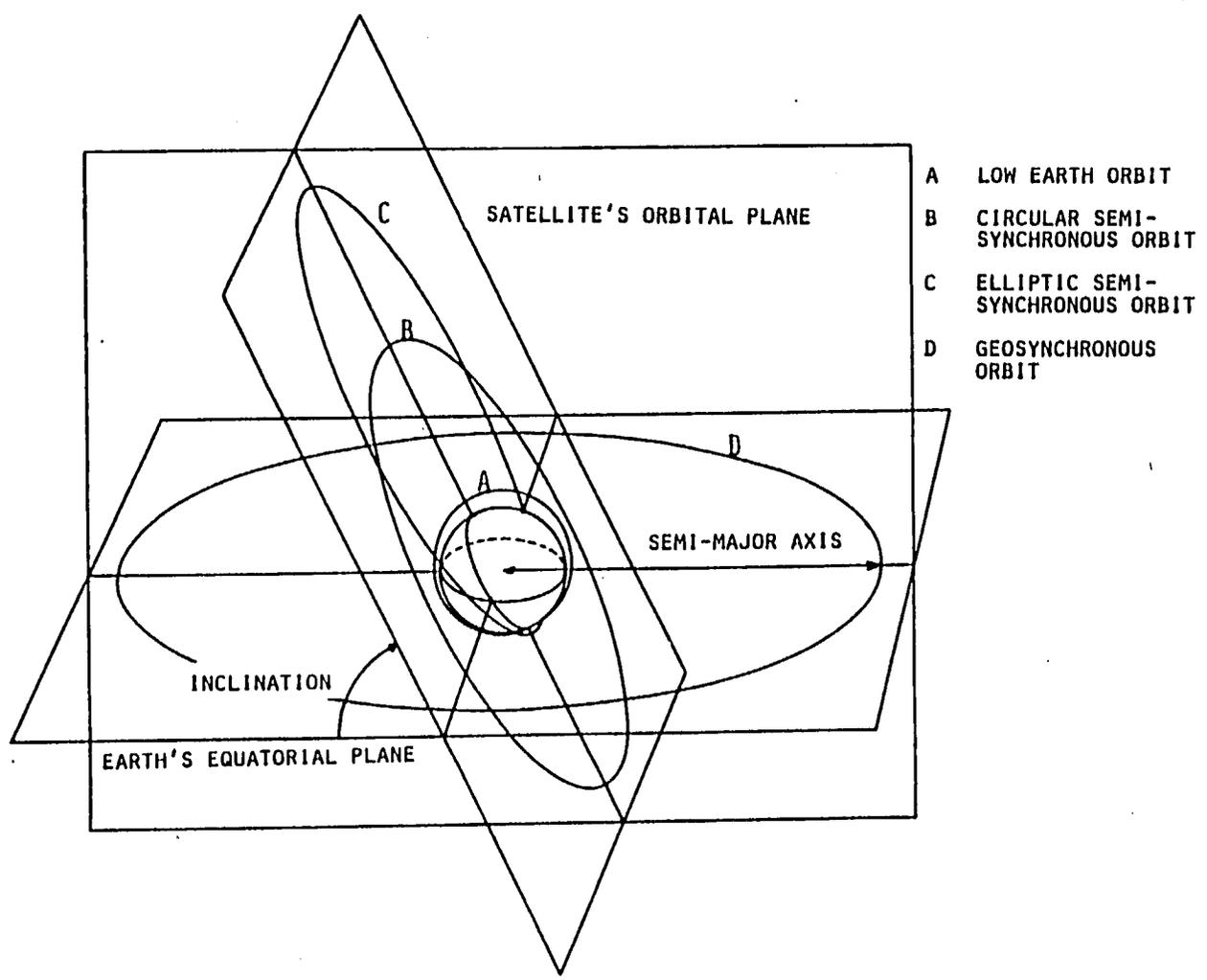
- 0 STATIONING SYSTEMS IN SPACE OFFERS
ADVANTAGES IN VIEWING THE EARTH AND/OR
VEHICLES IN FLIGHT ABOVE THE EARTH

 - 0 FORM FOLLOWS FUNCTION : LAUNCH
REQUIREMENTS IMPLY A HIGH DEGREE OF ORBIT
AND SPACECRAFT OPTIMIZATION FOR EACH
SPACEFLIGHT MISSION
-

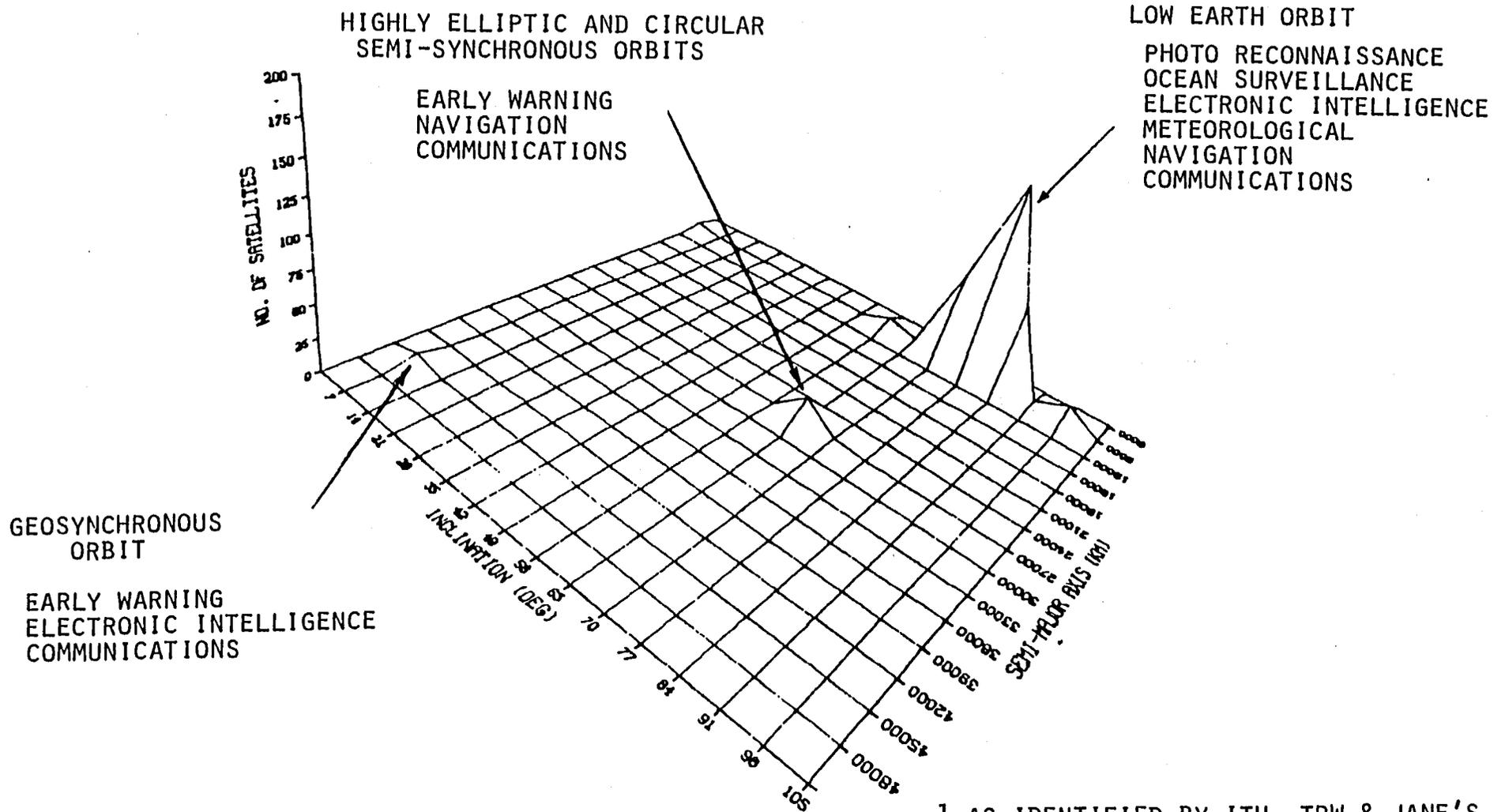
CAN A SPACE-BASED OBSERVATION
SYSTEM DETERMINE THE FUNCTION
OF AN OBJECT IN SPACE ?

- 0 HIGH RESOLUTION OPTICAL IMAGES
 - GENERAL CONFIGURATION
 - PRESENCE OF APERTURES/ANTENNAS & THEIR DIMENSIONS
 - PROPULSION SYSTEM DETAILS
 - 0 LOWER RESOLUTION THERMAL IMAGES
 - SPACECRAFT POWER UTILIZATION
 - 0 SPACECRAFT RF EMISSIONS
 - COMMUNICATIONS
 - CONTROL SIGNALS
 - DATA BACKHAUL
 - 0 SUPPLEMENTAL DETECTORS
 - RADIATION
 - CHEMICAL
-

ORBIT TERMINOLOGY

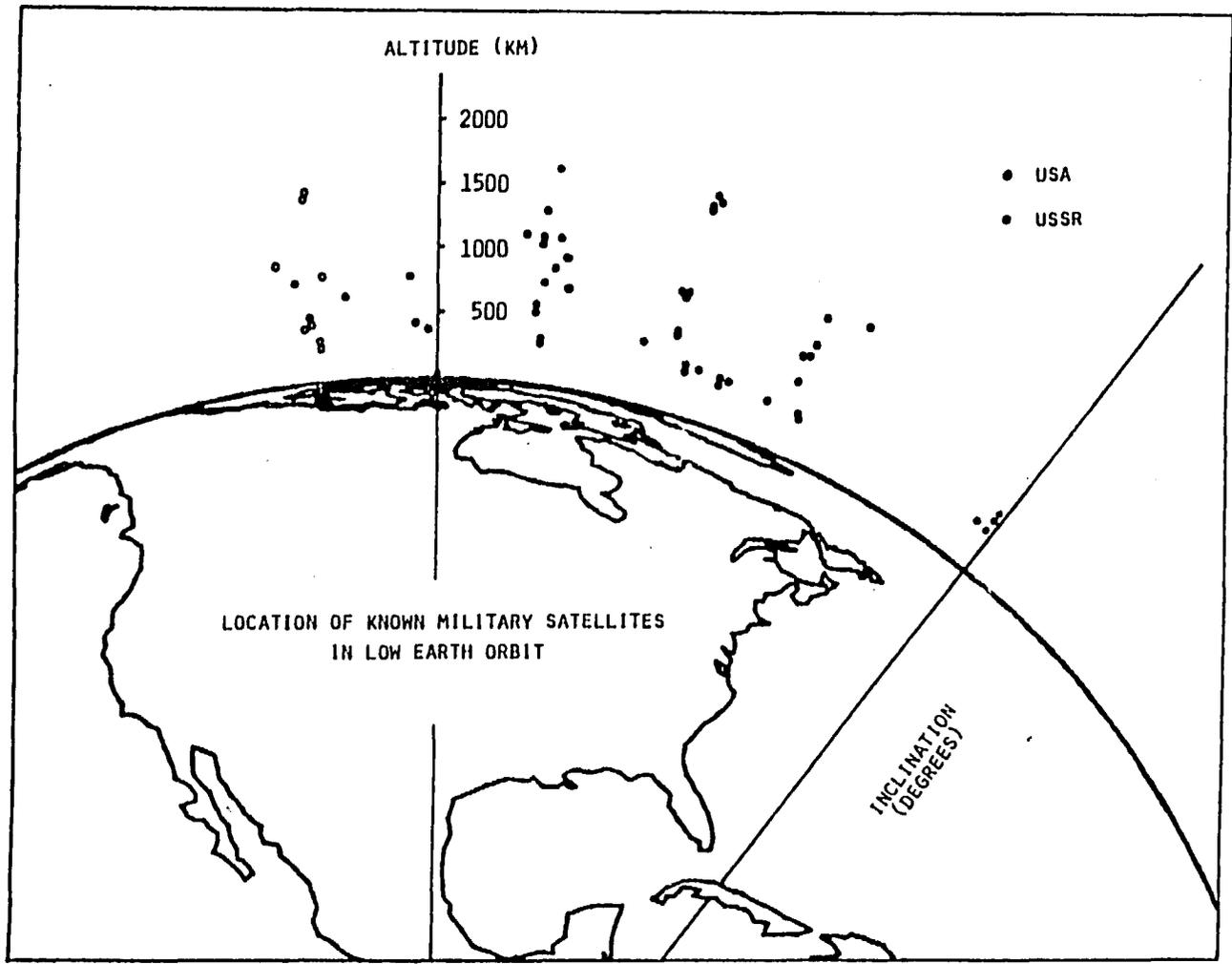


DISTRIBUTION OF KNOWN MILITARY¹ SPACECRAFT LAUNCHED 1980-1983



¹ AS IDENTIFIED BY ITU, TRW & JANE'S

MILITARY LOW EARTH ORBIT SATELLITE DISTRIBUTION



PAXSAT "A" INTERROGATION ALTERNATIVES

- 0 "FLY-BY" ENCOUNTERS
 - DIFFICULT SENSOR POINTING & RESOLUTION
 - SHORT VIEWING TIMES
 - MINIMUM FUEL USAGE FOR PAXSAT

 - 0 CO-ORBITAL RENDEZ-VOUS
 - MAXIMUM DATA REGARDING TARGET
 - ALTERNATIVE VIEWS OF TARGET
 - SUBSTANTIAL FUEL REQUIREMENT FOR PAXSAT SPACECRAFT OR LONG TIME PERIOD BEFORE TARGET ACQUISITION
-

PAXSAT "A" BASING ALTERNATIVES

- 0 LAUNCH-ON-DEMAND
 - PAXSAT LAUNCHED DIRECTLY INTO TARGET'S ORBIT FOR INVESTIGATION
 - LAUNCH TIMING SUBJECT TO LAUNCH MANIFEST OF PERIOD OR DEDICATED LAUNCH FACILITY AND VEHICLE IS REQUIRED
 - SHORT FLIGHT BUT CALL UP PERIODS OF 30-60 DAYS EXPECTED

 - 0 IN-ORBIT DORMANT PARKING
 - PAXSAT INITIALLY LAUNCHED INTO A RENDEZ-VOUS OPTIMIZED PARKING ORBIT AND AWAKENED FOR INVESTIGATION
 - DESIGN MAXIMUM PERIOD BEFORE RENDEZ-VOUS AT 90 DAYS
 - SUB-OPTIMAL USE OF PAXSAT FUEL FOR FIRST INVESTIGATION
 - REMOTE CONTROL REFUELING CAN EXTEND PAXSAT INVESTIGATIVE CAPABILITY
-

PAXSAT "A" PAYLOAD

- 0 VISIBLE IMAGING SYSTEM
 - 50 CM APERTURE
 - F/120 FOLDED OPTICS DESIGN
 - SPATIAL RESOLUTION OF 1 CM AT 10 KM RANGE

 - 0 THERMAL IMAGING SYSTEM
 - 5 K TEMPERATURE RESOLUTION IN MWIR (3-5 MICRON) BAND
 - F/20 DESIGN SHARING PRIMARY OPTICS OF VISIBLE SYSTEM
 - SPATIAL RESOLUTION OF 10 CM AT 10 KM RANGE
-

PAXSAT "A" PAYLOAD (CONT'D)

- 0 ELECTROMAGNETIC SUPPORT MEASURES SYSTEM
 - THREE STAGE RECEIVER DESIGN
 - FULL OPERATION FROM 350 MHZ TO 40 GHZ (UHF-EHF)

 - 0 SUPPLEMENTARY PAYLOADS
 - RADIATION: X & GAMMA RAY SPECTROMETERS
 - CHEMICAL: MASS SPECTROMETERS
-

PAXSAT "A" PAYLOAD SUPPORT SYSTEMS

0 SPACECRAFT SYSTEMS

- ND/YAG LASER DETECTION, ACQUISITION AND RANGING SYSTEM (LADAR) PROVIDES TARGET TRACKING FROM 50 KM TO CLOSE PROXIMITY
 - ON-BOARD COMPUTER ENABLES AUTONOMOUS CONTROL OF SPACECRAFT INCLUDING COLLISION AVOIDANCE MANOEUVRES
-

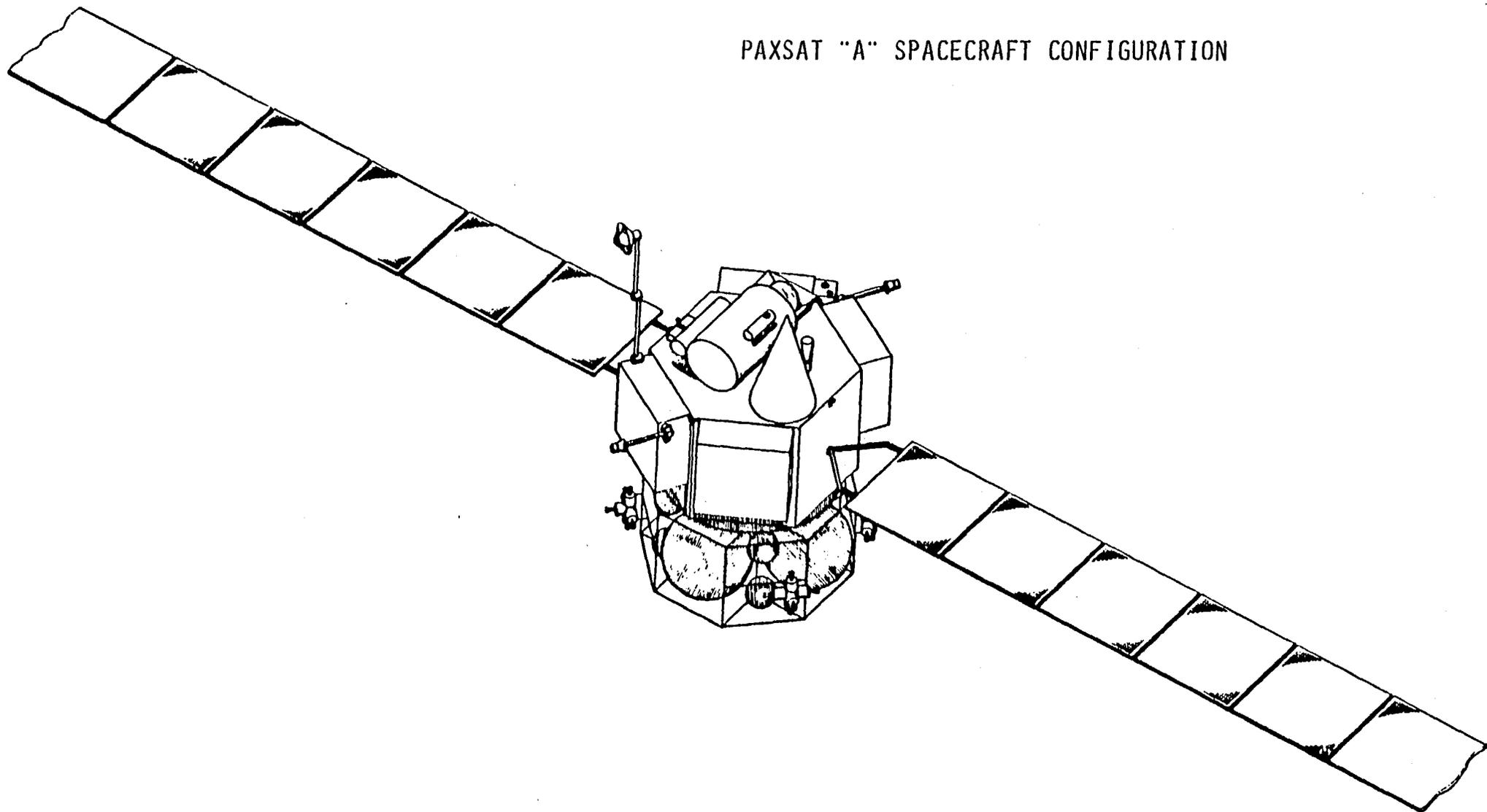
PAXSAT "A" PAYLOAD SUPPORT SYSTEMS (CONT'D)

0 SPACECRAFT SYSTEMS (CONT'D)

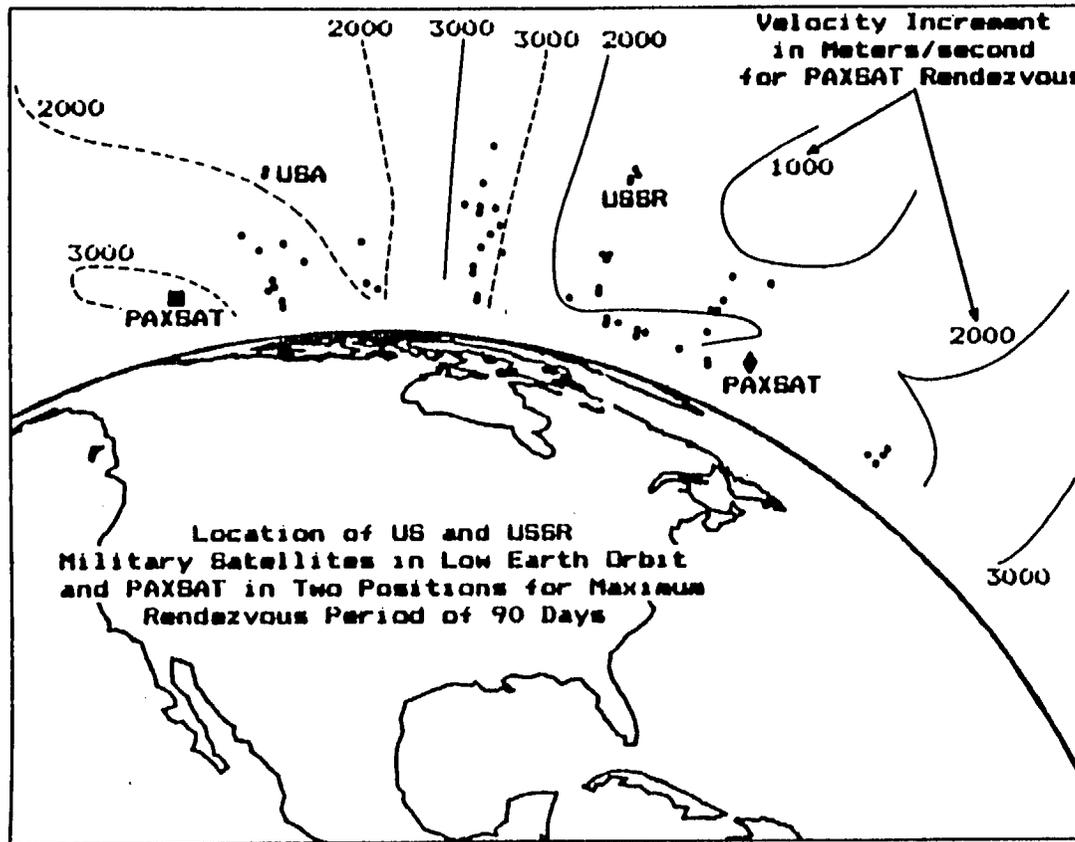
- COMMUNICATIONS & DATA HANDLING SYSTEM
PROVIDES TELEMETRY & CONTROL FUNCTIONS
AND FORMATS RECORDED SENSOR DATA FOR
DOWNLINK DURING GROUND STATION PASSES

 - DISPOSABLE PROPULSION MODULE PERMITS
REMOTE CONTROL REFUELING
-

PAXSAT "A" SPACECRAFT CONFIGURATION



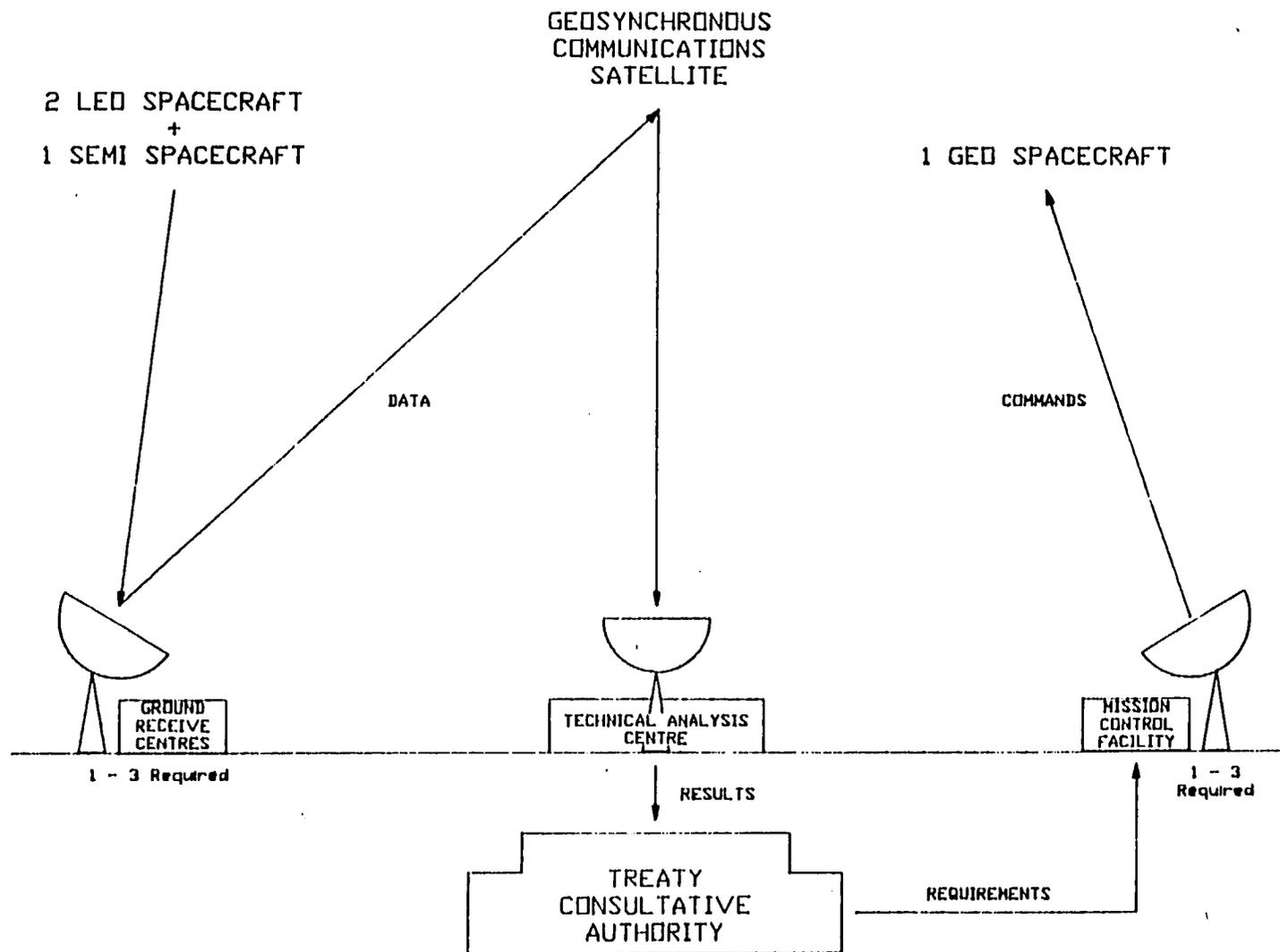
PAXSAT LOW EARTH ORBIT OPERATIONAL RANGE



PAXSAT "A" SUPPORT SYSTEMS

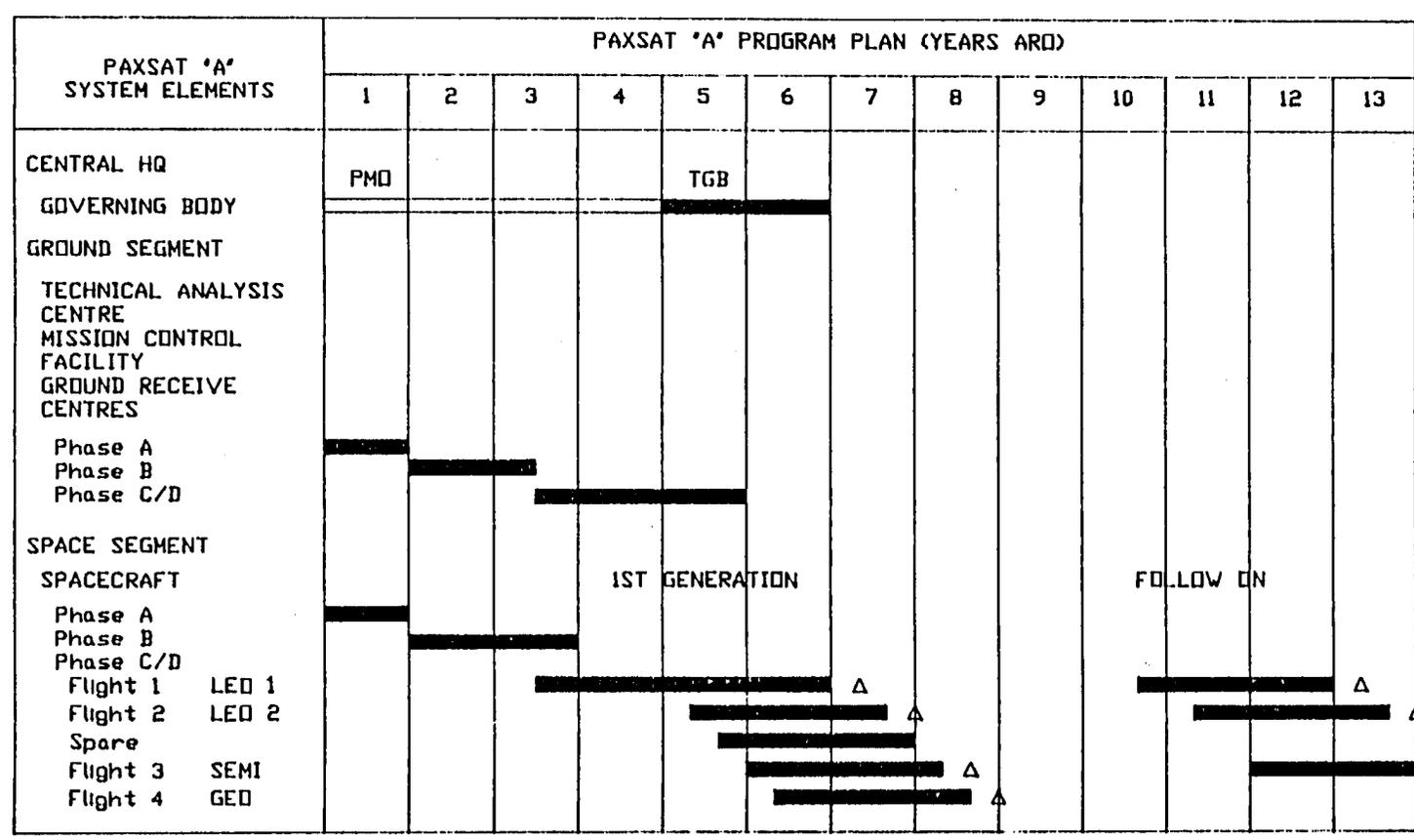
- 0 GROUND SYSTEMS
- ASSUMED AVAILABILITY OF ORBITAL DATA FOR TARGET AND SPACECRAFT
 - LOCAL DATA RECEIVE CENTRES AND COMMUNICATIONS CHANNELS MAY ALSO BE MADE AVAILABLE TO PAXSAT SPACECRAFT
 - ONE - THREE MISSION CONTROL FACILITIES CONTROL SPACECRAFT OPERATIONS
 - SINGLE TECHNICAL ANALYSIS CENTRE PROCESSES ALL SENSED DATA
 - TREATY SPECIFIC CONSULTATIVE AUTHORITY OVERSEES VERIFICATION & COMPLIANCE ISSUES
-

PAXSAT "A" SYSTEM CONFIGURATION

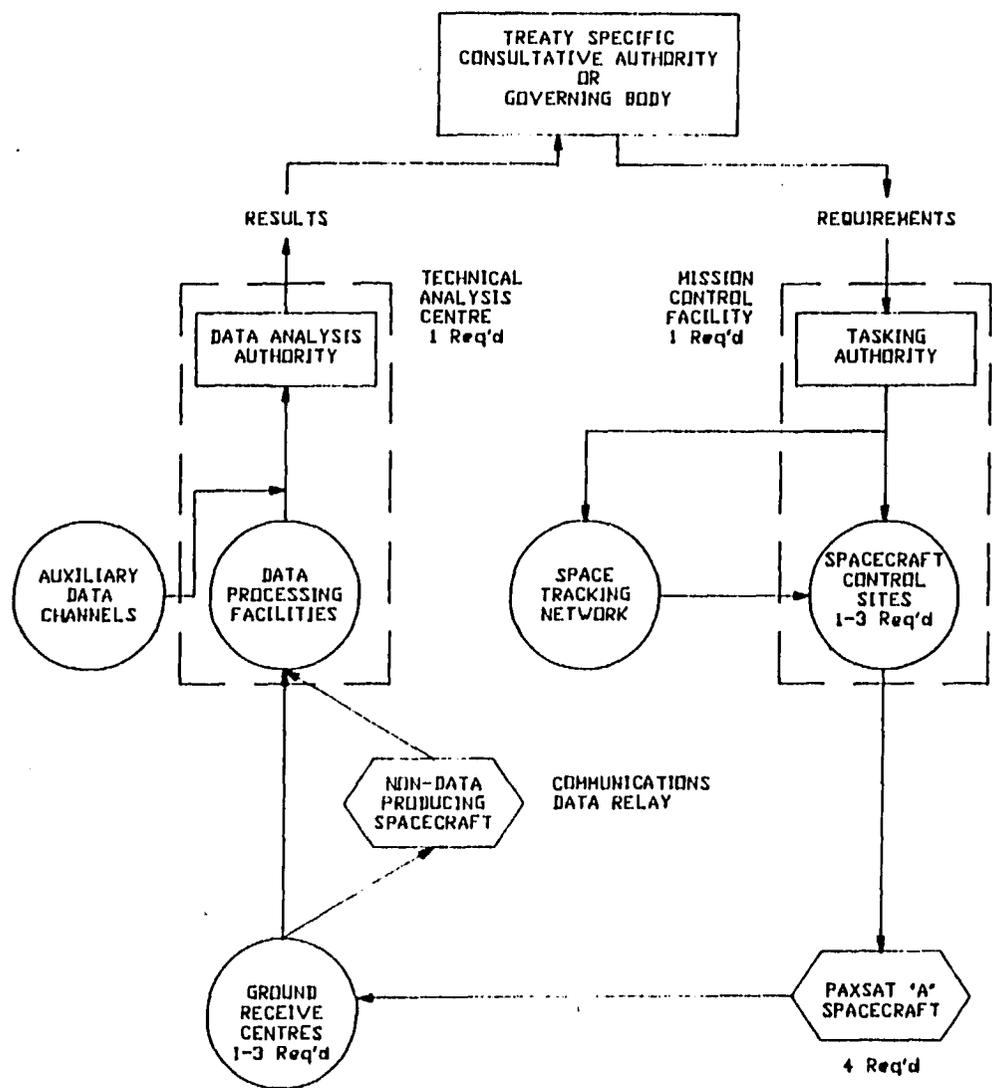




PAXSAT "A" PROGRAM PLAN



PAXSAT "A" DATA FLOW



TWO FUNDAMENTAL QUESTIONS ANSWERED

1. "CAN OBSERVATIONS OF AN OBJECT IN SPACE DETERMINE THE FUNCTION OF THE OBJECT - PARTICULARLY IN REFERENCE TO A WEAPONS SYSTEM ?"

PRELIMINARY STUDIES INDICATE A TENTATIVE "YES"

2. "WOULD THE OBSERVATIONAL REQUIREMENTS PERMIT A VIABLE SPACECRAFT DESIGN FOR THE OPERATIONAL MISSION ?"

PRELIMINARY STUDIES INDICATE A TENTATIVE "YES"

PAXSAT 'B'

PAXSAT "B" CONCEPT
FOR
ARMS CONTROL VERIFICATION
FROM
OUTER SPACE

THE PAXSAT "B" CONCEPT

CAN THE APPLICATION OF CIVILIAN SPACE-BASED
REMOTE SENSING TECHNOLOGY CONTRIBUTE TO THE
VERIFICATION OF CONVENTIONAL FORCES IN A
REGIONAL CONTEXT ?

PAXSAT "B" STUDY CONCLUSIONS

- 0 TREATY AGREEMENTS FOR CONVENTIONAL FORCES
IN EUROPE CAN BE ENVISAGED WHERE SPACE-
BASED ARMS CONTROL VERIFICATION CAN PLAY
AN IMPORTANT ROLE

 - 0 CURRENT OR PLANNED CIVILIAN REMOTE
SENSING SATELLITES POSSESS NEITHER THE
RESOLUTION NOR THE COVERAGE FREQUENCIES
SUFFICIENT TO MEET THE FULL ARMS CONTROL
VERIFICATION REQUIREMENTS

 - 0 ENHANCED REMOTE SENSING SATELLITES SUCH
AS RADARSAT COULD PROVIDE LOW RESOLUTION
OR "DETECTION" LEVEL DATA FOR POSSIBLE
USE IN A CONFIDENCE BUILDING CONTEXT BY
THE EARLY 1990'S
-

PAXSAT "B" STUDY CONCLUSIONS (CONT'D)

- 0 DEDICATED SENSORS AND PLATFORMS WOULD NEED TO BE DEVELOPED TO PERFORM THE FULL ARMS CONTROL VERIFICATION REQUIREMENTS IN A FORCE REDUCTION CONTEXT

 - 0 THE TECHNOLOGY BASE EXISTS IN NON-SUPERPOWER NATIONS FROM WHICH A FULLY CAPABLE PAXSAT "B" SYSTEM COULD BE DEVELOPED FOR THE MID - LATE 1990'S
-

EUROPEAN ARMS CONTROL ENVIRONMENT

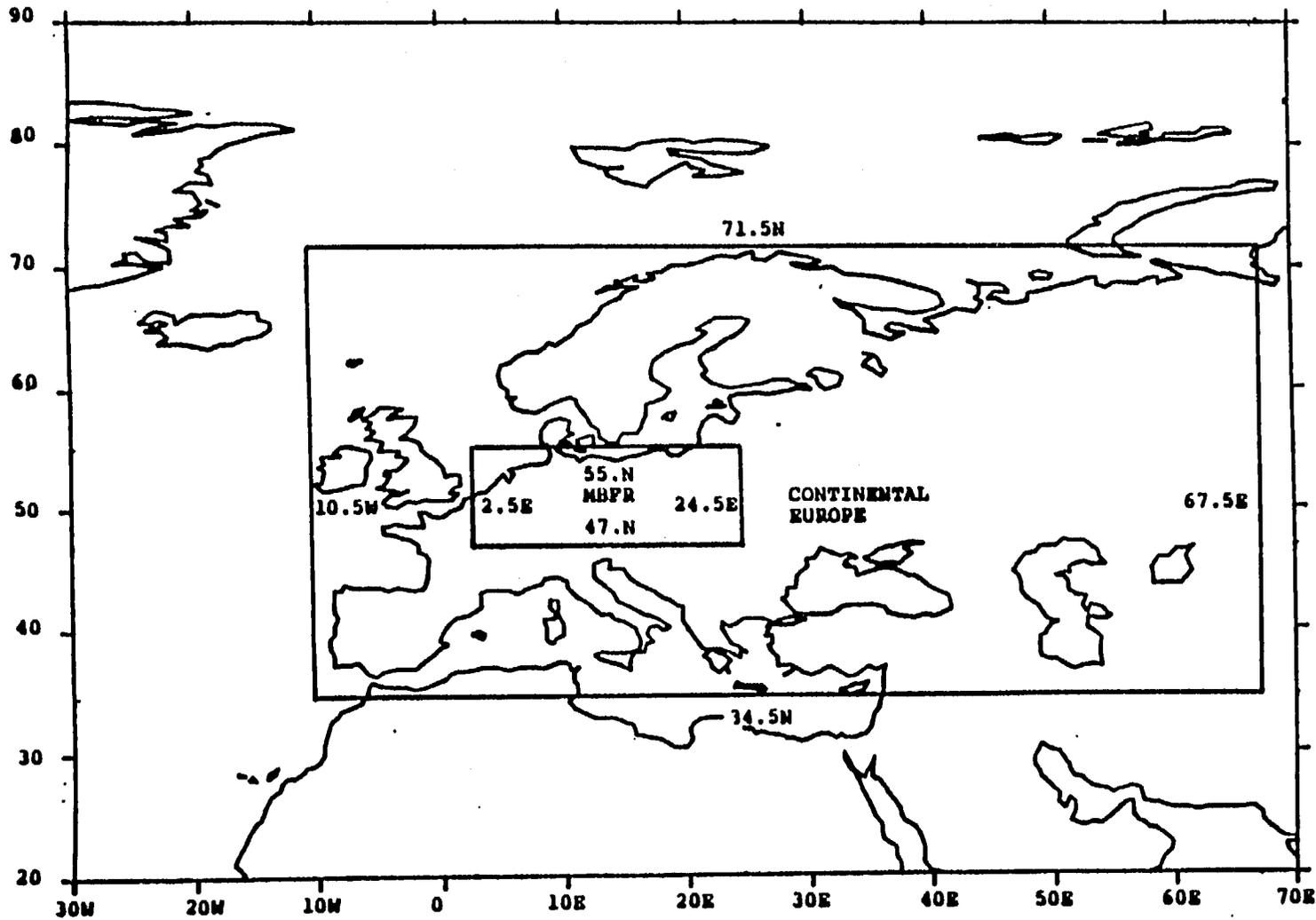
- 0 THERE EXIST TWO SIGNIFICANT ARMS CONTROL FORUMS CONCERNING CONVENTIONAL FORCES IN EUROPE :
 - CONFERENCE ON CONFIDENCE AND SECURITY BUILDING MEASURES AND DISARMAMENT IN EUROPE (CCSBMDE)
 - MUTUAL AND BALANCED FORCE REDUCTION TALKS (MBFR)

 - 0 AGREEMENTS IN EITHER REQUIRE VARIOUS FORMS OF VERIFICATION MEASURES AND SPACE-BASED VERIFICATION MEANS MAY FULFILL SOME OF THESE REQUIREMENTS
-

GENERAL VERIFICATION REQUIREMENTS

- 0 WIDE COVERAGE REGION
 - 0 TIMELY COVERAGE OF REGION
 - 0 ACCURATE DISCRIMINATION OF TARGETS
-

PAXSAT "B" REGIONAL REQUIREMENTS



PAXSAT "B" TEMPORAL REQUIREMENTS

- 0 CCSBMDE AGREEMENT DEMANDS 42 DAY NOTIFICATION PERIOD FOR MAJOR TROOP MOVEMENTS
 - 0 CURRENT MILITARY SURVEILLANCE TECHNIQUES CAN GIVE 48 HOUR NOTICE FOR "BOLT OUT OF THE BLUE" SURPRISE ATTACKS FROM FORWARD BASES
 - 0 PAXSAT "B" REQUIREMENT THEREFORE PLACES ABILITY TO SURVEY, OR ACCESS CONTINENTAL EUROPE EVERY 48 HOURS, AND ABILITY TO COVER OR MAP CONTINENTAL EUROPE EVERY MONTH
 - 0 PAXSAT "B" REQUIREMENT ALSO PLACES ABILITY TO ACCESS MBFR REGION EVERY 24 HOURS AND MAP MBFR EVERY WEEK
-

PAXSAT "B" TARGET REQUIREMENTS

- 0 TARGETS ARE CONVENTIONAL ARMED FORCES WITH AN EMPHASIS ON CONVENTIONAL LAND FORCES
- 0 CONVENTIONAL LAND FORCES ARE CHARACTERIZED BY ARMOURED DIVISIONS
- 0 POTENTIALLY MORE THREATENING AIRBORNE, AIR-MOBILE, AND AMPHIBIOUS FORCES ARE CHARACTERIZED BY BATTALIONS
- 0 PAXSAT "B" REQUIREMENTS CONSEQUENTLY REDUCE TO DISTINGUISHING AMONGST ARMOURED VEHICLES AND FORMATIONS
- 0 VERIFICATION OF TROOP LEVELS ARE DETERMINED FROM "FINGERPRINTS" OF VARIOUS MILITARY GROUPINGS

SPACE-BASED VERIFICATION SENSOR OPTIONS

1. SPACEBORNE RADARS
 - SYNTHETIC APERTURE RADAR (SAR)
 - REAL APERTURE RADAR (RAR)
 2. ELECTRO-OPTIC SENSORS
 - THERMAL INFRA-RED (IR)
 - VISIBLE & NEAR INFRA-RED (VIS)
 - COMBINED VIS & IR (VIR)
 3. ELECTRONIC SUPPORT MEASURES
 - ELECTRONIC INTELLIGENCE (ELINT)
-

RELATIVE MERITS OF SPACEBORNE VERIFICATION SENSORS

SPACEBORNE RADARS

ELECTRO-OPTICS

ELECTRONIC INTELLIGENCE

ADVANTAGES

- DAY/NIGHT
- FREQUENT ACCESS OF REGION
- ALL WEATHER

- DAY/NIGHT IR ONLY
- HIGH RESOLUTION IN VISIBLE
- IR CAMOUFLAGE IS DIFFICULT TO DO

- DAY/NIGHT
- LOCATION, ORDER & INTENT OF VIOLATION
- CONTINUOUS ACCESS
- ALL WEATHER

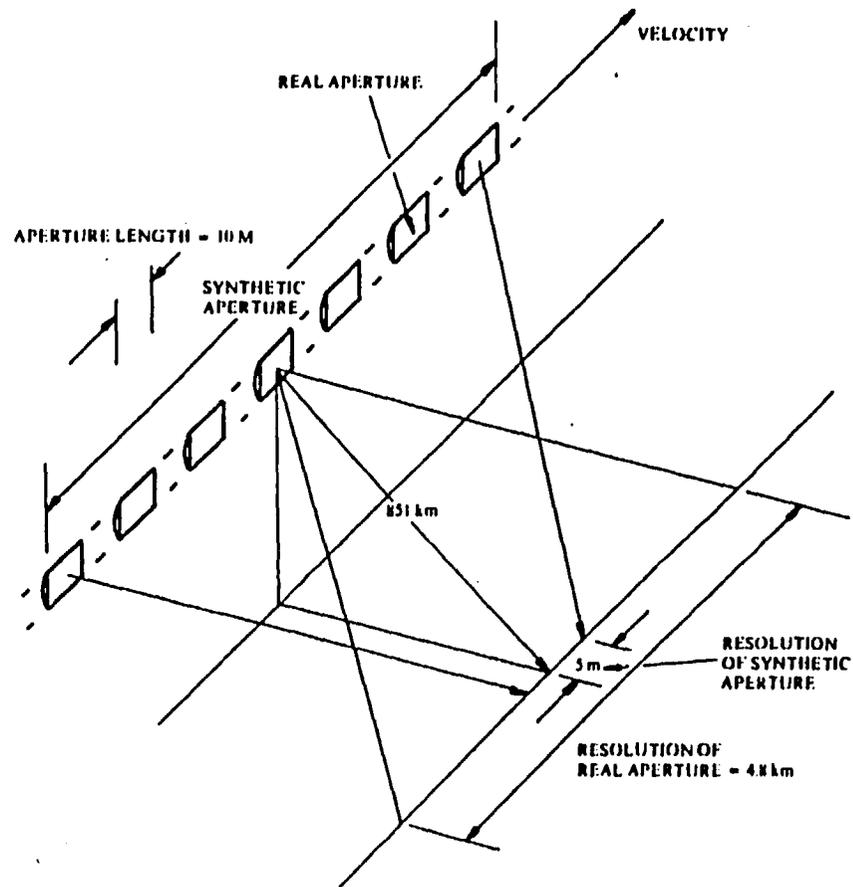
DISADVANTAGES

- DIFFICULT IMAGE PROCESSING
- DECOYS POSSIBLE

- FAIR WEATHER ONLY
- DAY ONLY IN VISIBLE
- VISIBLE CAMOUFLAGE IS EASY TO DO
- LIMITED ACCESS

- SIGNIFICANT WAR FIGHTING THREAT
- TECHNOLOGICALLY DIFFICULT
- SUSCEPTIBLE TO COUNTER MEASURES

THE SYNTHETIC APERTURE RADAR PRINCIPLE



SEASAT SAR

CHESAPEAKE BAY BRIDGE
ORBIT 133° SEP 28, 1978
25M RESOLUTION 4 LOOKS
SATELLITE HEADING 334.10 DEG



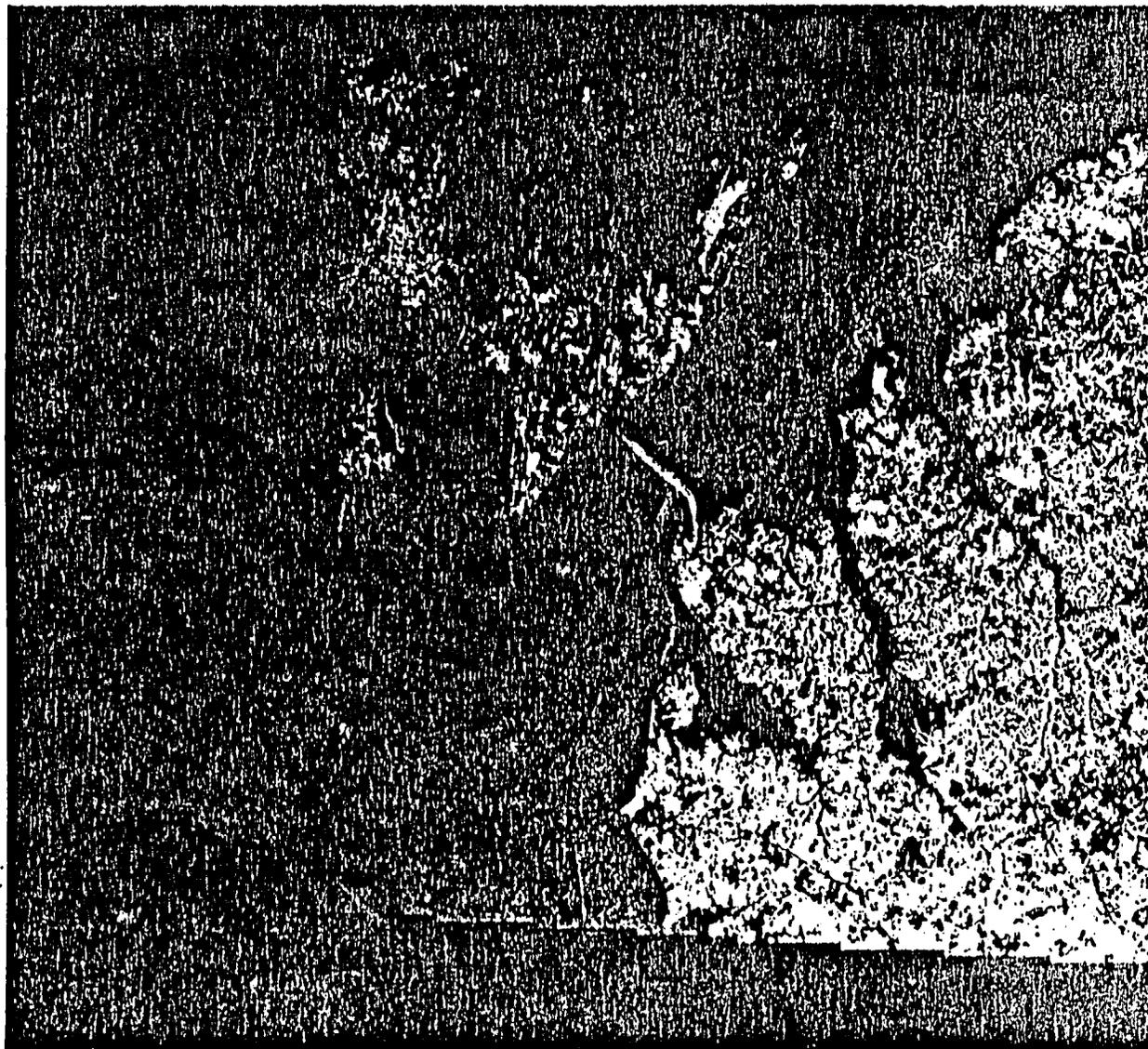
SCALE 1:250000

FRAME CENTRE

39 1 51 W

76 21 1 W

GROUND RANGE



ACIMUTH



CANADA SURVEY PROJECT

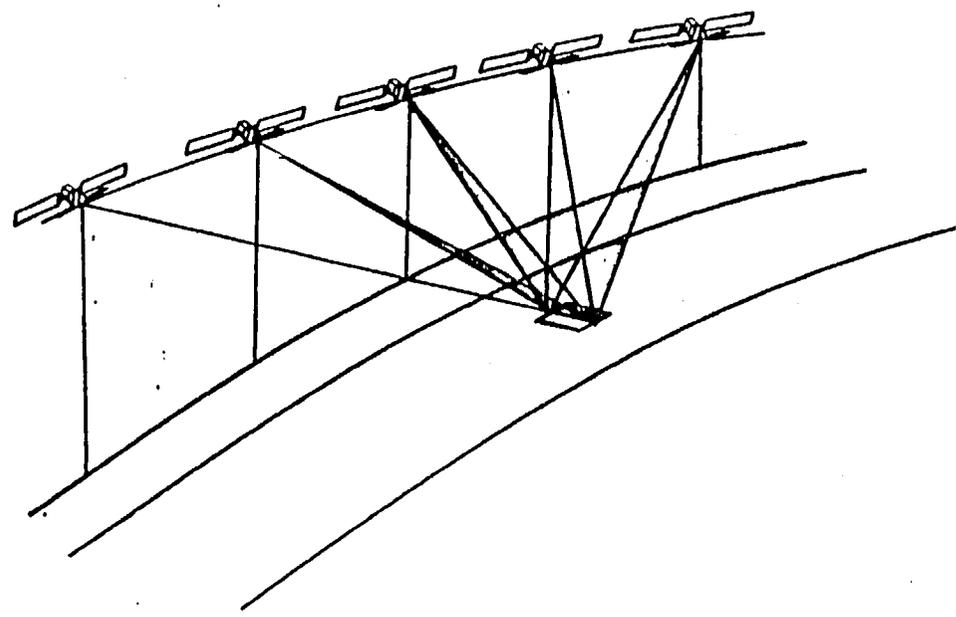
PHOTO CREDIT
MDA

TARGET RECOGNITION IN SAR IMAGES

- 0 LOW RESOLUTION
 - MEASURE TARGET RADAR CROSS SECTION AS A FUNCTION OF ASPECT ANGLE
 - CORRELATE MEASURED FLUCTUATIONS WITH THOSE OF KNOWN TARGETS

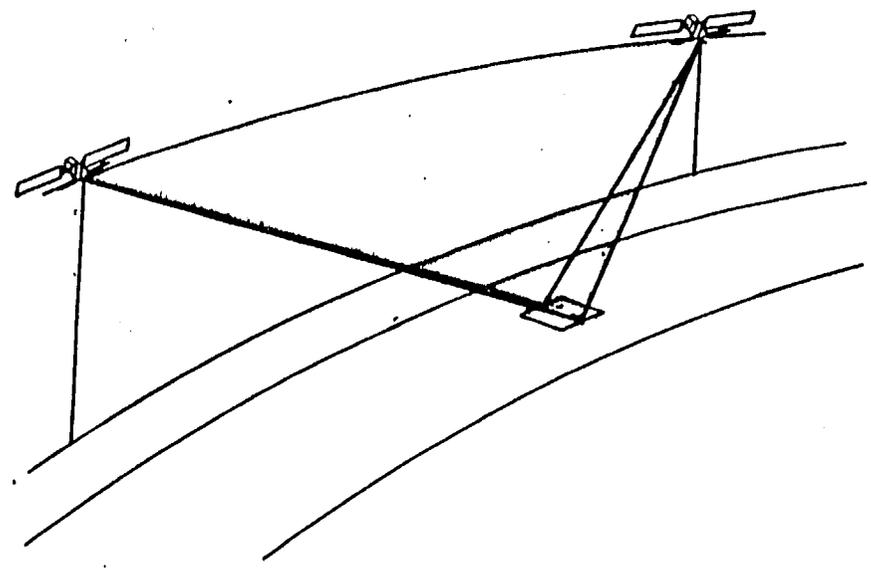
 - 0 HIGH RESOLUTION
 - OBTAIN HIGH RESOLUTION IMAGERY
 - CORRELATE WITH KNOWN TARGET CHARACTERISTICS
-

MULTI-VIEW AND SPOTLIGHT IMAGING



MULTI-VIEW

SPOTLIGHT



SPACEBORNE SYNTHETIC APERTURE RADAR
CAPABILITIES

- 0 TYPICAL RESOLUTION OF CURRENT AND PROPOSED SPACEBORNE SAR IS 30 M X 30 M FOR A FOUR-LOOK IMAGE, OR APPROXIMATELY 30 M X 10 M FOR A SINGLE-LOOK IMAGE
 - 0 CANADIAN RADARSAT MISSION HAS GREATEST SAR BEAM SELECTION ABILITY THEREBY ENABLING FREQUENT VIEWING OF INTERESTED REGIONS
 - 0 US SHUTTLE IMAGING RADAR PROGRAM WILL EXPERIMENT WITH MULTI-FREQUENCY AND POLARIZATION IMAGES
-

JOHNSON RESOLUTION REQUIREMENTS

- 0 WELL KNOWN "RULE OF THUMB" DEFINING RESOLUTION REQUIREMENTS FOR THE PERFORMANCE OF PHOTO-INTERPRETATION TASKS
- 0 RESOLUTION IS DEFINED IN TERMS OF BLACK & WHITE LINE PAIRS ACROSS THE TARGET
- 0 FOUR PHOTO-INTERPRETATION TASKS REQUIRE INCREASING NUMBER OF RESOLUTION LINE PAIRS

DETECTION	1 LINE PAIR
CLASSIFICATION	2 LINE PAIRS
RECOGNITION	4 LINE PAIRS
IDENTIFICATION	8 LINE PAIRS

ILLUSTRATION OF JOHNSON CRITERIA WITH A TANK
AS AN EXAMPLE VEHICLE



CLASSIFICATION
- TANK-LIKE VEHICLE



RECOGNITION
- TANK



IDENTIFICATION
- T-62 TANK

PHOTO CREDIT
SCIENTIFIC AMERICAN

VISIBLE TARGET DETECTION & RECOGNITION

- 0 TARGET DETECTION IS LARGELY DEPENDENT UPON THE CONTRAST OF THE TARGET WITH RESPECT TO THE BACKGROUND
- 0 CAMOUFLAGE MAY FOIL DETECTION ABILITY
- 0 SHADOWS INCREASE DETECTION ABILITY
- 0 PIXEL RESOLUTION REQUIREMENTS FOR A TYPICAL TANK ARE:

DETECTION	1.50 M
CLASSIFICATION	0.75 M
RECOGNITION	0.38 M
IDENTIFICATION	0.19 M
- 0 CONTEXTUAL INFORMATION MAY ENHANCE RECOGNITION EFFORTS AT LOWER RESOLUTIONS

SOVIET AIRCRAFT CARRIER UNDER CONSTRUCTION AS
PHOTOGRAPHED BY US DIGITAL RECONNAISSANCE
SATELLITE

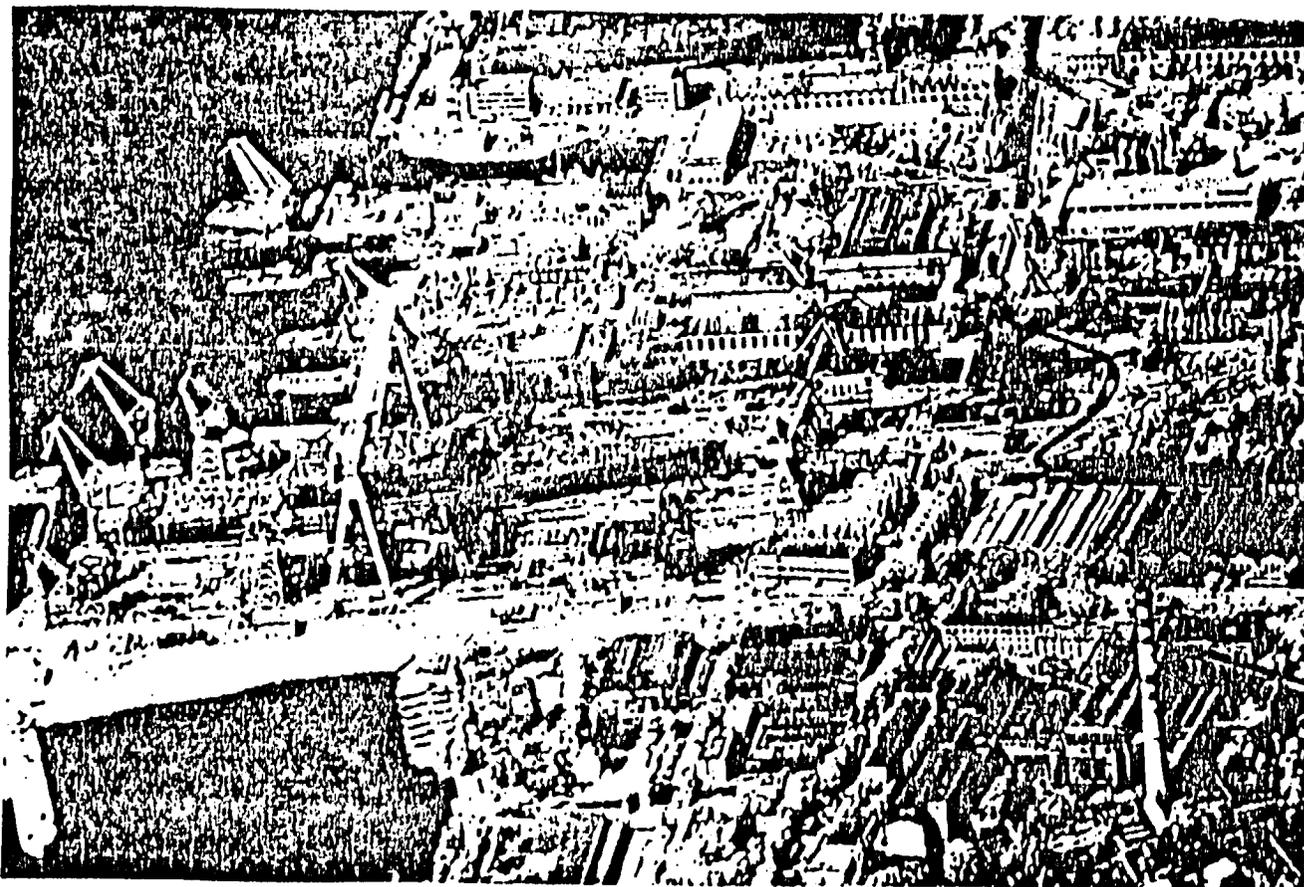


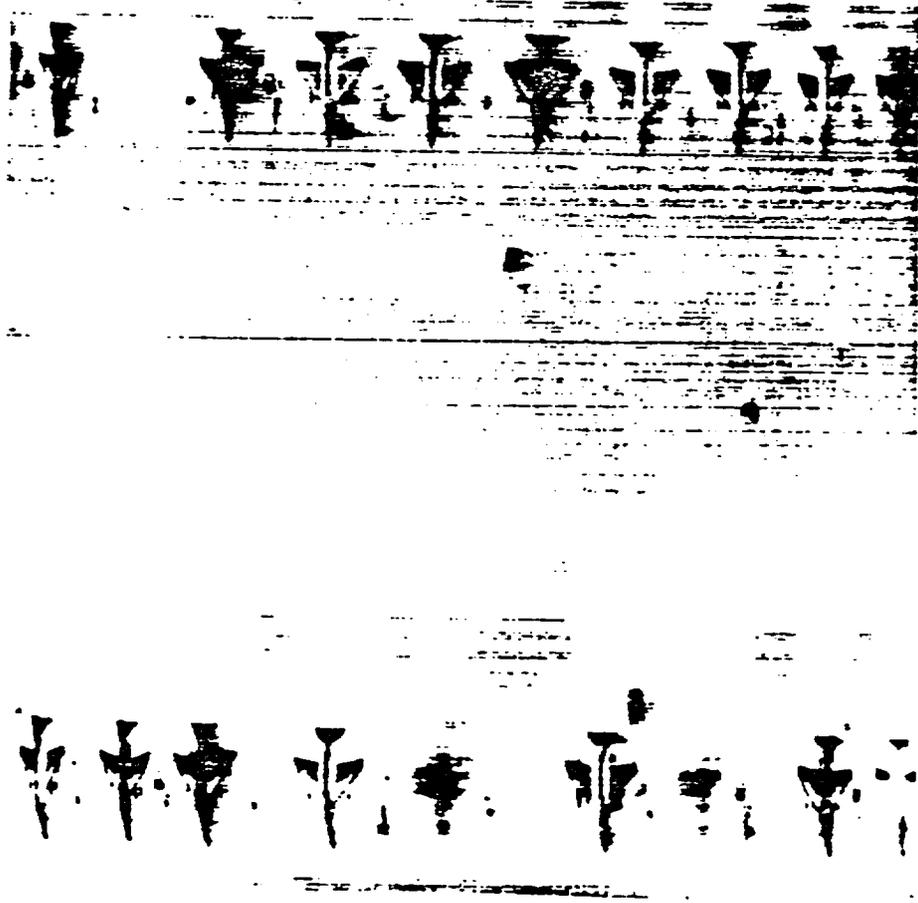
PHOTO CREDIT
SCIENTIFIC AMERICAN

INFRA-RED TARGET DETECTION & RECOGNITION

- 0 TARGET DETECTION IS DEPENDENT UPON THE TEMPERATURE DIFFERENCE OF THE TARGET AND ITS BACKGROUND
 - 0 MAXIMUM TEMPERATURE DIFFERENCE FOR TANKS OCCURS DURING MID-AFTERNOON
 - 0 MEAN TEMPERATURE DIFFERENCE OF A TANK ON A GRASS FIELD IS 6 °C
 - 0 PIXEL RESOLUTION REQUIREMENTS FOR A TANK ARE:

DETECTION	1.50 M
CLASSIFICATION	0.75 M
RECOGNITION	0.38 M
IDENTIFICATION	0.19 M
 - 0 CAMOUFLAGE RESISTANT DETECTION
-

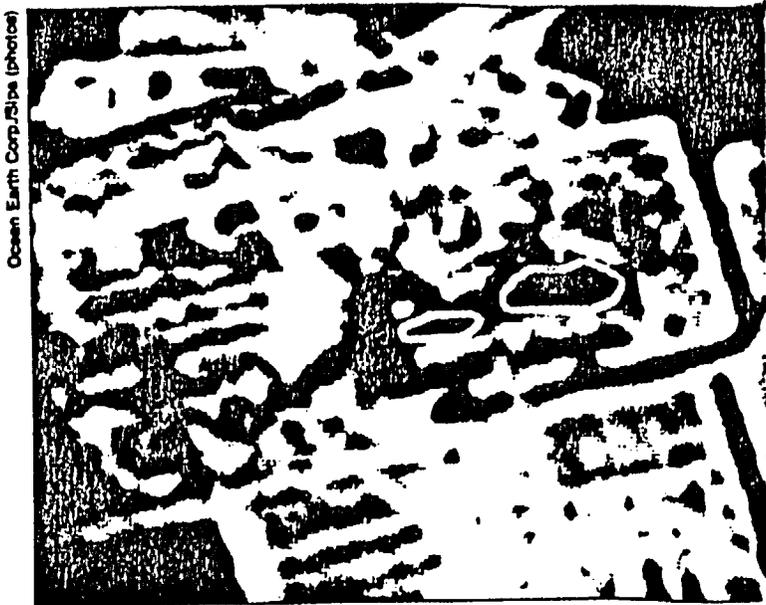
ROYAL AIR FORCE F-4 FIGHTERS IMAGED BY STABILEYE RPV
WITH REAL-TIME IR LINESCAN SENSOR



SPACE-BASED ELECTRO-OPTIC SENSOR CAPABILITIES

- 0 BEST CURRENT & PROPOSED CIVILIAN REMOTE SENSING SATELLITE IN THE VISIBLE BAND IS THE FRENCH SPOT SYSTEM
 - 0 SPOT'S RESOLUTION IN THE VISIBLE BAND IS 20 M (COLOUR) AND 10 M (PANCHROMATIC)
 - 0 BEST CURRENT & PROPOSED CIVILIAN REMOTE SENSING SATELLITE IN THE THERMAL INFRA-RED BAND IS THE US LANDSAT D SYSTEM
 - 0 LANDSAT D'S RESOLUTION IN THE THERMAL INFRA-RED BAND IS 120 M
-

THEMATIC MAPPER IMAGE OF CHERNOBYL NUCLEAR POWER PLANT



COVERAGE PERFORMANCE OF CIVILIAN REMOTE
SENSING SATELLITES

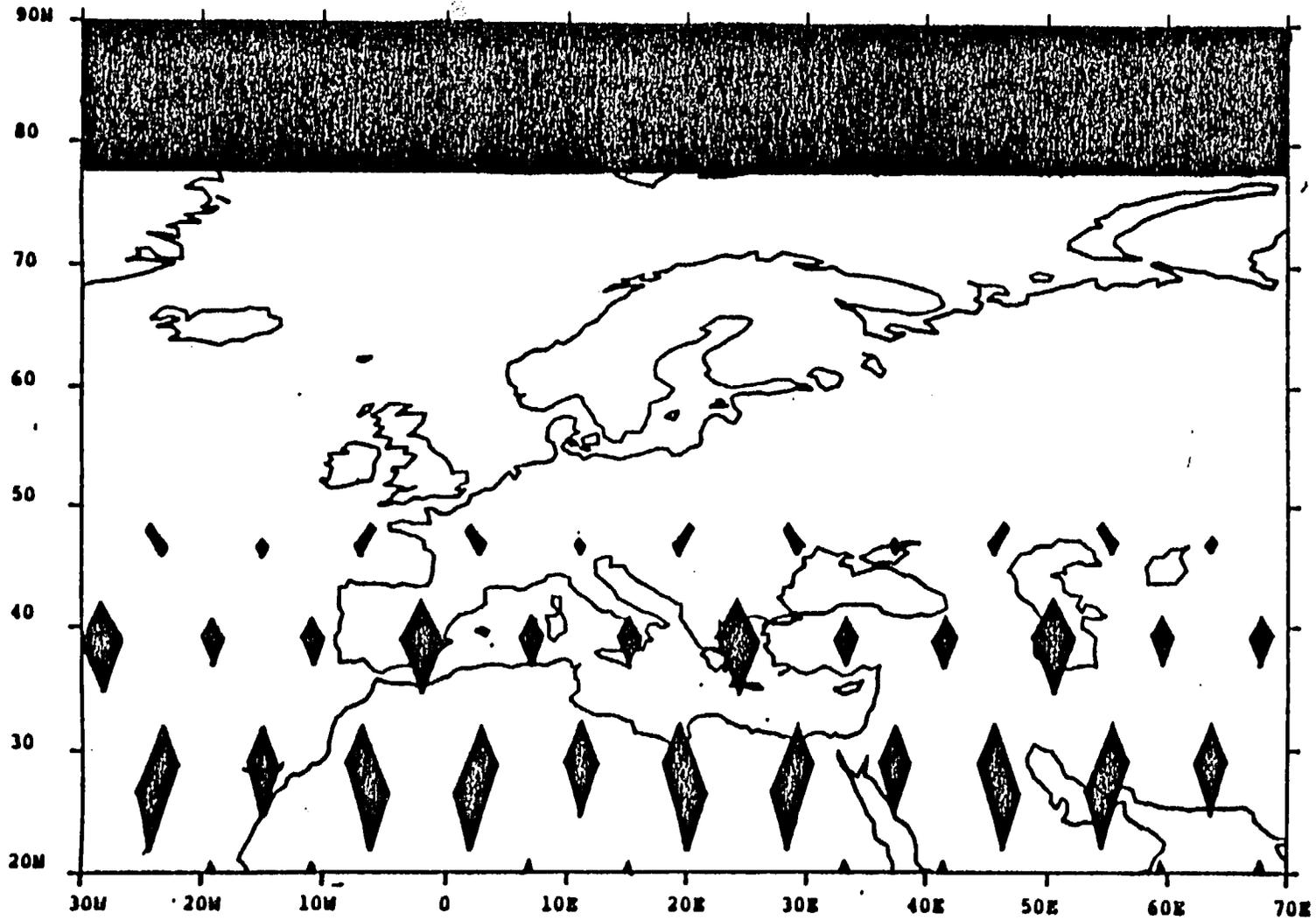
- 0 BEST COVERAGE PERFORMANCE OF EUROPE BY A
SAR SPACECRAFT IS THE CANADIAN RADARSAT
MISSION WITH:

	ACCESS	MAPPING
MBFR	3 DAYS	16 DAYS
CONTINENT	4 DAYS	16 DAYS

- 0 BEST COVERAGE PERFORMANCE OF EUROPE BY AN
ELECTRO-OPTIC SPACECRAFT IS THE FRENCH
SPOT MISSION WITH:

	ACCESS	MAPPING
MBFR	3 DAYS	26 DAYS
CONTINENT	7 DAYS	26 DAYS

3-DAY ACCESSIBILITY FOR THE RADARSAT SAR



CIVILIAN REMOTE SENSING SATELLITES SUITABILITY
TO PAXSAT "B" REQUIREMENTS

0 SITUATION:

- CURRENT OR PLANNED CIVILIAN REMOTE SENSING SATELLITES HAVE INSUFFICIENT RESOLUTION PERFORMANCE FOR FULL PAXSAT "B" REQUIREMENTS

 - COVERAGE FREQUENCIES OF MOST SATELLITES ARE ALSO INSUFFICIENT FOR FULL PAXSAT "B" REQUIREMENTS
-

CIVILIAN REMOTE SENSING SATELLITES SUITABILITY
TO PAXSAT "B" REQUIREMENTS (CONT'D)

0 CONCLUSION:

- DEDICATED PAXSAT "B" SENSORS AND
PLATFORMS ARE REQUIRED TO MEET FULL
VERIFICATION REQUIREMENTS

 - CIVILIAN SATELLITES CAN HOWEVER
PROVIDE USEFUL INFORMATION FOR THE
PAXSAT "B" MISSION
-

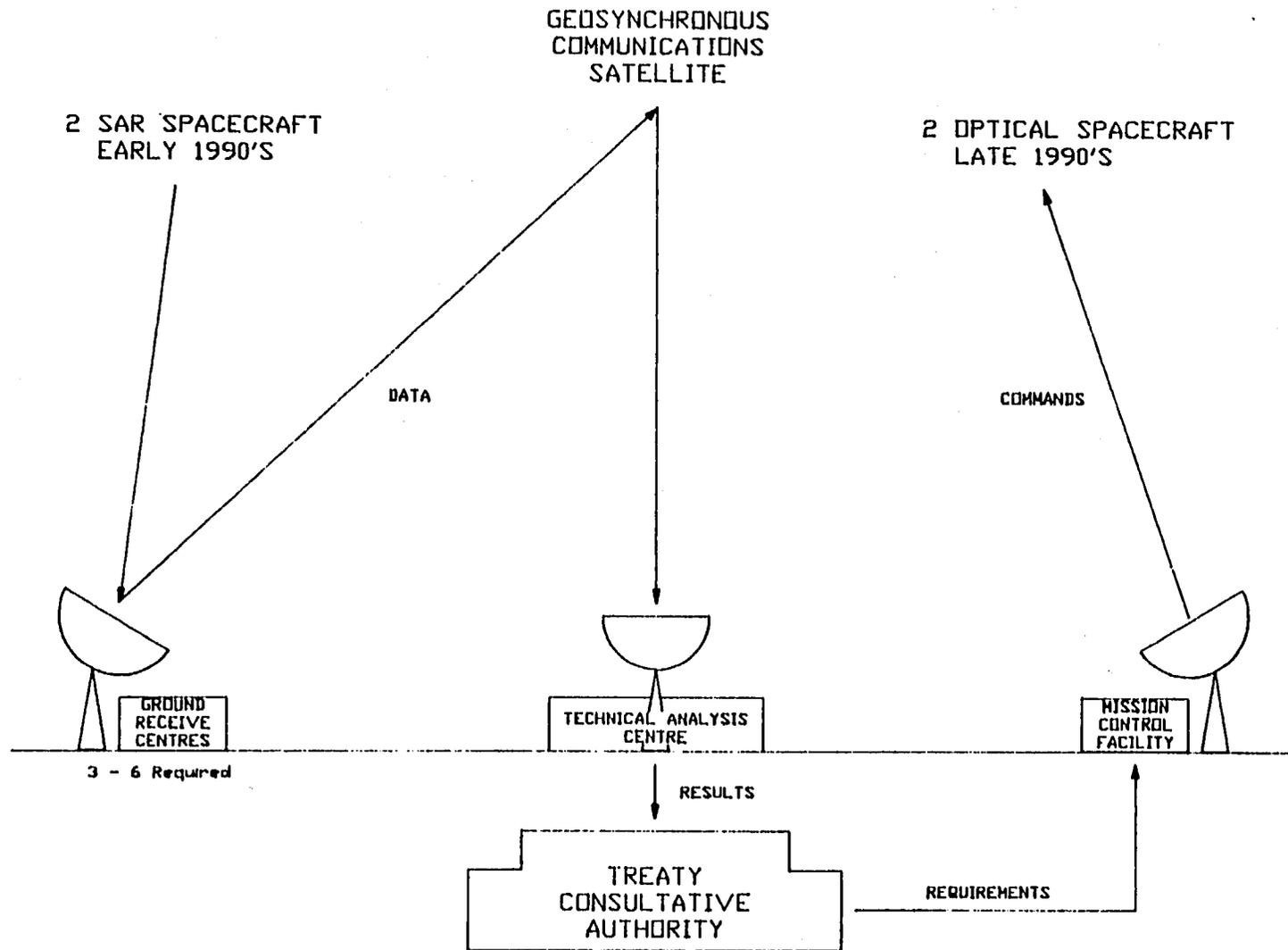
IMAGING CAPABILITIES OF SAR SENSORS

RADARSAT (1992)	ENHANCED RADARSAT (EARLY 1990'S)	PAXSAT "B" (MID - LATE 1990'S)
WIDE ACCESSIBILITY CHOICE OF LOOK ANGLES	WIDE ACCESSIBILITY CHOICE OF LOOK ANGLES	WIDE ACCESSIBILITY CHOICE OF LOOK ANGLES
	+ SCANSAR OPERATIONS FINER RESOLUTION (\approx 7 M)	+ SCANSAR OPERATIONS FINER RESOLUTION (\approx 1 M)
		+ SPOTLIGHT OPERATIONS AZIMUTH MULTIPLE VIEWS
		+ OPTIONS: DUAL-SIDED VIEWING DUAL-POLARIZATION MULTI-FREQUENCY
GOOD DETECTION POSSIBLE CCSBMDE APPLICATION	VERY GOOD DETECTION CCSBMDE APPLICATION	POSSIBLE RECOGNITION MBFR & CCSBMDE APPLICATION

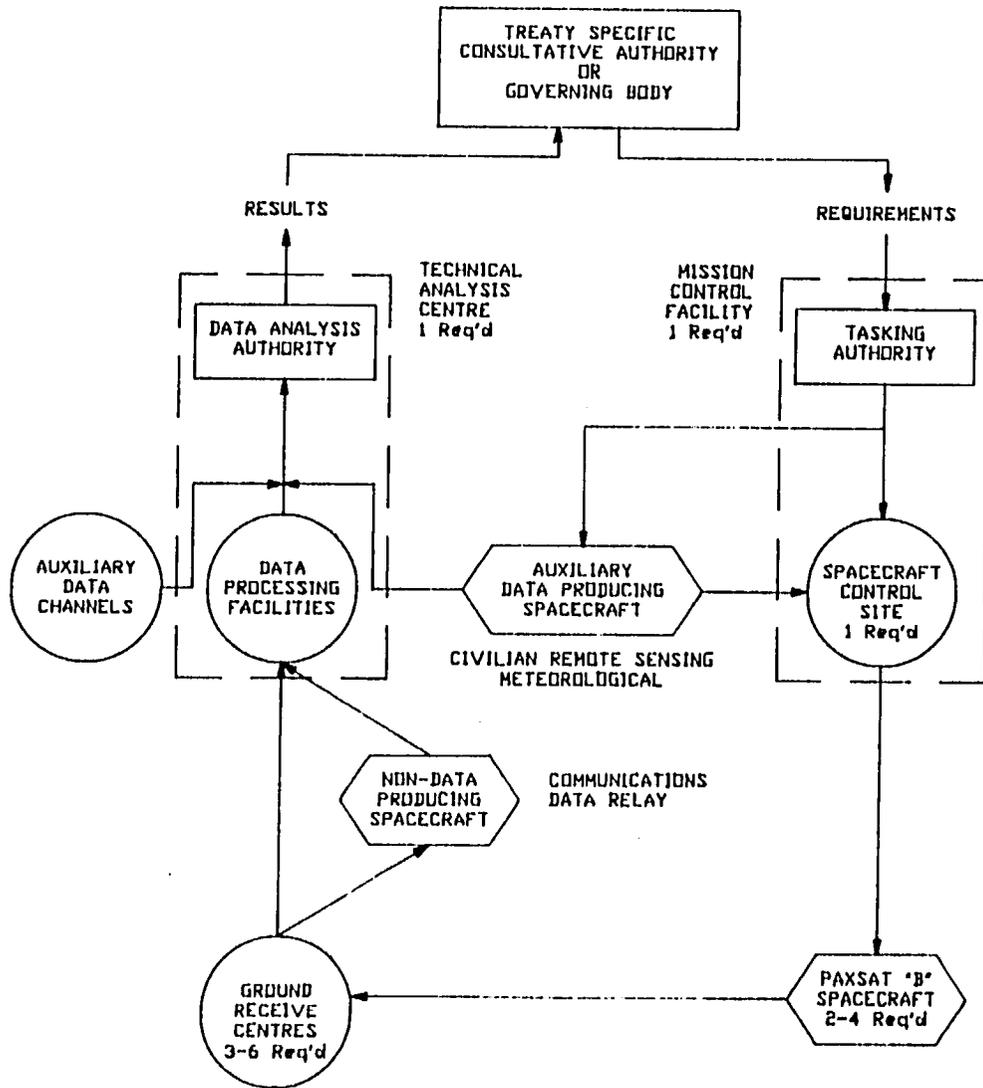
FIRST GENERATION PAXSAT "B" SYSTEM
CONFIGURATION (EARLY 1990'S)

- 0 TWO ENHANCED SYNTHETIC APERTURE RADAR
SATELLITES IN A HIGH ORBIT (\approx 800 KM)
PROVIDE ACCESSIBILITY OF EUROPE EVERY 1.5
DAYS AND MAPPED COVERAGE EVERY 8 DAYS
 - 0 TWO OPTICAL SATELLITES IN LOW EARTH ORBIT
(\approx 300 KM) PROVIDES ACCESSIBILITY OF
EUROPE EVERY 3.5 DAYS AND FULL COVERAGE
EVERY 105 DAYS
 - 0 THREE TO SIX REGIONALLY DISTRIBUTED
RECEIVE GROUND STATIONS PERMIT REAL-TIME
DATA TRANSMISSION
 - 0 CENTRAL TECHNICAL ANALYSIS CENTRE
PROCESSES DATA WITH A 36 HOUR TURNAROUND
 - 0 TREATY SPECIFIC CONSULTATIVE AUTHORITY
OVERSEES VERIFICATION & COMPLIANCE
ISSUES
-

FIRST GENERATION PAXSAT "B" SYSTEM CONFIGURATION



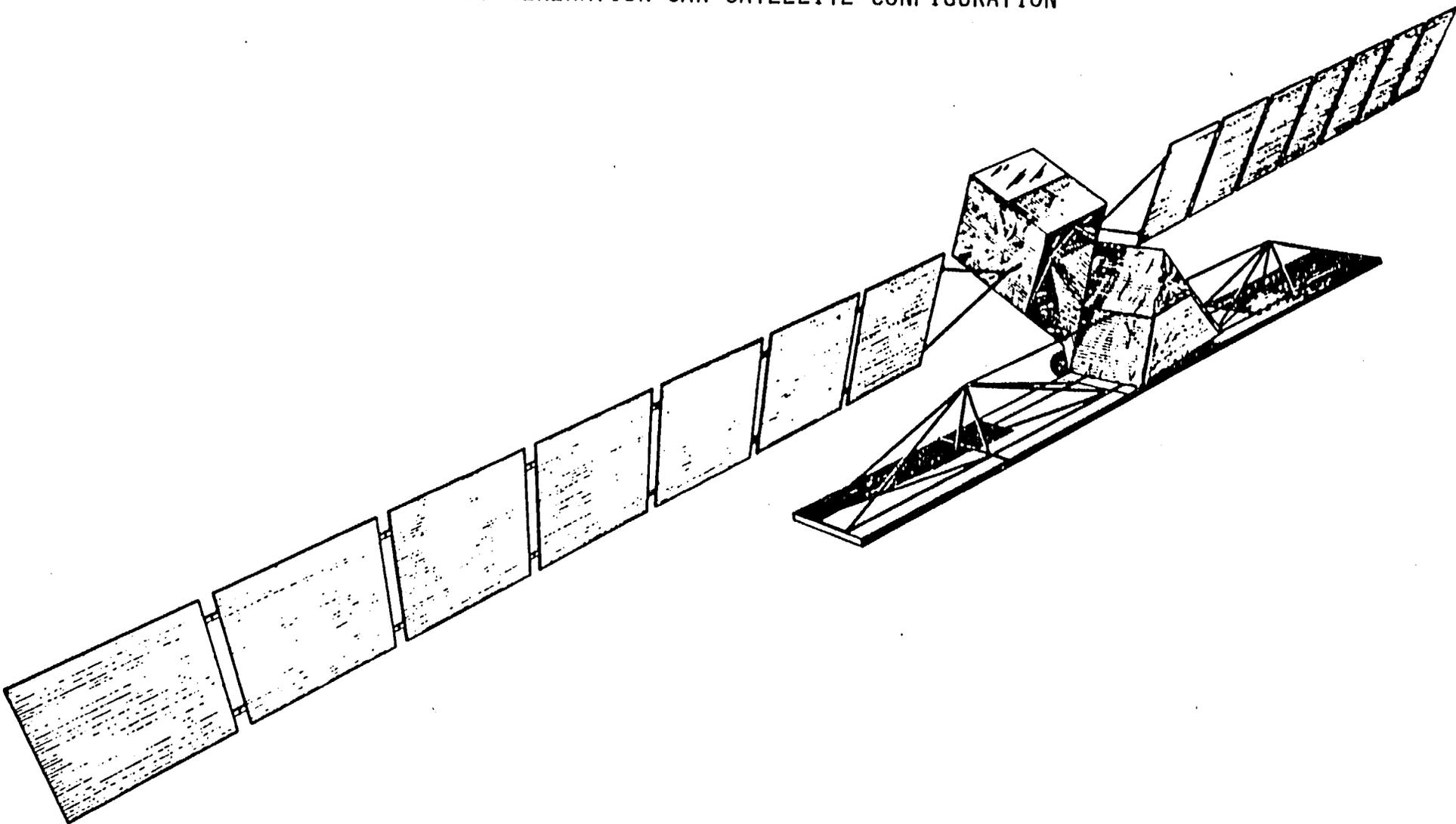
PAXSAT "B" DATA FLOW



PAXSAT "B" SAR SATELLITE CHARACTERISTICS
(EARLY 1990'S)

- 0 ENHANCED SAR SPACECRAFT GIVES
APPROXIMATELY A 7 M RESOLUTION SUITABLE
FOR THE DETECTION OF TANK-LIKE OBJECTS
 - 0 VARIABLE SAR BEAMS PERMITS FREQUENT
ACCESSIBILITY OF CONTINENTAL EUROPE
(= 1.5 DAYS)
 - 0 LARGE SWATH WIDTH ENABLES FREQUENT
MAPPING OF CONTINENTAL EUROPE
(= 8 DAYS)
 - 0 CAN PROVIDE TARGET TRAFFIC ANALYSIS
CAPABILITY WHICH COULD BE USED IN A
CCSBMDE CONTEXT TO TRIGGER INSPECTION
MEASURES
-

FIRST GENERATION SAR SATELLITE CONFIGURATION



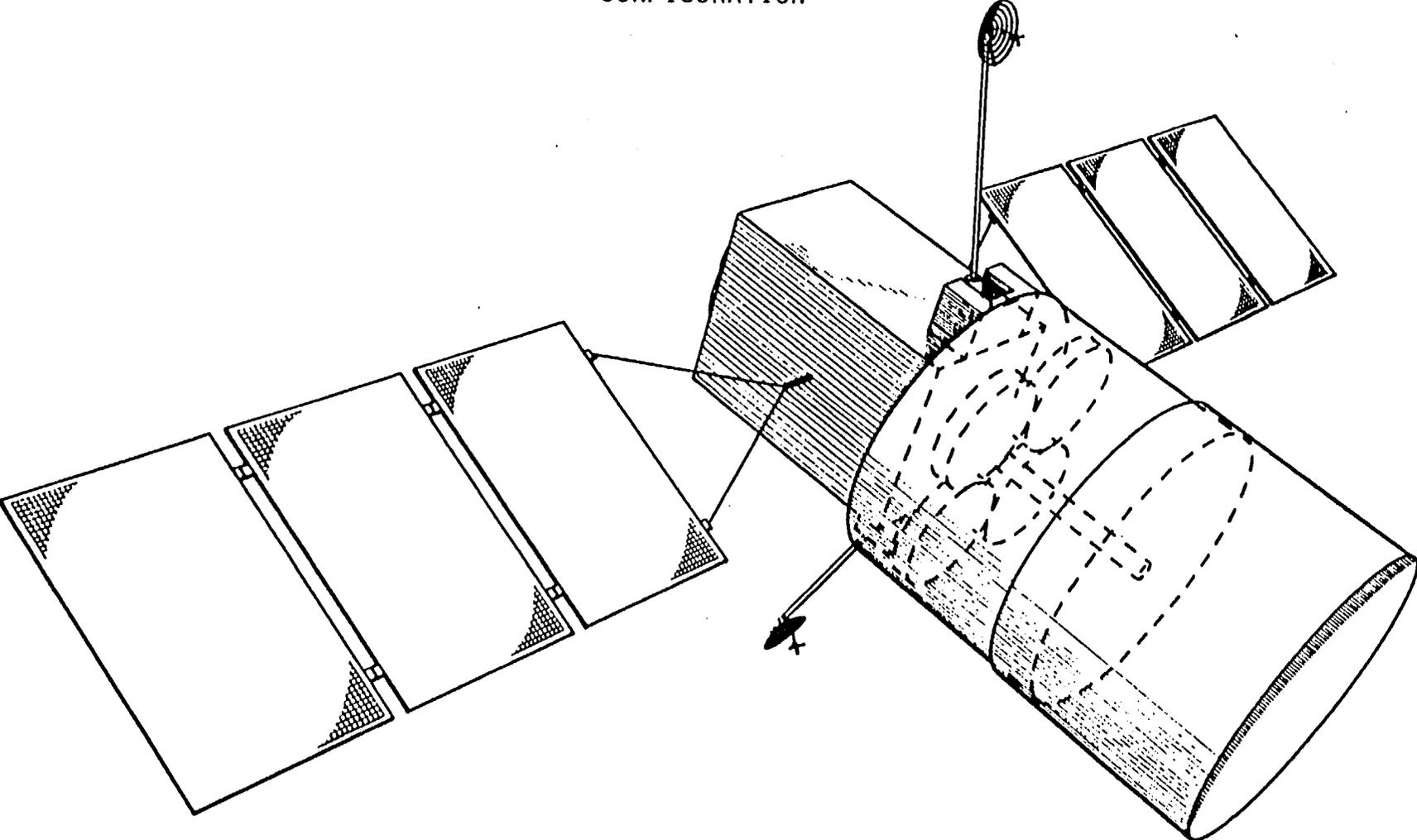
PAXSAT "B" OPTICAL SATELLITE CHARACTERISTICS
(MID - LATE 1990'S)

- 0 THERMAL IR RESOLUTION IS SUFFICIENT FOR THE DETECTION OF TANK-SIZED OBJECTS (\approx 1.5 M) AND THE HIGH VISIBLE RESOLUTION (\approx 35 CM) PROVIDES A RECOGNITION CAPABILITY

 - 0 OFF-NADIR LOOKING CAPABILITY PERMITS FREQUENT ACCESSIBILITY OF EUROPE (\approx 3.5 DAYS) WHILE SMALL FIELD-OF-VIEW IMPLIES LONG TERM MAPPING CAPABILITY FOR EUROPE (\approx 105 DAYS)

 - 0 CAN PROVIDE FAIR WEATHER RECOGNITION CAPABILITY SUITABLE FOR A FORCE REDUCTION APPLICATION
-

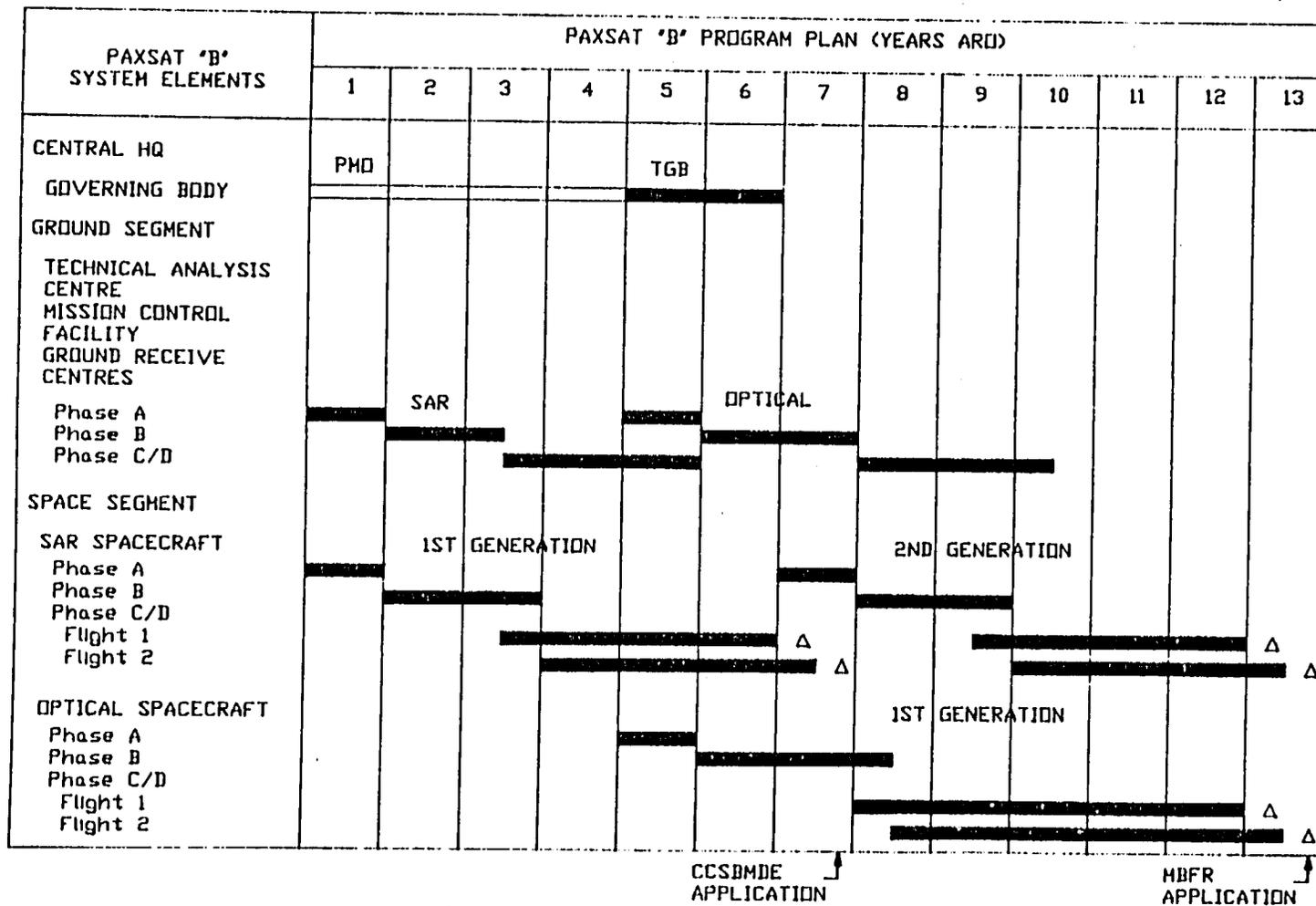
FIRST GENERATION OPTICAL SATELLITE
CONFIGURATION



FOLLOW-ON PAXSAT "B" SATELLITE CHARACTERISTICS
(MID - LATE 1990'S)

- 0 ENHANCED SAR PAYLOAD PROVIDES ALONG TRACK
SCANNING CAPABILITIES WHICH PERMITS
 - HIGH RESOLUTION (≈ 1 M) IMAGING OVER
A LIMITED AREA
 - MULTIPLE IMAGES OF SAME REGION TAKEN
FROM DIFFERING VIEWPOINTS
 - 0 MAY ENABLE ALL WEATHER RECOGNITION OF
TARGETS EITHER THROUGH HIGH RESOLUTION
IMAGERY OR THROUGH CHARACTERISTIC ANGULAR
VARIATIONS OF TARGET RADAR CROSS
SECTIONS
 - 0 FURTHER SAR OPTIONS INCLUDE
 - DUAL-POLARIZATION IMAGING
 - DUAL-FREQUENCY IMAGING
 - DUAL-SIDED IMAGING
-

PAXSAT "B" PROGRAM PLAN



PAXSAT "B" STUDY CONCLUSIONS

- 0 TREATY AGREEMENTS FOR CONVENTIONAL FORCES IN EUROPE CAN BE ENVISAGED WHERE SPACE-BASED ARMS CONTROL VERIFICATION CAN PLAY AN IMPORTANT ROLE
 - 0 CURRENT OR PLANNED CIVILIAN REMOTE SENSING SATELLITES POSSESS NEITHER THE RESOLUTION NOR THE COVERAGE FREQUENCIES SUFFICIENT TO MEET THE FULL ARMS CONTROL VERIFICATION REQUIREMENTS
 - 0 ENHANCED REMOTE SENSING SATELLITES SUCH AS RADARSAT COULD PROVIDE LOW RESOLUTION OR "DETECTION" LEVEL DATA FOR POSSIBLE USE IN A CONFIDENCE BUILDING CONTEXT BY THE EARLY 1990'S
-

PAXSAT "B" STUDY CONCLUSIONS (CONT'D)

- 0 DEDICATED SENSORS AND PLATFORMS WOULD NEED TO BE DEVELOPED TO PERFORM THE FULL ARMS CONTROL VERIFICATION REQUIREMENTS IN A FORCE REDUCTION CONTEXT
- 0 THE TECHNOLOGY BASE EXISTS IN NON-SUPERPOWER NATIONS FROM WHICH A FULLY CAPABLE PAXSAT "B" SYSTEM COULD BE DEVELOPED FOR THE MID - LATE 1990'S

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