NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

OAST SPACE THEME WORKSHOP

VOLUME II

(NASA-TM-80006) OAST SPACE THEME WORKSHOP. VOLUME 2: THEME SUMMARY. 5: GLOBAL SERVICE (NO. 11). A. STATEMENT. B. 26 APRIL 1976 PRESENTATION. C. SUMMARY (NASA) 45 p HC A03/MF A01 CSCL 22A G3/12

N79-15118

Unclas 42659

THEME SUMMARY

V. GLOBAL SERVICE (#11)

A. STATEMENT

B. APRIL 26, 1976, PRESENTATION

C. SUMMARY

HELD AT THE
LANGLEY RESEARCH CENTER
APRIL 26-30, 1976

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Foreword

The attached material represents the working papers from the OAST Space Theme Workshop held at the Langley Research Center, April 26-30, 1976, and contains a quick-look analysis of the proceedings. The material is unedited and intended for further use by the participants of the workshop and the planning elements of NASA concerned with space mission research and technology. It should be understood that the data do not represent official plans or positions but are part of the process of evolving such plans and positions.

Nearly 100 of the Agency's top technologists and scientists joined with another 35 theme specialists to produce this working document - a document that provides a technical foundation, including research and technology base candidates, for each of the six space themes.

The material in this report is considered essential to the development of Center initiatives in support of these themes. Copies of the report will be made available to the Center Management Board and the individuals at the Centers responsible for the FY'78 program planning cycle. The timing of this planning activity has caused us to distribute this document in this unedited form. Thus, it possibly contains errors, hopefully, more of a typographical rather than a technological nature. Nonetheless, the information contained is of a high professional level, reflecting the efforts of the workshop participants and will be invaluable to the planning and successful execution of the Agency's near- and far-term advanced technology program.

Stanley R. Sadin
OAST Space Theme Workshop
Chairman
NASA Headquarters
Study, Analysis, & Planning Office
Office of Aeronautics and
Space Technology

VOLUME II
V - A

Theme #11 - Global Service Systems

I Introduction

The focus of the Global Service Systems theme is on technology for spacecraft and space operations usually identified with the roles and missions of the Office of Applications. Because of the broad range of user-oriented activities covered by that Office's responsibilities, no attempt is made in this theme to establish a single mission as a model or standard for defining future technology requirements. Instead, a series of potential missions representative of the types of service needed by man and available from space have been selected to exemplify typical technology requirements in this theme. These missions correlate with the earth-oriented activities identified as future objectives in the Outlook for Space and can be easily identified with the definition of "Thrust" packages now being undertaken in the Applications program area.

Since most application missions depend on the accumulation and dissemination of information, the goal or objective selected for this theme is to provide a 1000-fold increase in our ability to effectively obtain useful information from space at less than current costs. The basis for this goal derives from the data explosion engendered by global observation and operations in space and the current bottlenecks encountered in converting that data into useful user-oriented information.

In section II of this document, a more detailed description of the theme is provided together with a brief rationale for the theme and a summary of needs and benefits. Section III describes technology requirements at a functional level and lists current new initiatives considered pertinent to this theme by the team leader and his HQ counterparts. Section IV of the document briefly outlines needs from the Working Groups as seen by the theme team. Section V identifies current theme team members.

II Background

Theme Description - Space provides a unique vantage point for global observation of the earth, its environment, and its natural and man-made features. The objective of this theme is to provide the technology needed to expand our ability to operate in that unique arena. Examples of typical spacecraft and missions which could enhance the benefits of space operations are appended as Enclosure A. Rough estimates of mission characteristics and technology requirements for each

of these missions are included in the enclosure. Enclosure B is an excerpt from a recently completed survey of Space Electronics Technology R&D and establishes technology needs in that discipline as an expansion of current knowledge and forecast of future capability. These needs closely follow the technology advances forecast in the Outlook for Space and, in many cases, were the source of - or directly resulted from - those forecasts.

The purpose of this theme is to combine those two approaches to technology definition into a viable technical program which can greatly increase the return on our space investment. The technical characteristics of Enclosure A should provide examples of performance capabilities sufficient to identify technology needs. The bottom-up approach of Enclosure B provides some idea of the approaches and schedules needed to achieve the 1000-fold increase in effectiveness.

Theme Advocacy Issues

Rationale: Application spacecraft operating in earth-oriented modes can provide practical global observation and operational services which will enable man to comprehend the physical impact and effect of his existence on the earth and its environment, to predict the cause and effect of natural and man-made changes in the earth's ecological characteristics, and to control and regulate the consumption and exploitation of our natural resources. Use of these services depends heavily on the ability to accumulate great quantities of data, and to effectively and efficiently convert that data to information or knowledge important to the user.

Need/Benefits: Operational global service systems can directly contribute to many of our national needs. Information management and distribution technologies applied in individual communications, electronic mail, and large-scale information handling can stimulate and support the national economy. Automated pollution monitoring from space can provide the key to preservation of the environment. Global monitoring and prediction of weather, crop conditions, and water availability can significantly aid efficient food production. Similar systems can be used to protect life and property through early warning of natural disasters and can help in the discovery and mapping of natural resources. In addition, the data handling capabilities developed for global service systems will reduce the cost of information reduction in the quest for new knowledge through the exploration of space.

Problem: Cost-effective, global service systems will require quantum improvements in the technical ability to acquire, reduce and distribute user-oriented information in near-real-time. These topics are discussed in subsequent paragraphs. An equally important problem requiring attention in this theme area is to obtain public and political acceptance of the concept that benefits derived from remote observation of the earth and its environment can outweigh concerns over personal and political privacy and/or security. A completed advocacy package must treat this latter problem in detail.

III Technology Needs

Areas of Emphasis: Global service systems operating in space will require technical advances in a number of functional areas. A ten fold increase in the dimensions of deployable (100m.) and erectable (1km.) structures will be needed to provide booms, antennas and platforms for global sensor systems. Control and stabilization systems capable of pointing accuracies of 1 arc second or less will be needed to locate targets of interest and maintain platform or sensor orientation during operations. A factor of five improvement in spacecraft power capacity will be required to support payloads of multiple sensors and supporting electronics. Auxiliary propulsion systems capable of 5-10 years operation on orbit will be needed to satisfy operating life requirements of cost-effective service platforms. Multipurpose sensors capable of 10 times better resolution (10 meters), extended spectral range and increased sensitivity will be necessary to provide detection and identification of earth and atmospheric characteristics. End-to-end data management systems capable of a 1000 fold improvement in the conversion of raw data to useful information will be required to ensure transfer of knowledge to the user community on a near-real-time basis.

Approach: Development of the technical base needed to support practical global service systems will build on the current OAST R&T Base programs in Materials and Structures, Space Power and Propulsion, and Guidance, Control and Information Systems. New initiatives and/or program augmentations will be implemented to provide an orderly evolution to the necessary levels of technical capability in each of the above functional areas.

(a) Large Structures - Current technology programs are aimed at definitions of structural concepts, thermal control and dynamic response of large area space structures. A proposed new initiative (Large Space Structures Technology) in FY 1978 will collect these conceptual studies into a comprehensive design, demonstration and verification program culminating in flight tests onboard the Shuttle/Spacelab in the CY 1984-85 time frame.

(b) Control and Stabilization - Current technology programs are exploring potential capabilities of several pointing system concepts including supporting technologies such as sensors, support systems and actuators. Several new initiatives relative to instrument pointing and control and the erection and control of large space structures have been proposed for FY 1978 and subsequent years. Key technology needs are the development of an Experiment Isolation and Pointing System aimed at the demonstration of precision earth-pointing capability on a Shuttle payload in the CY 1981-82 period and development of remote manipulator technology for assembly of large structures in space by the CY 1981-82 period.

(c) Power - Current technology programs center on the development of high efficiency, low cost solar cells, and long life energy conversion and storage components. Key technology needs are to develop and demonstrate radiation resistant solar cells and long life, highly efficient batteries. Battery programs are proposed as FY 1978 new initiatives culminating in flight demonstrations during the CY 1981-83 time frame. Solar cell demonstration programs are proposed for initiation in FY 1979 with flight demonstrations in CY 1981-82.

(d) Auxiliary Propulsion - Current technology programs concentrate on the development of ion thrusters for auxiliary propulsion and north-south station keeping functions. Key technology needs are demonstration of thruster life in space and assessment of contamination on sensors and spacecraft structures due to ion thruster firings. This data is expected to be available from the proposed FY 1978 SPHINX new initiatives, but will require alternate approaches if that activity is not approved.

(e) Multipurpose Sensors - Current programs are concentrated on active and passive optical sensors for measuring atmospheric constituents. Key technology needs are spaceborne active microwave systems to permit day-night measurements of the earth's characteristics and uncooled sensors operating in the IR, millimeter and submillimeter frequency bands to broaden the scope of sensor spectral sensitivity. New initiatives in these areas are needed and should be started in FY 1978 to ensure available technology in the 1985 time frame.

(f) End-To-End Data Management - Current technology programs are focussed on a variety of component and subsystem concepts, all of which serve as elements in a comprehensive data management system. These include experimental CCD devices for data processing, parallel processors for high speed data handling, microwave and optical components for data transfer, and a multipurpose user-oriented software development program. To provide a thousand-fold increase in data management, new initiatives are needed to flight test and demonstrate on-board processors, to demonstrate high-data-rate space-to-space communication links and to develop and demonstrate low-cost ground-based user terminals. A significant part of this program should be to design and demonstrate, for Shuttle payload flight, a total end-to-end information system which can be configured to accept new components or concepts in data handling as they develop and evaluate their performance in a system capability context.

Specific Technical Activities: Enclosure C lists classes of new initiatives required to support the Global Service Systems theme and follows that listing with a summary of current new initiatives submitted by the Centers during the recent call for FY 1978 inputs.

IV Working Group Directive

The principal need in the Global Service Systems theme is a more detailed and careful analysis of technical activities necessary to insure technology availability in the 1990 time frame. Areas the theme team feels are particularly weak or inadequately defined include structures, power, auxiliary propulsion, end-to-end data systems with particular emphasis on software and data reduction, and advanced sensor technology.

Comment and critique of the overall theme is urgently solicited and any assistance the Working Groups can provide in quantifying and strengthening the needs/benefits aspects of this theme would be sincerely welcomed.

V Theme Team Membership

Headquarters

Pontious - OAST/RES Team Leader
Gilstad - OAST/RW
Lazar - OAST/RP
Ernst - OA/EC
Kaufman - OSS/ST

Center

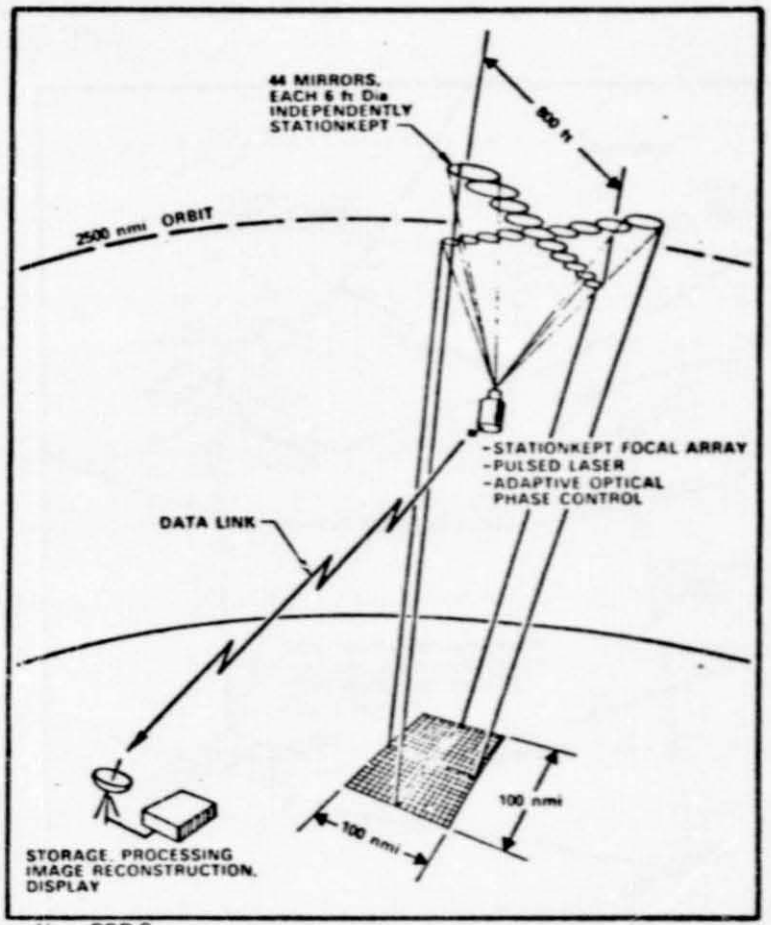
Deerwester - ARC
Plotkin - GSFC
Wolff - GSFC
Hibbs - JPL
Moore - LaRC
Sivo - LeRC
Wallace - MSFC

EXTREMELY HIGH RESOLUTION OBSERVATION (CO-4)

- **PURPOSE**
  To observe the surface with extreme resolution.

- **RATIONALE**
  Crop yield forecasts, insect control, resource conservation, etc., may be aided by imaging with extreme resolution.

- **CONCEPT DESCRIPTION**
  Adaptive stationkept optical array is used in conjunction with laser illumination to reduce effects of atmospheric scintillation.



- **CHARACTERISTICS**

• WEIGHT	40,000 lb
• SIZE	800 ft
• RAW POWER	10 kW
• ORBIT	2500 nmi circular, 45° inclination
• CONSTELLATION SIZE	1
• LIFE/SERVICING PERIOD	10/3 yrs
• TIME FRAME	2000
• IOC COST	300 M

- **PERFORMANCE**
  Less than a few feet ground resolution (passive); up to one order of magnitude improvement in resolution with pulsed laser illumination.

- **BUILDING BLOCK REQUIREMENTS**

• TRANSPORTATION	Shuttle and large tug and/or SEPS
• ON-ORBIT OPERATIONS	Automated or manned "assembly" and servicing
• SUBSYSTEMS	Stationkept mirrors; focal plane; high rate communication
• TECHNOLOGY	Image processing in focal plane; adaptive corrections; shielding
• OTHER	None

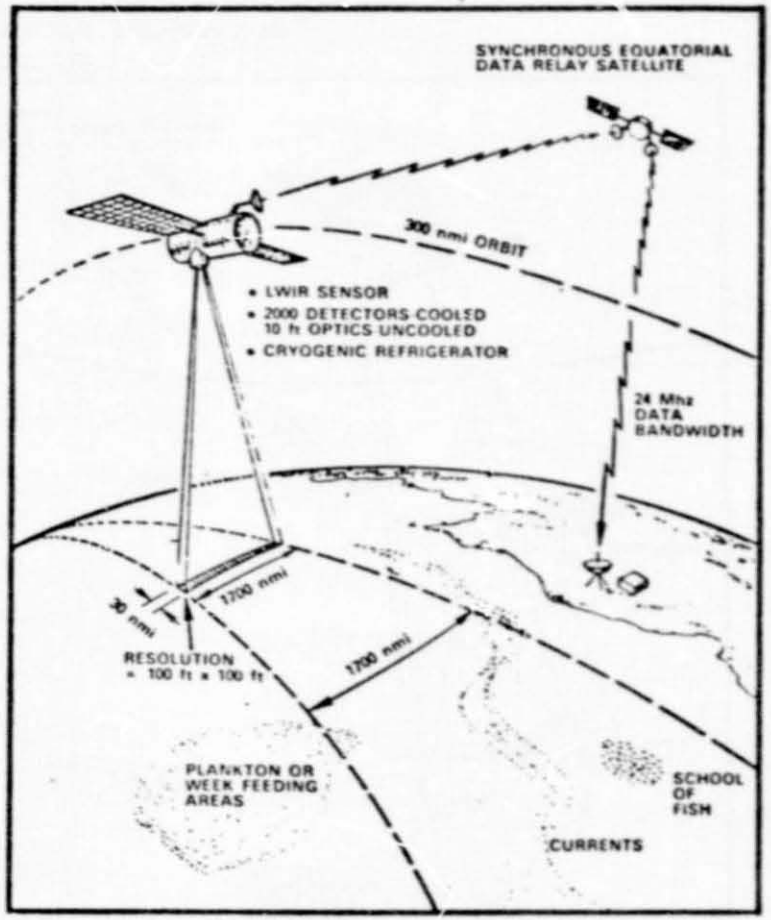
ENCLOSURE A

OCEAN RESOURCES AND DYNAMICS SYSTEM (CO-15)

- **PURPOSE**
  To locate schools of fish and to map ocean dynamic signatures.

- **RATIONALE**
  Fish protein resource yield needs to be maximized due to world protein shortage. Mapping instruments needed.

- **CONCEPT DESCRIPTION**
  Temperature and emissivity differences in surface water caused by schools of fish, currents, and plankton concentrations are detected by the differences in their self-emission in the long-wave infrared.



- **CHARACTERISTICS**

• WEIGHT	15,000 lb
• SIZE	10 x 60 ft
• RAW POWER	25 kW
• ORBIT	300 nmi polar
• CONSTELLATION SIZE	1
• RISK CATEGORY	I (Low)
• TIME FRAME	1985
• IOC COST (SPACE ONLY)	300 M

- **PERFORMANCE**
  100-ft resolution attained over all ocean surfaces every 12 hours. Sensitivity equivalent to 0.002 deg C achieved.

- **BUILDING BLOCK REQUIREMENTS**

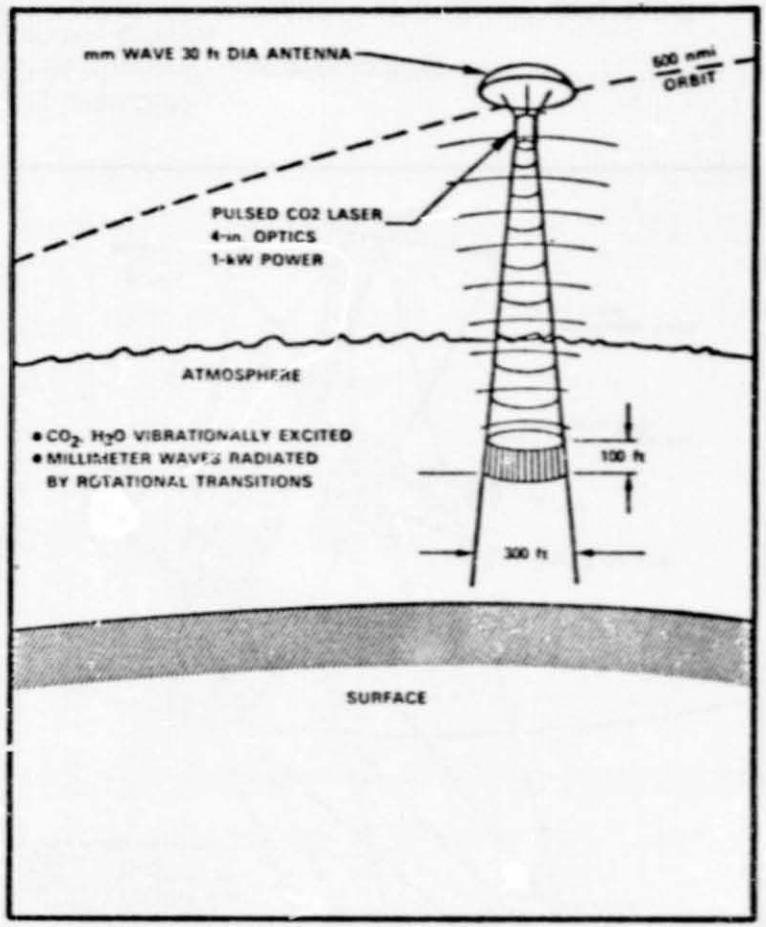
• TRANSPORTATION	Shuttle
• ON-ORBIT OPERATIONS	Shuttle attached manipulator
• SUBSYSTEMS	Thermal dissipation, sensor, cryogenic cooler
• TECHNOLOGY	Large LWIR sensor; cryogenic refrigerator; LSI data processor
• OTHER	None

ATMOSPHERIC TEMPERATURE PROFILE SOUNDER (CO-11)

- **PURPOSE**
  To measure actual profiles of temperature in the atmosphere.

- **RATIONALE**
  Weather prediction requires knowledge of temperature profiles, as well as other phenomena.

- **CONCEPT DESCRIPTION**
  Pulsed laser vibrationally excites CO_2 or H_2O molecules. Subsequent rotational transitions in the millimeter wave spectrum show temperature dependence which is measured by ratio of energy in several lines.



- **CHARACTERISTICS**

• WEIGHT	4000 lb
• SIZE	30-ft dia antenna
• RAW POWER	5 kW
• ORBIT	600-nmi polar
• CONSTELLATION SIZE	4
• RISK CATEGORY	III (Moderate)
• TIME FRAME	1990
• IOC COST (SPACE ONLY)	250 M

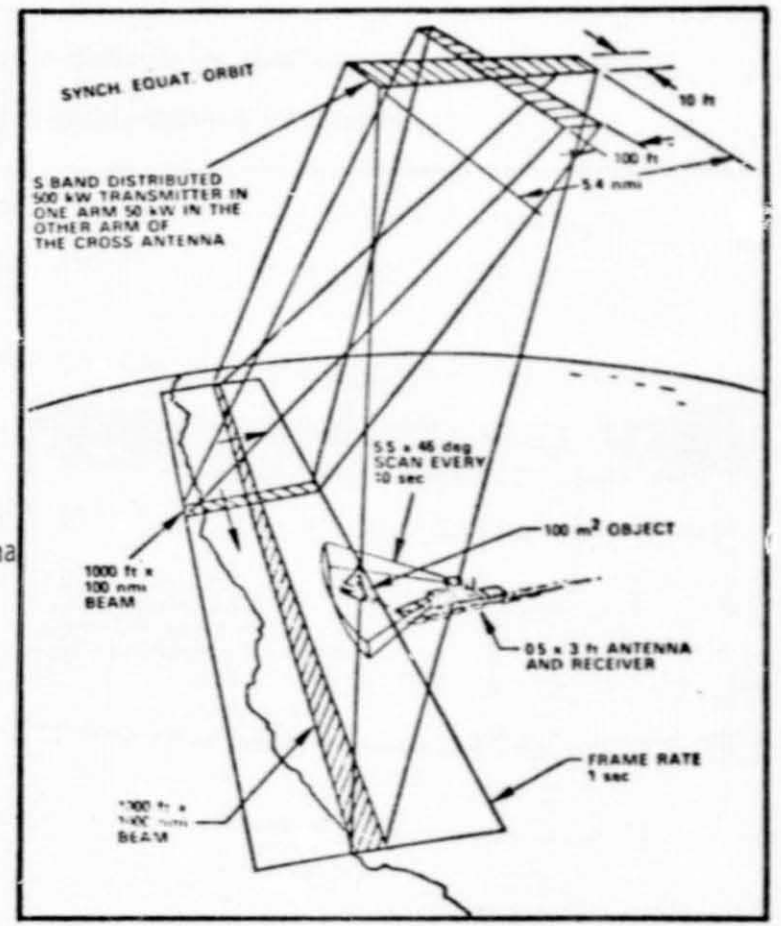
- **PERFORMANCE**
  Entire atmosphere measured, with resolution of 300 ft horizontally and 100 ft vertically, every four hours. Emission lines and signal strength imprecisely defined at present.

- **BUILDING BLOCK REQUIREMENTS**

• TRANSPORTATION	Shuttle and tug/IUS
• ON-ORBIT OPERATIONS	Automated service unit/Shuttle-attached manipulator
• SUBSYSTEMS	Antenna, laser, attitude control
• TECHNOLOGY	Laser, power dissipation, antenna, pointing, sensitive heterodyne receiver
• OTHER	

COASTAL ANTI-COLLISION PASSIVE RADAR (CO-9)

- **PURPOSE**
  Inexpensive and lightweight radar for all surface vessels - navigation; collision avoidance
- **RATIONALE**
  Conventional radar too heavy, expensive, and interferrence prone. Pleasure craft usually denied radar benefits.
- **CONCEPT DESCRIPTION**
  Use space illuminator of seacoasts with scanning microwave beams. Scanning receiving antennas on boats obtain range and angle data.



- **CHARACTERISTICS**

• WEIGHT	110,000 lb
• SIZE	5.4 nmi crossed antenna
• RAW POWER	2 MW
• ORBIT	Synch. Equat.
• CONSTELLATION SIZE	1
• LIFE/SERVICING PERIOD	10/3 Years
• TIME FRAME	1995
• IOC COST	1.1 B

- **PERFORMANCE**
  Relative location of all objects > 100 m^2 to within 100 ft in range and 300 ft in angle in 50^0 sector. 3 x 0.5 ft antenna in vessel.

- **BUILDING BLOCK REQUIREMENTS**

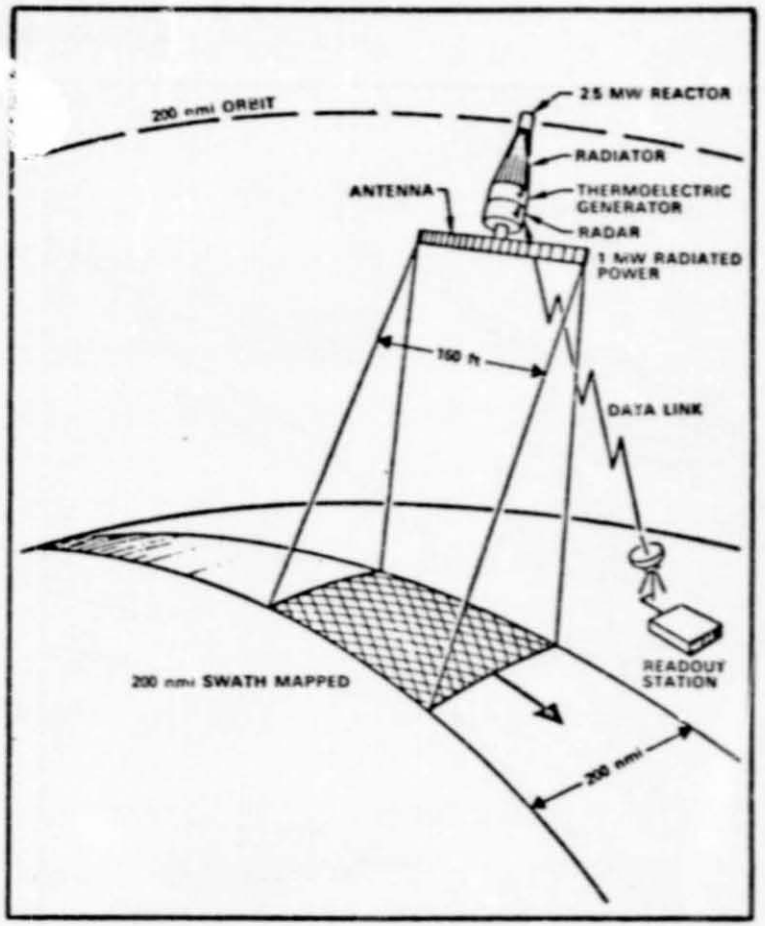
• TRANSPORTATION	Shuttle and large tug or large SEPS
• ON-ORBIT OPERATIONS	Automated or manual servicing unit; Assemble in orbit
• SUBSYSTEMS	Structures; attitude control; antenna
• TECHNOLOGY	Large adaptive microwave antenna; laser master measuring and control unit
• OTHER	None

HIGH RESOLUTION EARTH MAPPING RADAR (CO-13)

- **PURPOSE**
  To provide maps of the surface with high resolution through cloud cover.

- **RATIONALE**
  Resources, pollution, crop, water, and other observations may be aided by high resolution and frequent coverage regardless of weather.

- **CONCEPT DESCRIPTION**
  Synthetic array radar of very high power provides high resolution. On-board image processing allows microwave data link for all weather capability.



- **CHARACTERISTICS**

• WEIGHT	110,000 lb
• SIZE	15 x 160 ft
• RAW POWER	2.5 MW
• ORBIT	200 nmi polar
• CONSTELLATION SIZE	1
• LIFE/SERVICING PERIOD	10/1 yr
• TIME FRAME	1990
• IOC COST	500 M

- **PERFORMANCE**
  200 nmi ground swath mapped to less than a few feet resolution once a day. U. S. covered every six days.

- **BUILDING BLOCK REQUIREMENTS**

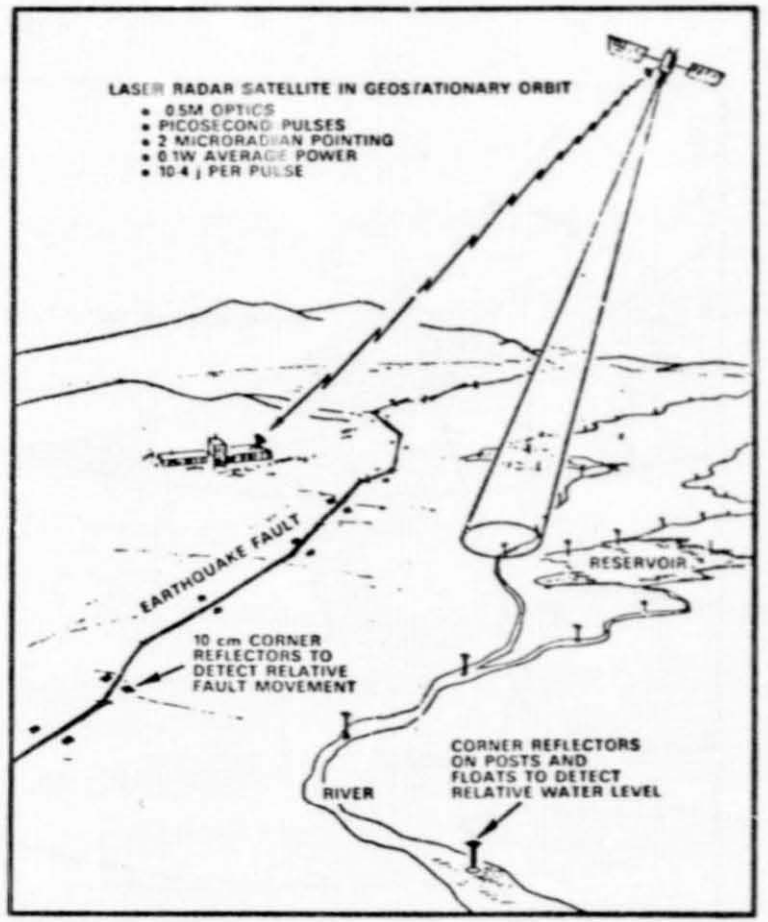
• TRANSPORTATION	Shuttle
• ON-ORBIT OPERATIONS	Shuttle manipulator; servicing
• SUBSYSTEMS	Thermal, nuclear, power generator, radar
• TECHNOLOGY	High power transmitter; automated image processor, reactor, shielding
• OTHER	None

WATER LEVEL AND FAULT MOVEMENT INDICATOR (CO-3)

- **PURPOSE**
  To make precision measurements in many places in rapid succession for aid in earthquake prediction, water resources establishment, disaster use, etc.

- **RATIONALE**
  Prediction of earthquakes, floods, droughts, and accurate water resources would be of great social and economic benefit.

- **CONCEPT DESCRIPTION**
  Picosecond (10^{-12} sec) pulsed laser radar in orbit obtains precision differential range measurements from corner reflectors implaced on both sides of faults, river banks and floats, etc.



- **CHARACTERISTICS**

• WEIGHT	800 lb
• SIZE	0.5 m optics
• RAW POWER	250 W
• ORBIT	Geostationary
• CONSTELLATION SIZE	1
• RISK CATEGORY	1 (Low)
• TIME FRAME	1985
• IOC COST (SPACE ONLY)	50 M

- **PERFORMANCE**
  Relative range obtained to ± 0.03 millimeters at any number of points separated by 100 meters or more. 10^5 instrumented points can be measured every hour.

- **BUILDING BLOCK REQUIREMENTS**

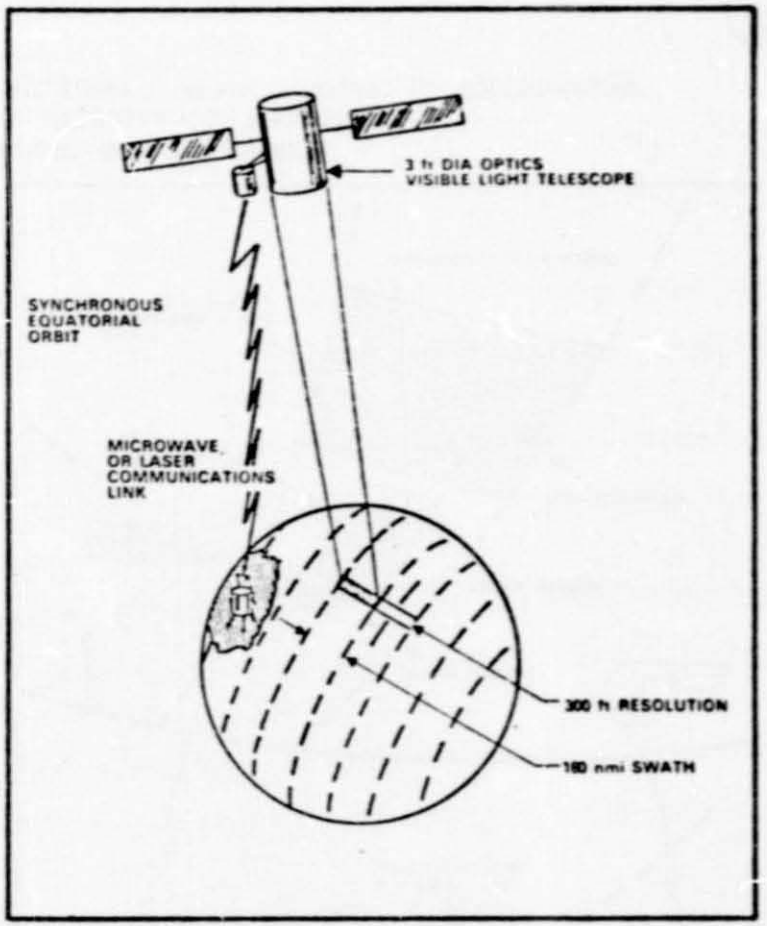
• TRANSPORTATION	Shuttle, IUS/Tug
• ON-ORBIT OPERATIONS	Automated or manned servicing
• SUBSYSTEMS	Picosecond receiver, transmitter, 2 μr pointing
• TECHNOLOGY	Streak camera converter, mode locked laser and switch
• OTHER	

SYNCHRONOUS METEOROLOGICAL SATELLITE (CO-12)

- **PURPOSE**
  To collect wor'dwide atmospheric data for global weather prediction.

- **RATIONALE**
  High resolution and frequent coverage of globe are needed for forecasts..

- **CONCEPT DESCRIPTION**
  Optical sensor with 1 meter mirror collects visible light data on gross meteorological features. Same instrument makes spectrum measurements for detailed information on atmosphere.



- **CHARACTERISTICS**

• WEIGHT	3000 lb
• SIZE	5 x 20 ft
• RAW POWER	1 kW
• ORBIT	Synch. Equat.
• CONSTELLATION SIZE	3
• LIFE/SERVICING PERIOD	10/3 Years
• TIME FRAME	1985
• IOC COST	190 M

- **PERFORMANCE**
  Ground resolution 300 ft dia. Scan rate: Earth coverage in 20 sec for clouds, etc. Detailed measurements of spectrum every 200 sec.

- **BUILDING BLOCK REQUIREMENTS**

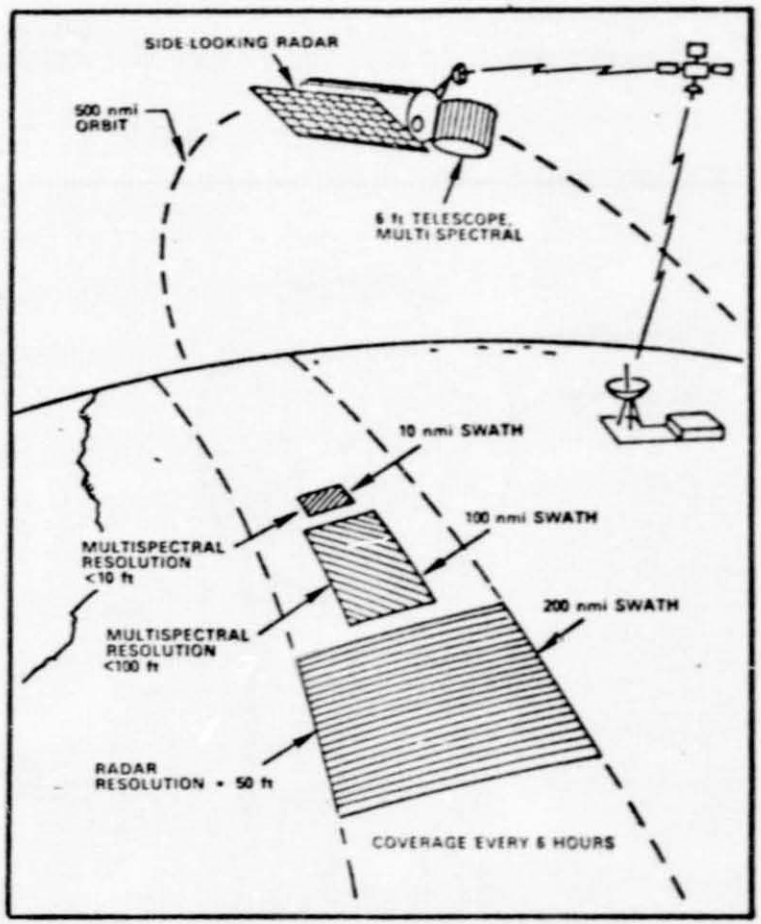
• TRANSPORTATION	Shuttle and tug
• ON-ORBIT OPERATIONS	Automated or Manual Servicing Unit
• SUBSYSTEMS	Laser
• TECHNOLOGY	Comm. link: 10 gigabits/sec from each satellite. Ground computer center.
• OTHER	Weather calculation method.

ADVANCED RESOURCES/POLLUTION OBSERVATORY (CO-1) (U)

- **PURPOSE**
  To provide high quality, multispectral earth resources and pollution data.

- **RATIONALE**
  Integrated ERTS-like system, real-time data distribution to world-wide users, active sensors needed.

- **CONCEPT DESCRIPTION**
  Active and passive sensors, large aperture, high, medium, and low resolution imaging obtained in multispectral region and radar. Data disseminated by laser link through relay satellite.



- **CHARACTERISTICS**

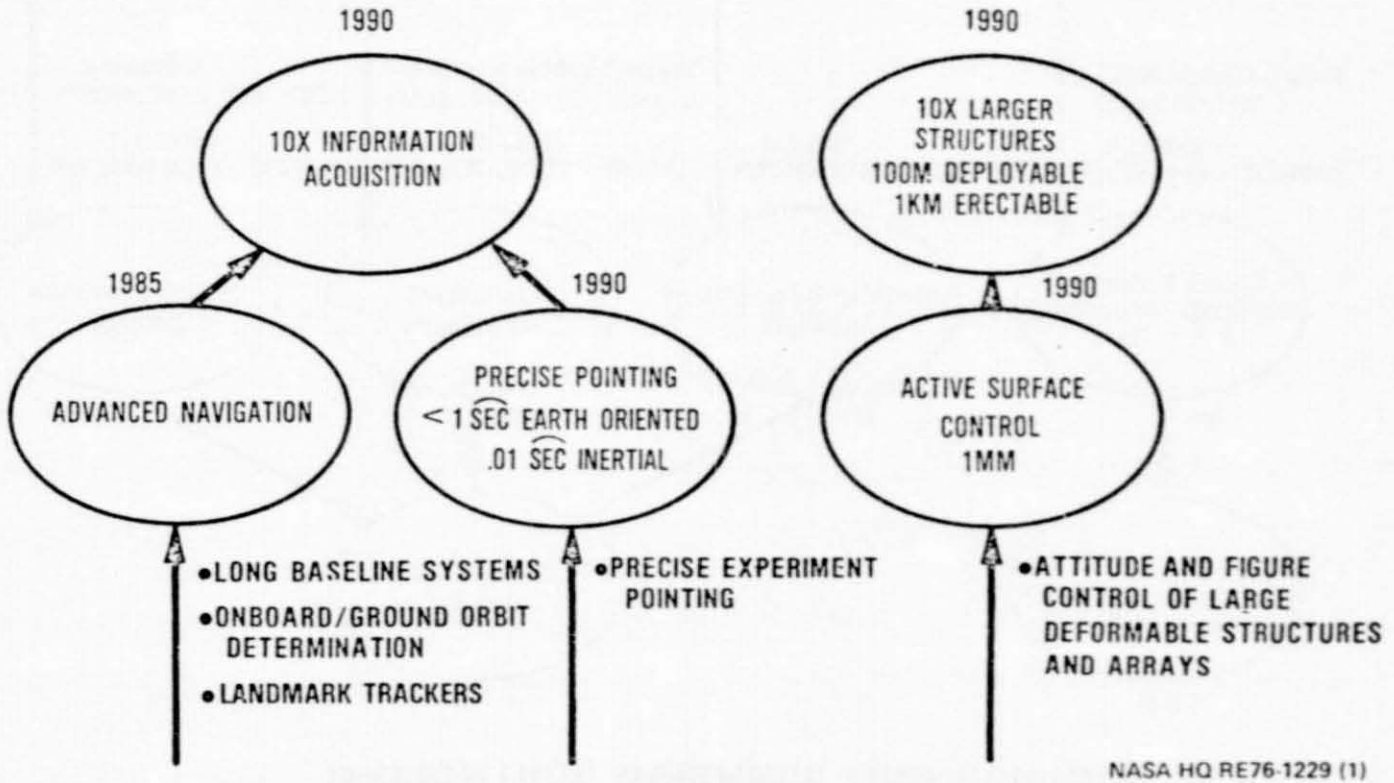
• WEIGHT	30,000 lb
• SIZE	10 x 60 ft
• RAW POWER	12 kW
• ORBIT	500 nmi sun synch.
• CONSTELLATION SIZE	1
• LIFE/SERVICING PERIOD	10/3 Years
• TIME FRAME	1985
• IOC COST	350 M

- **PERFORMANCE**
  Multispectral resolutions varying from < 10 to < 100 ft obtained world-wide.

- **BUILDING BLOCK REQUIREMENTS**

• TRANSPORTATION	Shuttle and Tug
• ON-ORBIT OPERATIONS	Shuttle attached manipulator, servicing stages
• SUBSYSTEMS	Guidance and navigation; attitude control; transmitter
• TECHNOLOGY	Large radar antenna; high power tubes and modulator; LSI data processor
• OTHER	None

NAVIGATION, GUIDANCE AND CONTROL



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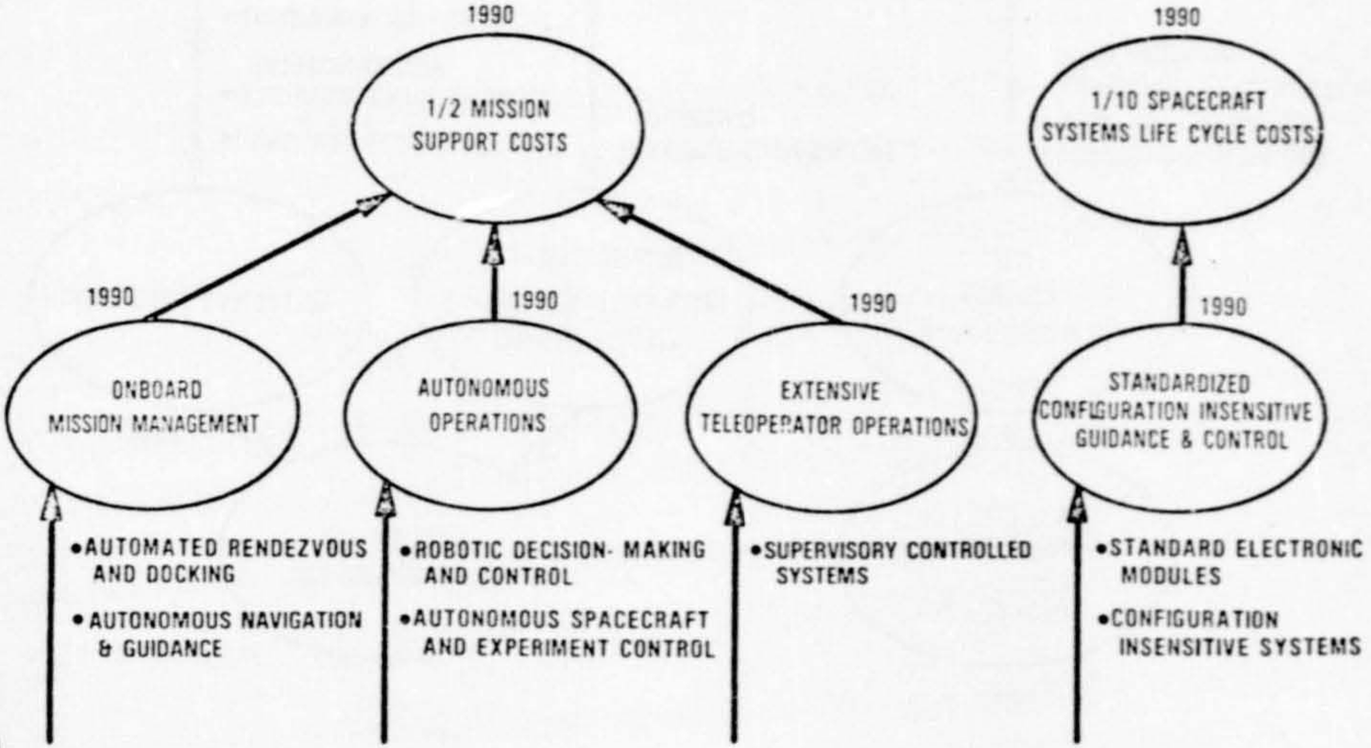
ENCLOSURE B

NAVIGATION, GUIDANCE AND CONTROL



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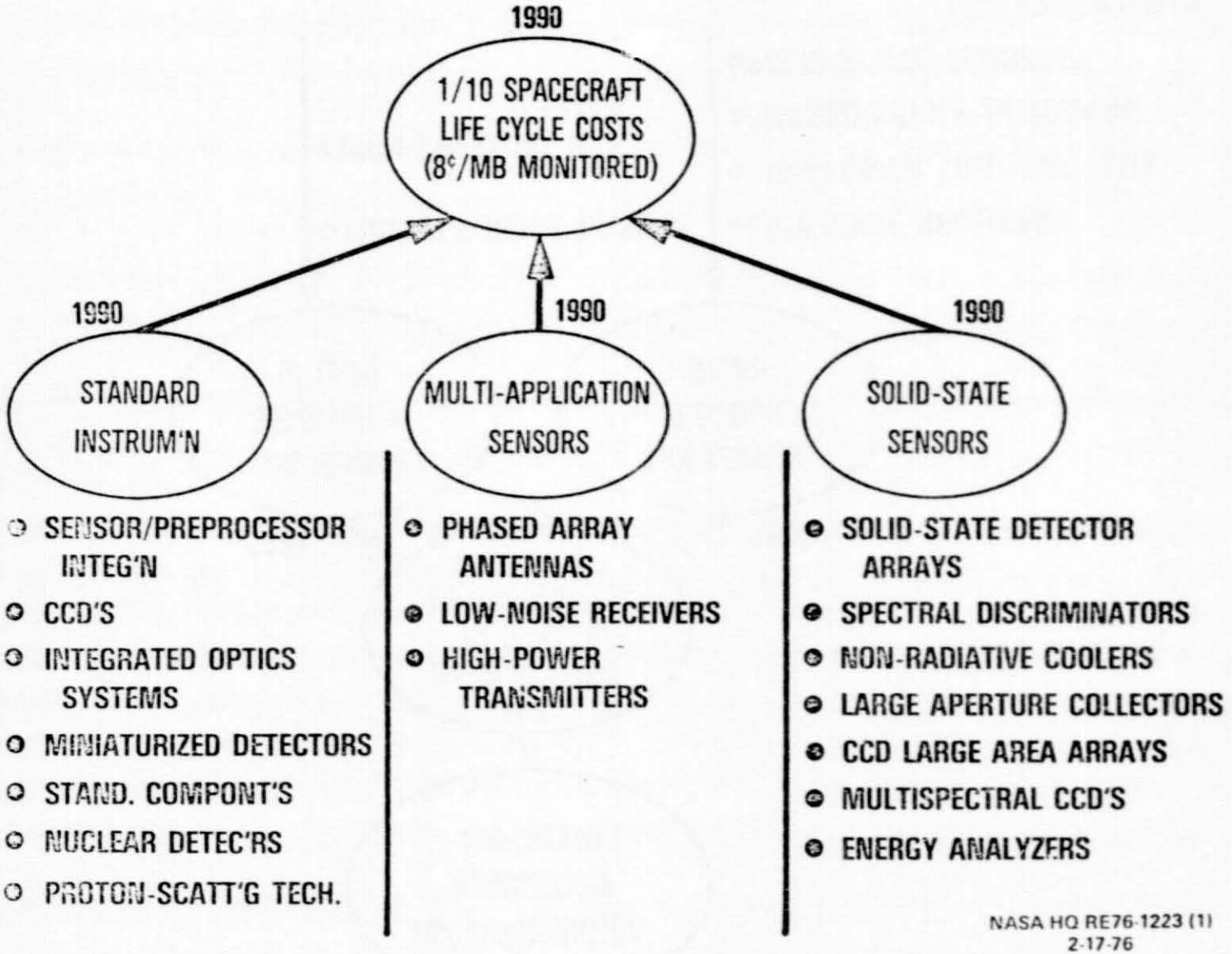

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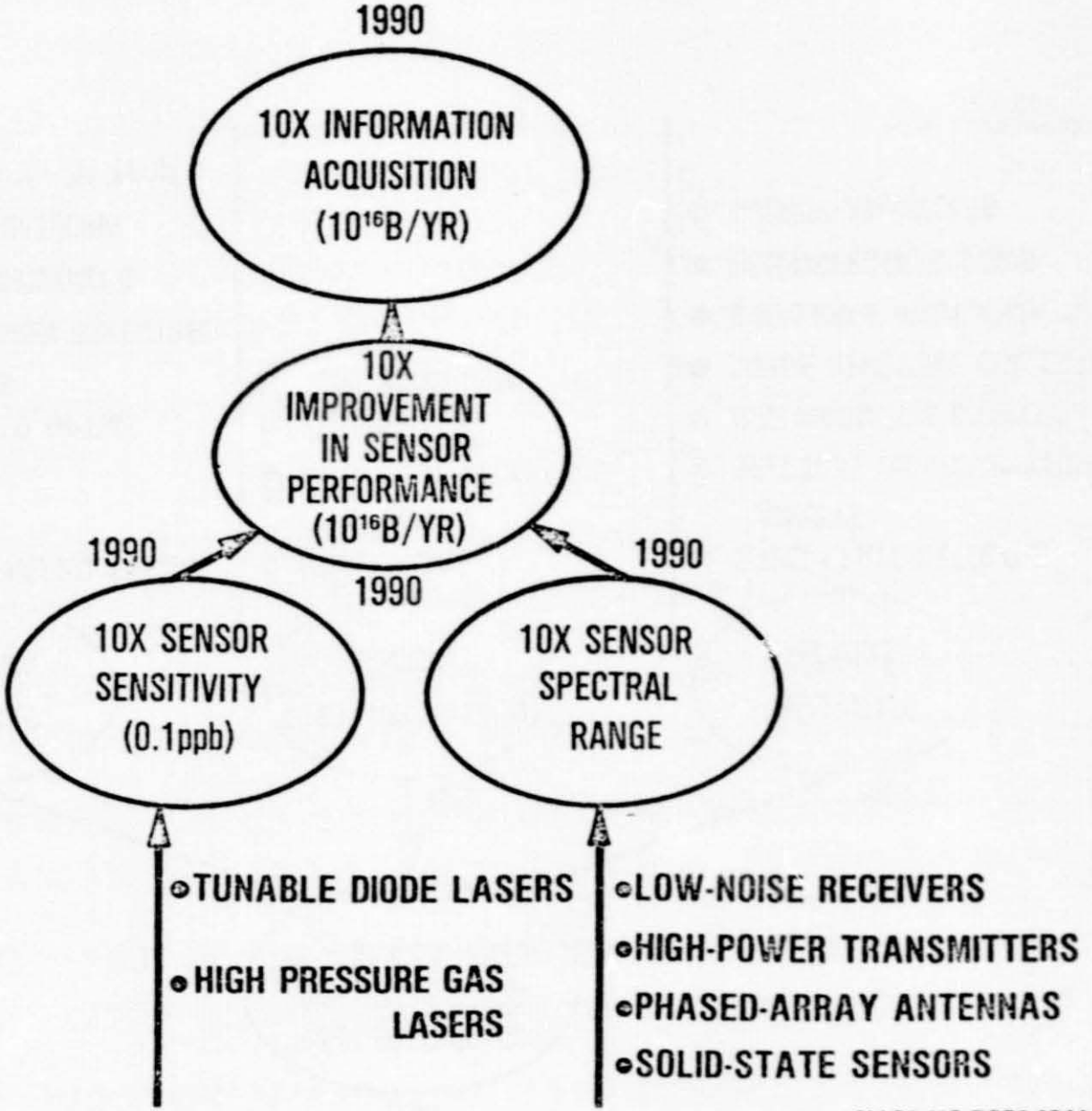

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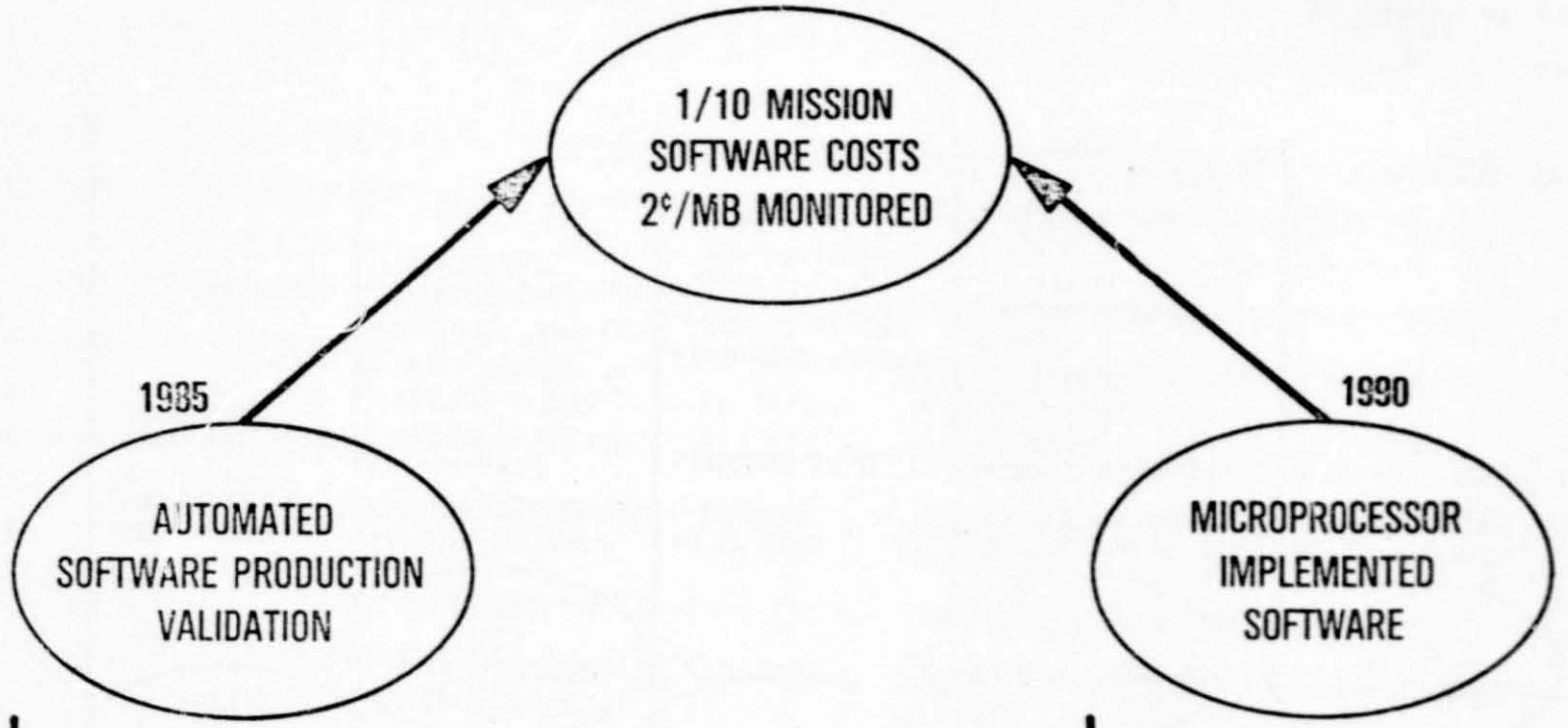

- COMPILER WRITING SYSTEMS
- STRUCTURED PROGRAMMING TECHNIQUES

- MODULAR ARCHITECTURE

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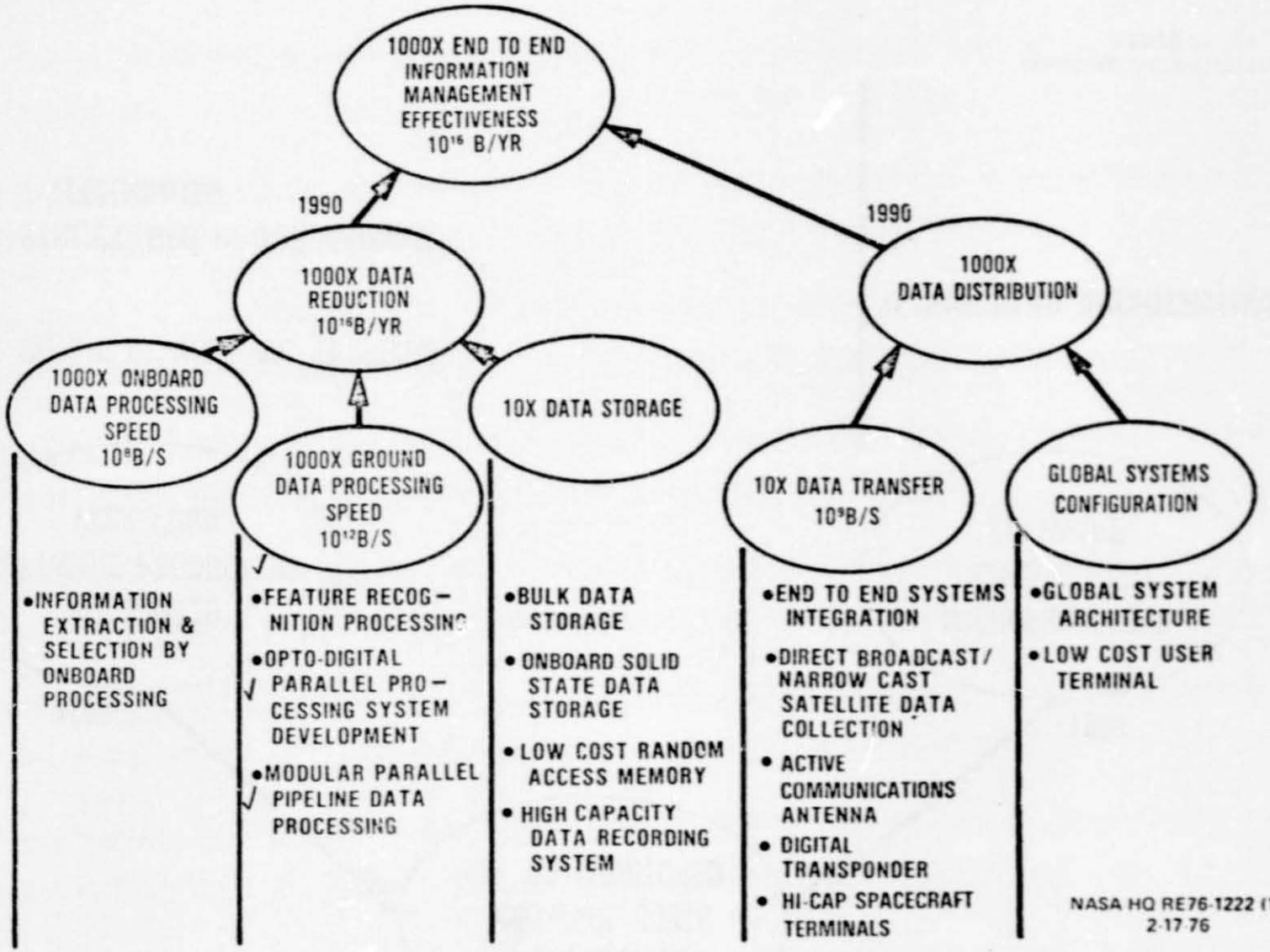
1000X END TO END INFORMATION MANAGEMENT EFFECTIVENESS 10^{16} B/YR
1990
1990
1000X DATA REDUCTION 10^{16}B/YR
1000X DATA DISTRIBUTION
1000X ONBOARD DATA PROCESSING SPEED 10^{8}B/S
1000X GROUND DATA PROCESSING SPEED 10^{12}B/S
10X DATA STORAGE
10X DATA TRANSFER 10^{9}B/S
GLOBAL SYSTEMS CONFIGURATION
•INFORMATION EXTRACTION & SELECTION BY ONBOARD PROCESSING
✓
•FEATURE RECOG-NITION PROCESSING
•OPTO-DIGITAL ✓ PARALLEL PRO-CESSING SYSTEM DEVELOPMENT
•MODULAR PARALLEL ✓ PIPELINE DATA PROCESSING
•BULK DATA STORAGE
• ONBOARD SOLID STATE DATA STORAGE
• LOW COST RANDOM ACCESS MEMORY
• HIGH CAPACITY DATA RECORDING SYSTEM
•END TO END SYSTEMS INTEGRATION
•DIRECT BROADCAST/ NARROW CAST SATELLITE DATA COLLECTION
• ACTIVE COMMUNICATIONS ANTENNA
• DIGITAL TRANSPONDER
• HI-CAP SPACECRAFT TERMINALS
•GLOBAL SYSTEM ARCHITECTURE
•LOW COST USER TERMINAL
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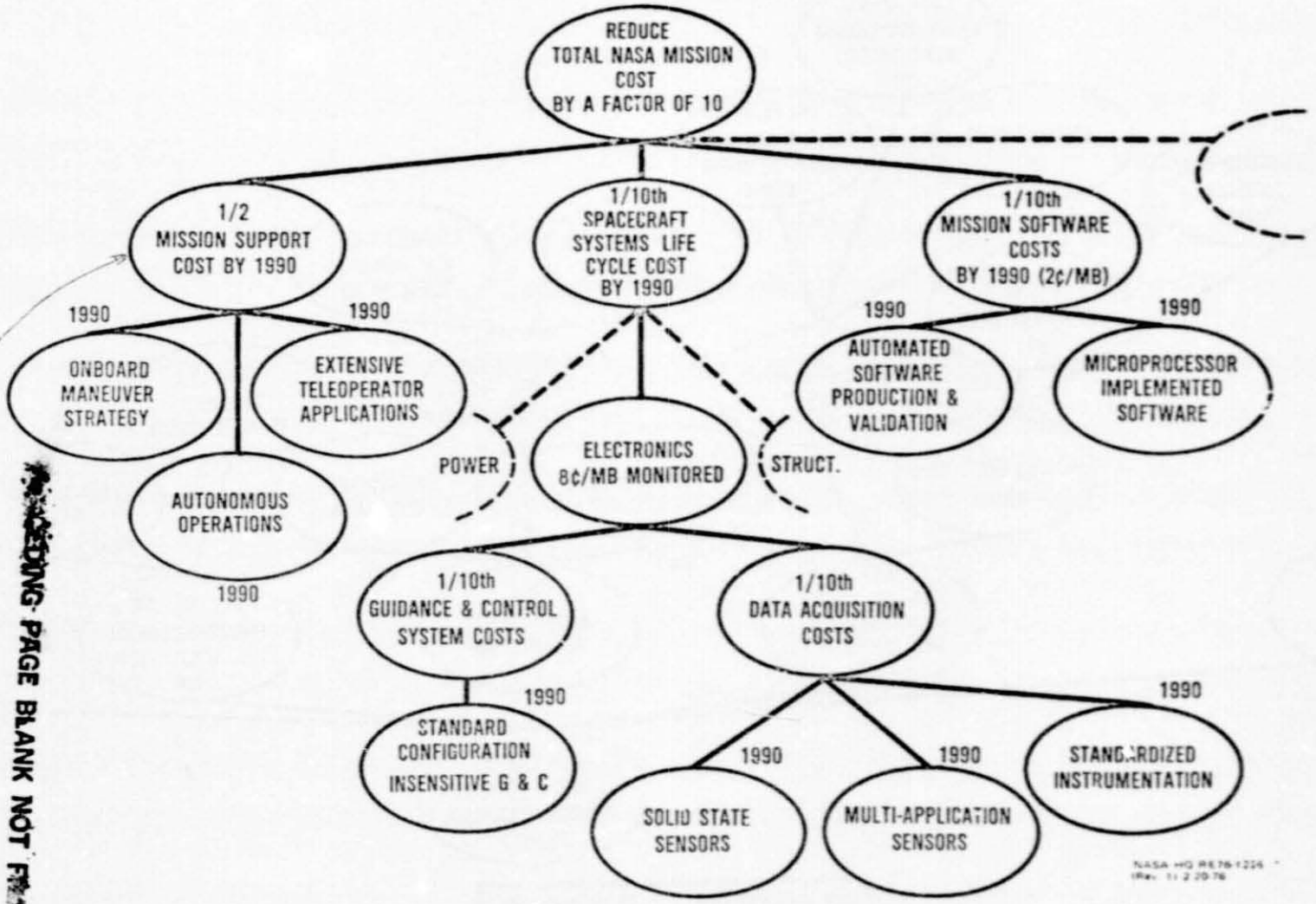
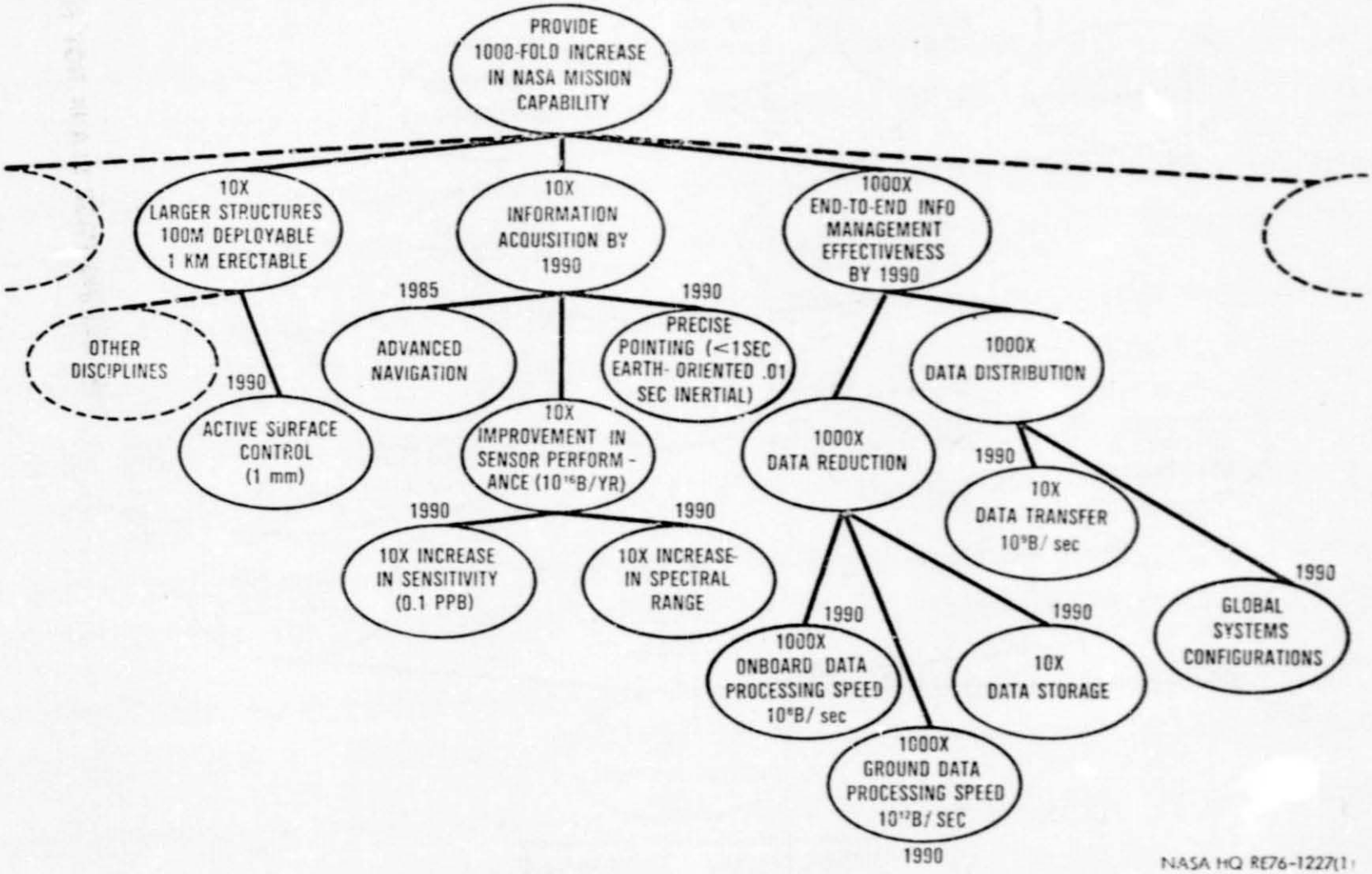
SPACE ELECTRONICS TECHNOLOGY REVIEW

MAJOR THRUSTS



SPACE ELECTRONICS TECHNOLOGY REVIEW

MAJOR THRUSTS



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11-11-75

ENCLOSURE C

GLOBAL SERVICE SYSTEMS
FY 1978 New Initiative Needs

1. Large Structures - Develop and demonstrate erection, assembly and deployment of large space structures in space.

2. Control & Stabilization - Develop and demonstrate precise earth-pointing system capability.
   - Develop and demonstrate remote manipulator technology for assembling large structures in space.

3. Power - Design and demonstrate highly efficient energy storage system in space.

4. Auxiliary Propulsion - Demonstrate ion thruster technology for satellite station keeping (SPHINX B/C).

5. Multipurpose Sensors - Develop and demonstrate uncooled IR and submillimeter sensors for measuring atmospheric constituents.

6. End-To-End Data Management - Develop and demonstrate on-board CCD data processor.
   - Design, develop and demonstrate modular end-to-end information management system.

SUPPORTING PROPOSALS - #11-GLOBAL SERVICE SYSTEMS SUPPORTING INITIATIVES

		N.I. NO.		FY 78	I.T.C.
o DIRECT SUPPORT	1.	103	CCD - UNIFIED DATA PROCESSOR * (10)		
	2.	104	DEXTEROUS MANIPULATOR *	0.3	2.8
	3.	105	ATTITUDE CONTROL OF LARGE STRUCTURES *	0.2	0.6
	4.	112	NICKEL/HYDROGEN BATTERY *	0.2	0.6
	5.	113B	LAZER HETERODYNE SPECTROMETER * (10)	---	---
	6.	113C	EXPERIMENT ISOLATION AND POINTING SYSTEM *	0.6	4.1
	7.	113D	MICROWAVE RADIOMETER	0.3	4.0
	8.	114	LARGE AREA SPACE STRUCTURES *(8)	---	---
	9.	115	ON-BOARD CCD PROCESSOR * (10)	---	---
	10.	118	SPHINX B/C * (7)	---	---
	11.	120	SILVER/HYDROGEN BATTERY * (10)	---	---
	12.	121	41-43 GHF TRANSPONDER * (11)	0.5	3.0
	13.	306	50-500 WE ISOTOPE POWER SYSTEM *		
o GENERICALLY OR	14.	110	SETI * (9)		
PARTLY RELATED	15.	125	CRYOGENIC FLUID MANAGEMENT *		

SUPPORTING PROPOSALS - #11-GLOBAL SERVICE SYSTEMS SUPPORTING INITIATIVES (CONTINUED)

		N.I. NO.		FY 78	I.T.C.
	16.	128	ATL *		
	17.	303	PHOTO CHEMICAL SOLAR CONVERSION		
	18.	308	HYDROGEN/OXYGEN FUEL CELL *		
	19.	310	HIGH POWER DENSITY COMPONENTS		
	20.	312	BRAYTON ISOTOPE POWER		
o TASK-TEAM	21.	---	MULTIPURPOSE SENSORS		
IDENTIFIED	22.	---	MODULAR END-TO-END INFORMATION	0.5	6.0
			MANAGEMENT	1.0	13.0

PRELIMINARY FY 78 TOTAL TO AA: $3.6M, TTC. 34.1M

THEME #11

GLOBAL SERVICE SYSTEMS

OBJECTIVE: 1000-FOLD INCREASE IN EFFECTIVE USE OF SPACE FOR PRACTICAL GLOBAL OBSERVATION AND OPERATION SERVICES

SCENARIO:

1978 - 1985

INDIVIDUAL MISSIONS PROVIDING SERVICES TO USER COMMUNITY THROUGH CENTRAL DATA FACILITY

- o VARIED ORBITS
- o SENSOR DEVELOPMENT
- o DATA MANAGEMENT
- o USER EDUCATION
- o 10-FOLD INCREASE

1985 - 2000

MULTIFUNCTION MISSIONS SERVING USER COMMUNITY DIRECTLY ON REAL TIME BASIS

- o LOW COST USER TERMINALS
- o HI SPEED, ONBOARD DATA PROCESSING
- o ON-ORBIT REPAIR & REFURBISHMENT
- o ADVANCED SENSORS
- o 1000-FOLD INCREASE

GLOBAL SERVICE SYSTEMS (CONT.)

APPROACH: ESTABLISH MISSION SET CONSISTENT WITH NEEDS IDENTIFIED BY OUTLOOK FOR SPACE

DETERMINE COMMON TECHNOLOGIES, TECHNICAL PLANS, NEW INITIATIVES

ESTIMATE CHARACTERISTICS OF MULTIFUNCTION MISSION CONCEPT

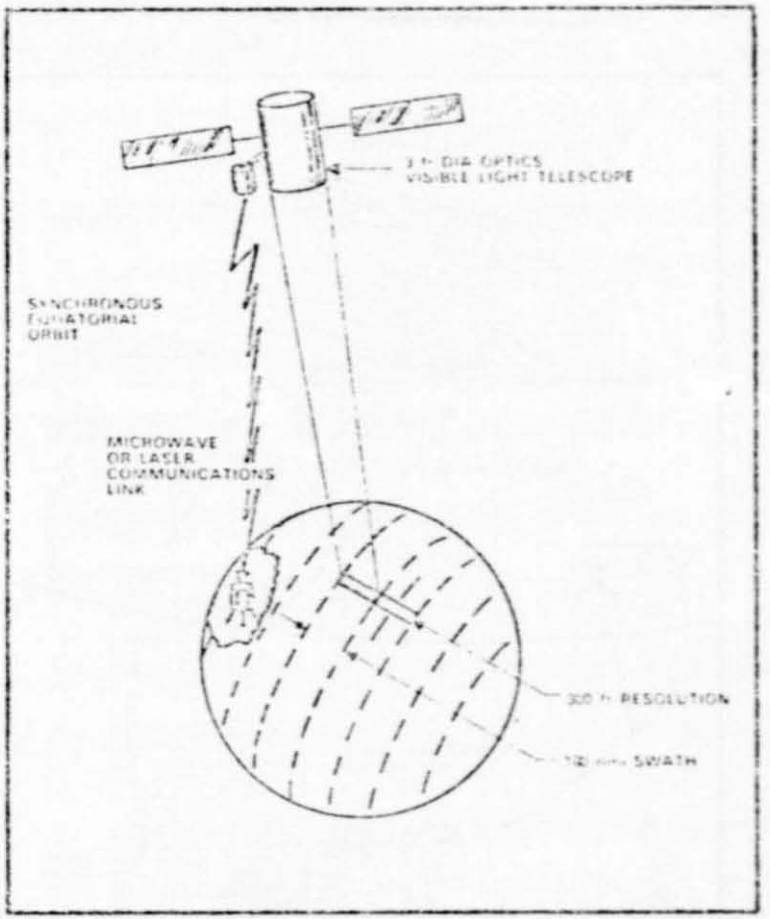
DEFINE TECHNOLOGY NEEDS, TECHNICAL PLANS

SYNCHRONOUS METEOROLOGICAL SATELLITE (CO-12)

- **PURPOSE**
  To collect worldwide atmospheric data for global weather prediction.

- **RATIONALE**
  High resolution and frequent coverage of globe are needed for forecasts..

- **CONCEPT DESCRIPTION**
  Optical sensor with 1 meter mirror collects visible light data on gross meteorological features. Same instrument makes spectrum measurements for detailed information on atmosphere.



- **CHARACTERISTICS**

• WEIGHT	3000 lb
• SIZE	5 x 20 ft
• RAW POWER	1 kW
• ORBIT	Synch. Equat.
• CONSTELLATION SIZE	3
• LIFE/SERVICING PERIOD	10/3 Years
• TIME FRAME	1985
• IOC COST	190 M

- **PERFORMANCE**
  Ground resolution 300 ft dia. Scan rate: Earth coverage in 20 sec for clouds, etc. Detailed measurements of spectrum every 200 sec.

- **BUILDING BLOCK REQUIREMENTS**

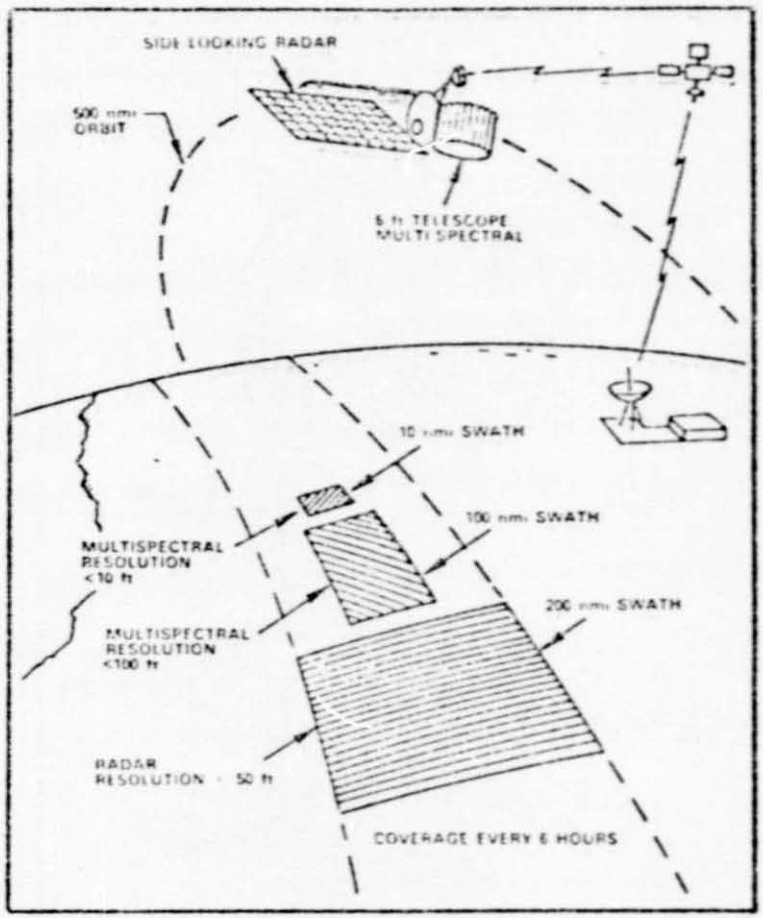
• TRANSPORTATION	Shuttle and tug
• ON-ORBIT OPERATIONS	Automated or Manual Servicing Unit
• SUBSYSTEMS	Laser
• TECHNOLOGY	Comm. link: 10 gigabits/sec from each satellite. Ground computer center.
• OTHER	Weather calculation method.

ADVANCED RESOURCES/POLLUTION OBSERVATORY (CO-1) (U)

- **PURPOSE**
  To provide high quality, multispectral earth resources and pollution data.

- **RATIONALE**
  Integrated ERTS-like system, real-time data distribution to world-wide users, active sensors needed.

- **CONCEPT DESCRIPTION**
  Active and passive sensors, large aperture, high, medium, and low resolution imaging obtained in multispectral region and radar. Data disseminated by laser link through relay satellite.



- **CHARACTERISTICS**

WEIGHT	30,000 lb
SIZE	10 x 60 ft
RAW POWER	12 kW
ORBIT	500 nmi sun synch.
CONSTELLATION SIZE	1
LIFE/SERVICING PERIOD	10/3 Years
TIME FRAME	1985
IOC COST	350 M

- **PERFORMANCE**
  Multispectral resolutions varying from ≤ 10 to ≤ 100 ft obtained world-wide.

- **BUILDING BLOCK REQUIREMENTS**

TRANSPORTATION	Shuttle and Tug
ON-ORBIT OPERATIONS	Shuttle attached manipulator, servicing stages
SUBSYSTEMS	Guidance and navigation; attitude control; transmitter
TECHNOLOGY	Large radar antenna; high power tubes and modulator; LSI data processor
OTHER	None

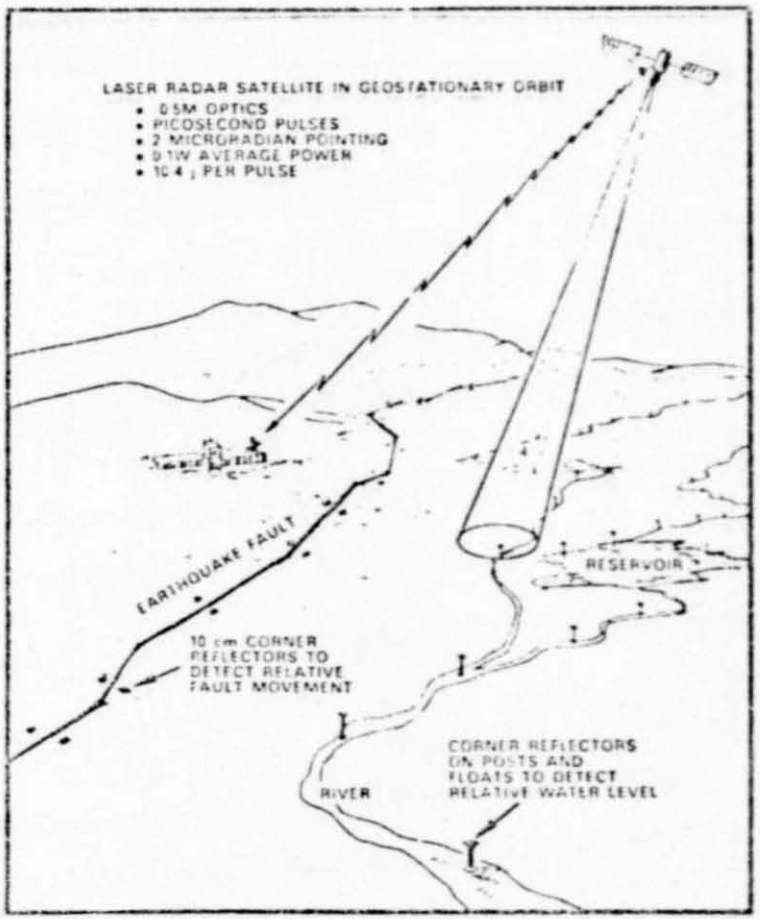
(A1)

WATER LEVEL AND FAULT MOVEMENT INDICATOR (CO-3)

- **PURPOSE**
  To make precision measurements in many places in rapid succession for aid in earthquake prediction, water resources establishment, disaster use, etc.

- **RATIONALE**
  Prediction of earthquakes, floods, droughts, and accurate water resources would be of great social and economic benefit.

- **CONCEPT DESCRIPTION**
  Picosecond (10^{-12} sec) pulsed laser radar in orbit obtains precision differential range measurements from corner reflectors implaced on both sides of faults, river banks and floats, etc.



- **CHARACTERISTICS**

WEIGHT	800 lb
SIZE	0.5 m optics
RAW POWER	250 W
ORBIT	Geostationary
CONSTELLATION SIZE	1
RISK CATEGORY	1 (Low)
TIME FRAME	1985
IOC COST (SPACE ONLY)	50 M

- **PERFORMANCE**
  Relative range obtained to ± 0.03 millimeters at any number of points separated by 100 meters or more. 10^5 instrumented points can be measured every hour.

- **BUILDING BLOCK REQUIREMENTS**

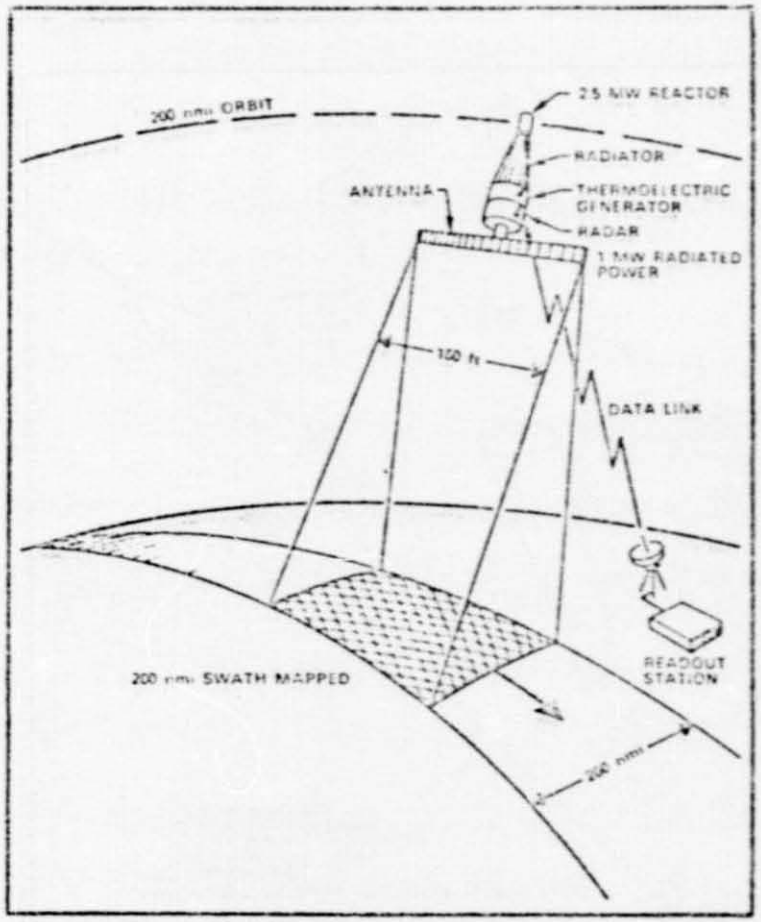
TRANSPORTATION	Shuttle, IUS/Tug
ON-ORBIT OPERATIONS	Automated or manned servicing
SUBSYSTEMS	Picosecond receiver, transmitter, 2 μr pointing
TECHNOLOGY	Streak camera converter, mode locked laser and switch
OTHER	

HIGH RESOLUTION EARTH MAPPING RADAR (CO-13)

- **PURPOSE**
  To provide maps of the surface with high resolution through cloud cover.

- **RATIONALE**
  Resources, pollution, crop, water, and other observations may be aided by high resolution and frequent coverage regardless of weather.

- **CONCEPT DESCRIPTION**
  Synthetic array radar of very high power provides high resolution. On-board image processing allows microwave data link for all weather capability.



- **CHARACTERISTICS**

• WEIGHT	110,000 lb
• SIZE	15 x 160 ft
• RAW POWER	2.5 MW
• ORBIT	200 nmi polar
• CONSTELLATION SIZE	1
• LIFE/SERVICING PERIOD	10/1 yr
• TIME FRAME	1990
• IOC COST	500 M

- **PERFORMANCE**
  200 nmi ground swath mapped to less than a few feet resolution once a day. U. S. covered every six days.

- **BUILDING BLOCK REQUIREMENTS**

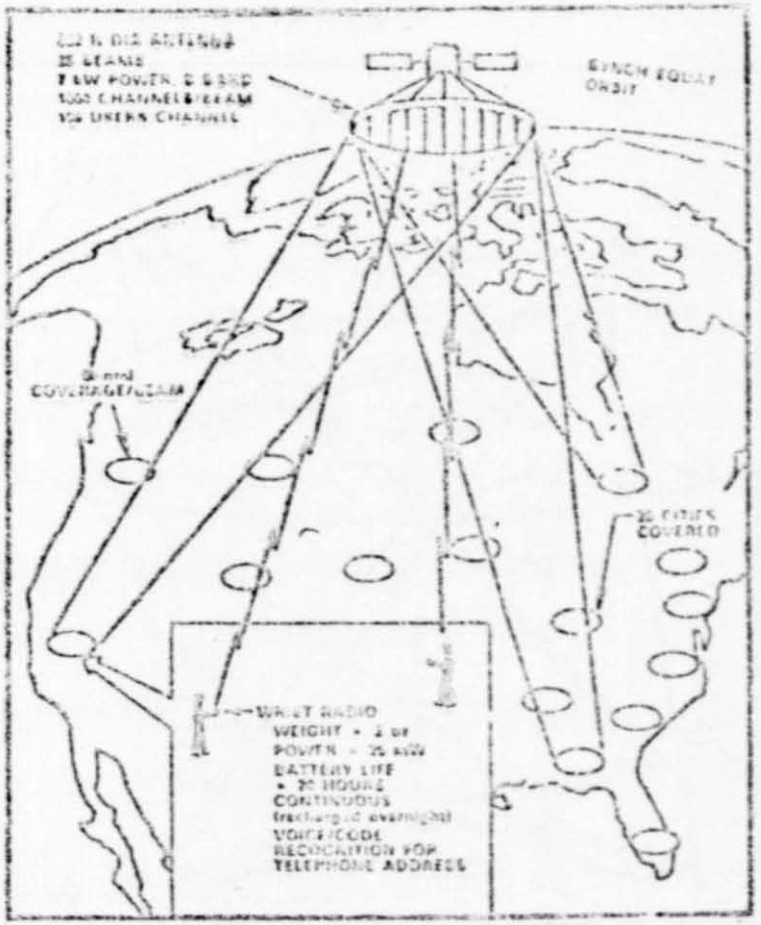
• TRANSPORTATION	Shuttle
• ON-ORBIT OPERATIONS	Shuttle manipulator; servicing
• SUBSYSTEMS	Thermal, nuclear, power generator, radar
• TECHNOLOGY	High power transmitter; automated image processor, reactor, shielding
• OTHER	None

PERSONAL COMMUNICATIONS WRIST RADIO(100-9)

- **PURPOSE**
  To allow citizens to communicate through exchanges by voice, from anywhere.

- **RATIONALE**
  Mobile telephones are desirable, but should be wrist worn. Uses include emergency, recreation, business, rescue, etc.

- **CONCEPT DESCRIPTION**
  Multichannel switching satellite and wrist transmitter-receivers connect people anywhere to each other directly or to telephone networks. Analog or vocoded voice used.



- **CHARACTERISTICS**

• WEIGHT	16,000 lb
• SIZE	200 ft dia antenna
• RAW POWER	21 kW
• ORBIT	Synch. Equat.
• CONSTELLATION SIZE	1
• RISK CATEGORY	1 (Low)
• TIME FRAME	1990
• IOC COST (SPACE ONLY)	300M

- **PERFORMANCE**
  25,000 simultaneous voice channels, each shared by up to 100 users: 2.5 million people communicate by normal voice.

- **BUILDING BLOCK REQUIREMENTS**

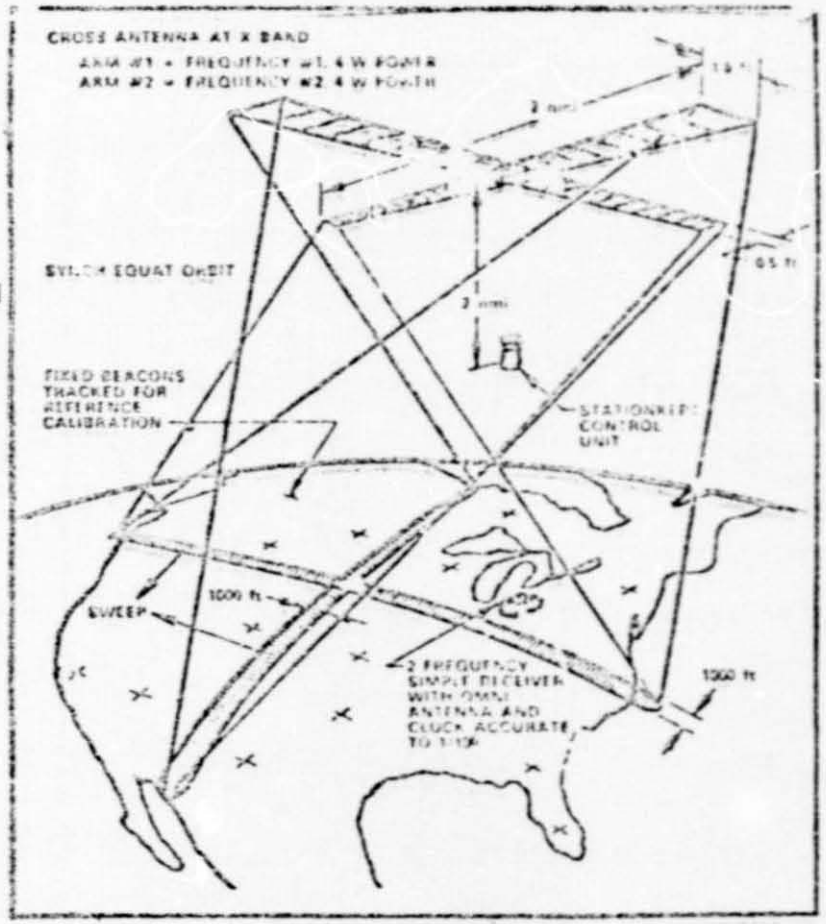
• TRANSPORTATION	Shuttle and large/tandem tug or SEPS
• ON-ORBIT OPERATIONS	Automated or manual servicing unit; assembly on orbit
• SUBSYSTEMS	Attitude control; antenna; processor; repeater
• TECHNOLOGY	Large multibeam antenna; multi-channel repeater; LSI processor, multiple-access techniques
• OTHER	Wrist transceiver, LSI technology

PERSONAL NAVIGATION WRIST SET (CS-7)

- **PURPOSE**
  To provide accurate relative position location with very inexpensive user equipment.

- **RATIONALE**
  Navigation system costs are dominated by user equipment costs.

- **CONCEPT DESCRIPTION**
  Narrow beams are swept over the U. S. by large phased arrays in space. Very simple receivers measure time elapsed between pulses received and display distances (N-S, E-W) to fixed point.



- **CHARACTERISTICS**

WEIGHT	3000 lb
SIZE	2 nmi cross
RAW POWER	2 kW
ORBIT	Sync. Equat.
CONSTELLATION SIZE	1
RISK CATEGORY	II (Moderate)
TIME FRAME	1990
IOC COST (SPACE ONLY)	100 M

- **PERFORMANCE**
  User position located to 300 ft every .0 sec relative to a fixed location < 100 nmi away.

  User receiver can cost less than $1) in mass production.

- **BUILDING BLOCK REQUIREMENTS**

TRANSPORTATION	Shuttle and Tug
ON-ORBIT OPERATIONS	Manned or automated assembly and servicing units
SUBSYSTEMS	Antenna with independently stationkept subunits.
TECHNOLOGY	Ion thruster, adaptive RF phase control, laser master measuring unit
OTHER	LSI receivers

THEME #11 GLOBAL SERVICE SYSTEMS

TECHNOLOGY AREAS OF EMPHASIS

LARGE SPACE STRUCTURES FOR ANTENNAS, SENSOR PLATFORMS
(TO > 100M DEPLOYABLE, 1 KM ERECTABLE)

CONTROL AND STABILIZATION FOR SENSOR POINTING AND ORIENTATION
($\gg$ 1 ARC SECOND)

SPACECRAFT POWER FOR MULTIPLE SENSORS, SIGNAL PROCESSORS AND COMMUNICATIONS

($\gg$ 2 KW)

AUXILIARY PROPULSION FOR LONG LIFE ORBITS AND STATIONKEEPING

(5-10 YEAR OPERATING LIFE)

MULTIPURPOSE SENSORS FOR INCREASED RESOLUTION, SENSITIVITY SPECTRAL RANGE
($\ll$ 10 METER GROUND RESOLUTION)

END-TO-END DATA MANAGEMENT FOR CONVERTING RAW DATA TO USER-ORIENTED KNOWLEDGE IN NEAR-REAL-TIME

SUPPORTING PROPOSALS - #11-GLOBAL SERVICE SYSTEMS SUPPORTING INITIATIVES

		N.I. NO.		FY 78	I.I.C.
o DIRECT SUPPORT	1.	103	CCD - UNIFIED DATA PROCESSOR * (10)		
	2.	104	DEXTEROUS MANIPULATOR *	0.3	2.8
	3.	105	ATTITUDE CONTROL OF LARGE STRUCTURES *	0.2	0.6
	4.	112	NICKEL/HYDROGEN BATTERY *	0.2	0.6
	5.	113B	LAZER HETERODYNE SPECTROMETER * (10)	---	---
	6.	113C	EXPERIMENT ISOLATION AND POINTING SYSTEM *	0.6	4.1
	7.	113D	MICROWAVE RADIOMETER	0.3	4.0
	8.	114	LARGE AREA SPACE STRUCTURES *(8)	---	---
	9.	115	ON-BOARD CCD PROCESSOR * (10)	---	---
	10.	118	SPHINX B/C * (7)	---	---
	11.	120	SILVER/HYDROGEN BATTERY * (10)	---	---
	12.	121	41-43 GHF TRANSPONDER * (11)	0.5	3.0
	13.	306	50-500 WE ISOTOPE POWER SYSTEM *		
o GENERICALLY OR	14.	110	SETI * (9)		
PARTLY RELATED	15.	125	CRYOGENIC FLUID MANAGEMENT *		

SUPPORTING PROPOSALS - #11-GLOBAL SERVICE SYSTEMS SUPPORTING INITIATIVES (CONTINUED)

		N.I. NO.		FY 78	I.T.C.
	16.	128	ATL *		
	17.	303	PHOTO CHEMICAL SOLAR CONVERSION		
	18.	308	HYDROGEN/OXYGEN FUEL CELL *		
	19.	310	HIGH POWER DENSITY COMPONENTS		
	20.	312	BRAYTON ISOTOPE POWER		
o TASK-TEAM	21.	---	MULTIPURPOSE SENSORS		
IDENTIFIED	22.	---	MODULAR END-TO-END INFORMATION	0.5	6.0
			MANAGEMENT	1.0	13.0

PRELIMINARY FY 78 TOTAL TO AA: $3.6M, TTC. 34.1M

THEME #11 GLOBAL SERVICE SYSTEMS

ISSUES AND PROBLEMS

TECHNICAL: QUANTUM JUMPS IN TECHNICAL CAPABILITY NEEDED
LARGE NUMBER OF RELEVANT NEW INITIATIVES
SPHINX B/C, LASS, EIPS, LHS, CCD DATA PROCESSORS
END-TO-END DATA MANAGEMENT

SOCIO-POLITICAL: INDIVIDUAL PRIVACY, SECURITY
NATIONAL BOUNDARIES, SECURITY
AGENCY RESPONSIBILITES

THEME TEAM:

	NASA		EXTERNAL
CHAIRMAN --	PONTIOUS, RE	WALLACE, MSFC	RTAC
	ERNST, E	WOLFF, GSFC	ASEB
	SIVO, LERC	MOORE, LARC	DDR&E, NOAA, EPA, DPT. AGRIC.
	HIBBS, JPL	PLOTKIN, GSFC	GE, AEROSPACE, TRW, HUGHES
		DEERWESTER, ARC	

Theme #11 - Global Service Systems

The objective of the Global Serivce Systems theme is to provide the technology needed to enable a 1000 fold increase in man's ability to use space for his own betterment and benefit. The workshop activity has centered on a review of the theme concept and a more detailed evaluation of technology requirements. Results of the workshop activity are summarized in the following paragraphs.

1. Theme Concept

The definition and assessment of technology requirements for Global Service Systems was based on a time-phased mission scenario. In the initial phase (1978-1985 era) it was postulated that user-oriented space missions would operate in varied orbits designed to evaluate the potential payoffs of global space observations and operations, and to serve as precursors or first-generation operational systems. Each mission would be dedicated to a particular function such as earth observation, hazard warning, weather prediction or pollution monitoring. Functional operation would be controlled through a central ground-based facility responsible for acquisition fo data from a satellite and distribution of that data to the user community. Primary technical emphasis during this phase of the scenario would be placed on the development of data management techniques and a refinement of sensor technology.

The second phase of the mission scenario (1985-2000 era) contemplated a limited number of multifunction satellites located in geosynchronous orbit and supported by a series of dedicated, single-function satellites in low-earth or sun-synchronous orbits. The principle operational change in this era would be user access to satellite generated information on a direct, real-time basis. Implicit in this mode of operation was the technical requirement for high speed, on-board data processing technology and low-cost user terminals. Large antenna structures in space, high levels of power generation and storage, long life, auxiliary propulsion, precision pointing, autonomous operational capability and improved sensors would also be technical requisites to mission operations in this phase.

Review of the mission scenario by the theme team assembled at the workshop produced general agreement with the overall approach. Exchanges between working group and theme team representatives emphasized the basic need for effective data management as a major technical prerequisite to operational global service systems. Theme team discussions pointed to the critical need for predictive models capable of assimulating large quantities of data from multiple sources. Such a capability is essential to the development of operational real-time user interfaces with space observation systems.

The theme team also considered the credibility of the Global Service Systems theme as a coupling mechanism for OAST technology efforts with future NASA and national needs. Their conclusions generally supported the validity of this theme as a focus for OAST technical activities, especially in the data handling and sensors area. They found direct couplings between the theme concept and the new program thrusts being developed by the Office of Applications, e.g. Communications and Environmental/Resources/Earth Sciences. The overall relevance of global observations and operations to the application of space for local, national and international benefits further substantiates the credibility of this theme area.

2. Technology

Technology needs identified in the theme concept generally covered the total discipline spectrum of OAST with emphasis on quantum improvements in performance capability and system cost reduction. The Working Group reviews of the mission scenario and conceptual program descriptions reiterated the need for substantial performance gains. Emphasis on data systems, software, sensor technology, power, thermal control, large structures, and precision pointing and control systems was substantiated. The most critical areas identified were data systems and software which would be expected in a theme area heavily oriented toward the acquisition of data and the translation of that data into useful information for a broad spectrum of users.

Practical attainment of needed technology did not present an insoluble problem to the Working Groups. Of the 34 highest priority technology needs identified for this theme, half were considered enabling technology by the technical experts. The remainder were classed as enhancing technology of varying degrees of risk. A very limited amount of current R&T Base activities were associated directly with this theme, possibly because of the heavy emphasis on SETI, Extra Solar Exploration and Multiple Space Power Platforms by many of the Working Groups. The limits of achievable technology are probably governed by the availability of resources to support its development, therefore, a tradeoff between technology cost and capability should be considered. A very important part of such a tradeoff is an explicit definition of technology needs and, for this theme, the emphasis on modelling techniques which can predict system requirements.

3. Critical Issues

Reviews by both the theme team and the Working Groups identified three issues of vital importance to further development of technology for Global Service Systems. The first issue is the need for prediction modelling capability within the agency which was discussed in preceeding paragraphs. The second critical issue was the need for more emphasis on mission

definition. This issue was emphasized in discussions with the Working Groups where a better definition of mission characteristics was needed to properly assess technical requirements and capabilities. The third critical issue was a need for a better appreciation or coupling with the ultimate users of Global Service Systems. This last issue involves both credibility of theme and mission models of which reflect real user needs. It is necessary to instill confidence in the technical tasks undertaken to support the development of Global Service Systems.

OVERALL THEME TECHNOLOGY RANKING AND INITIATIVE ACTION

TT # 11 Global Service Systems

FORM V
PAGE 1
DATE 4/29/76

TECHNOLOGY NEED NO	OVERALL T.T PRIORITY	INITIATIVE ACTION		
		REVISE EXISTING INITIATIVE	DRAFT NEW INITIATIVE	NONE REQUIRED
E-2-01 End-to-End Data Mgm't	1			
E-4-01 Multidimension Data Systems	2			
E-2-05 Hi Rate Data Processing	3			
E-3-xx Microwave Sensor & Comp.	4			
E-1-04 Precision Pointing (Non-inertial)	5			
E-4-11 Operations Languages	6			
E-2-04 Data Set Selection	7			
M-1-03 Long Life Cryogenic Systems	8			
E-2-14 Large Capacity Ground Storage	9			
E-2-08 Large Capacity Onboard Storage	10			
E-1-11 Autonomous Operations	11			
E-3-xx UV/Visible/IR Components	12			
E-2-09 Low Cost User Distribution	13			
P-2-PC-7 Solar Arrays	14			
M-2-08-1 Large Structures Deployed	15			
M-2-08-2 Large Structures Assembled	16			

OVERALL THEME TECHNOLOGY RANKING AND INITIATIVE ACTION

TT # 11 Global Service Systems

FORM V
PAGE 2
DATE 4 / 29 / 76

TECHNOLOGY NEED NO	OVERALL T.T PRIORITY	INITIATIVE ACTION		
		REVISE EXISTING INITIATIVE	DRAFT NEW INITIATIVE	NONE REQUIRED
E-1/15 Control of Large Structures	17			
P-1/12, 13 MPD, Elec. Prop., OTV	18			
E-4/9 System Integrity	19			
P-2/ES-3 Long-Life, Light Nicads	20			
P-2/PP-1 Electron Power Condition	21			
E-1/23 Robotics and Teleoperators	22			
E-4/6 Pattern Recognition	23			
E-4/13 Algorthms/Numer. Anal.	24			
E-2/3 Modular Data Sys. Architec.	25			
P-2/PP-8 Multi-K.W. Distrib.	26			
E-3/(misc.) U.V./Vis/I.R. Instru.	27			
E-3/(misc) Laser Technology	28			
E-1/5 Autonomous Navigation	29			
E-4/12 Intelligent Executive	30			
E-4/10 Evolutionary Software	31			
E-2/13 Pattern Recog. Analyzer	32			

OVERALL THEME TECHNOLOGY RANKING AND INITIATIVE ACTION

TT # 11 Global Service Systems

FORM V

DATE 4/29/76

TECHNOLOGY NEED NO	OVERALL T.T PRIORITY	INITIATIVE ACTION		
		REVISE EXISTING INITIATIVE	DRAFT NEW INITIATIVE	NONE REQUIRED
M-2-08-3 Large Structures Manufactured	33			
M-1-02 Materials for InSitu Manufacture	34			