FY 79 - LSST ANTENNA TECHNOLOGY DEVELOPMENT

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For review purposes, the objective and near-term technology requirements of the LSST antenna development effort are listed below.

LSST
REFLECTOR CONCEPT DEVELOPMENT

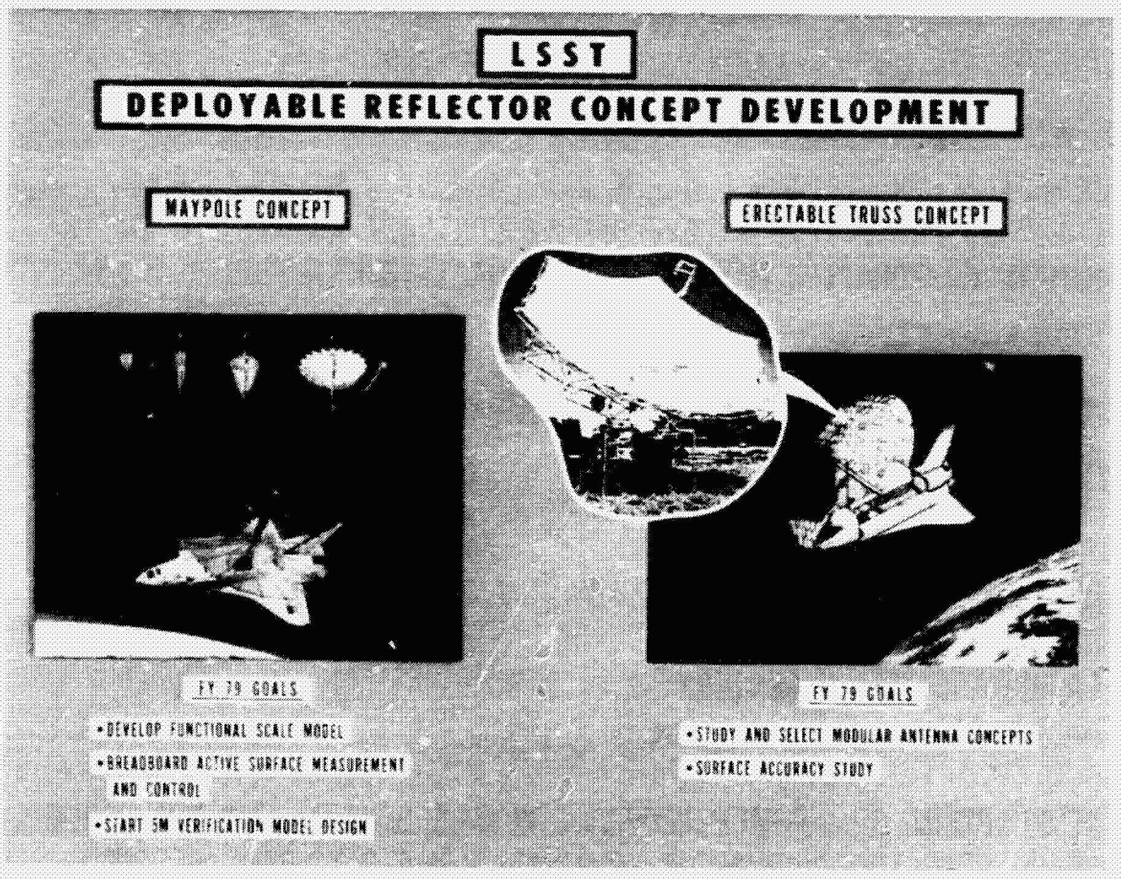
OBJECTIVE

- TO DEVELOP TECHNOLOGY NEEDED TO EVALUATE, DESIGN, FABRICATE, PACKAGE, TRANSPORT AND DEPLOY LARGE ANTENNA SYSTEMS FOR CLASSES OF POTENTIAL APPLICATIONS.

TECHNOLOGY REQUIREMENTS (NEAR TERM)

- TO DEVELOP DEPLOYABLE ANTENNA SYSTEMS
- SIZE RANGE UP TO 100 METERS IN DIAMETER
- FREQUENCY RANGE 1 TO 15 GHz
- TECHNOLOGY AVAILABLE CY 1983

The deployable reflector concept development effort for FY 79 was divided into two concept areas--the Maypole (Hoop/Column) for near term applications, and the Erectable Truss Concept for far term mission applications.



Associated with the Maypole and Erectable Truss development efforts are the following tasks for FY 79.

LANGLEY RESEARCH CENTER

- DEPLOYABLE REFLECTOR CONCEPT DEVELOPMENT - MAYPOLE (HOOP/ COLUMN); PHASE I TASK DEVELOPMENT CONTRACT AWARDED TO THE HARRIS CORPORATION MAY 1, 1979. (NAS1-15763)

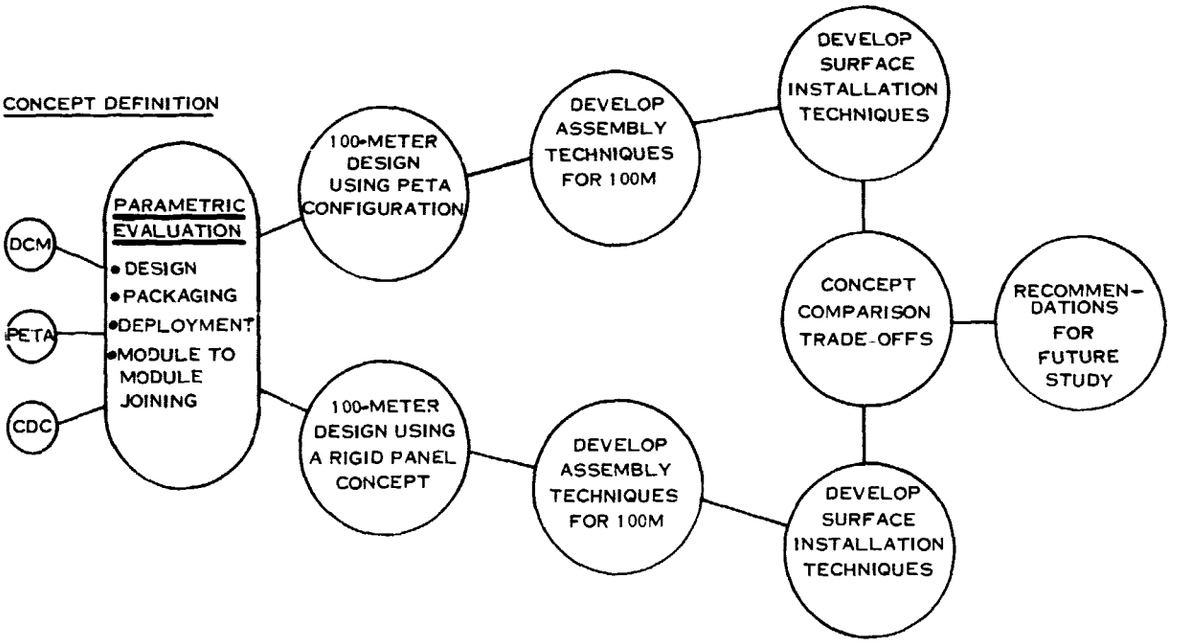
- MODULAR REFLECTOR STUDY CONTRACT AWARDED TO GENERAL DYNAMICS APRIL 5, 1979. (NAS1-15753)

- DEVELOPMENT OF ELECTROMAGNETIC ANALYSIS METHODS FOR LARGE APERTURE ANTENNAS. (CONTINUING IN-HOUSE ACTIVITY AT THE LANGLEY RESEARCH CENTER)

- DEVELOPMENT OF SURFACE ACCURACY MEASUREMENT SYSTEM FOR LARGE SPACE STRUCTURES; PHASE-I CONTRACT AWARDED TO TRW, REDONDO BEACH, CA; SEPTEMBER 12, 1978. COMPLETION OF PHASE-I FEBRUARY 15, 1980. (NAS1-15520)

The technology development plan for the modular reflector concepts is shown below. After completing the parametric evaluations, design configurations for 100-meter diameters using the PETA and the rigid panel concepts were to be developed for concept comparison and trade-off studies.

MODULAR REFLECTOR CONCEPT DEVELOPMENT



The following accomplishments were made in FY 79 related to the development of modular reflector concepts.

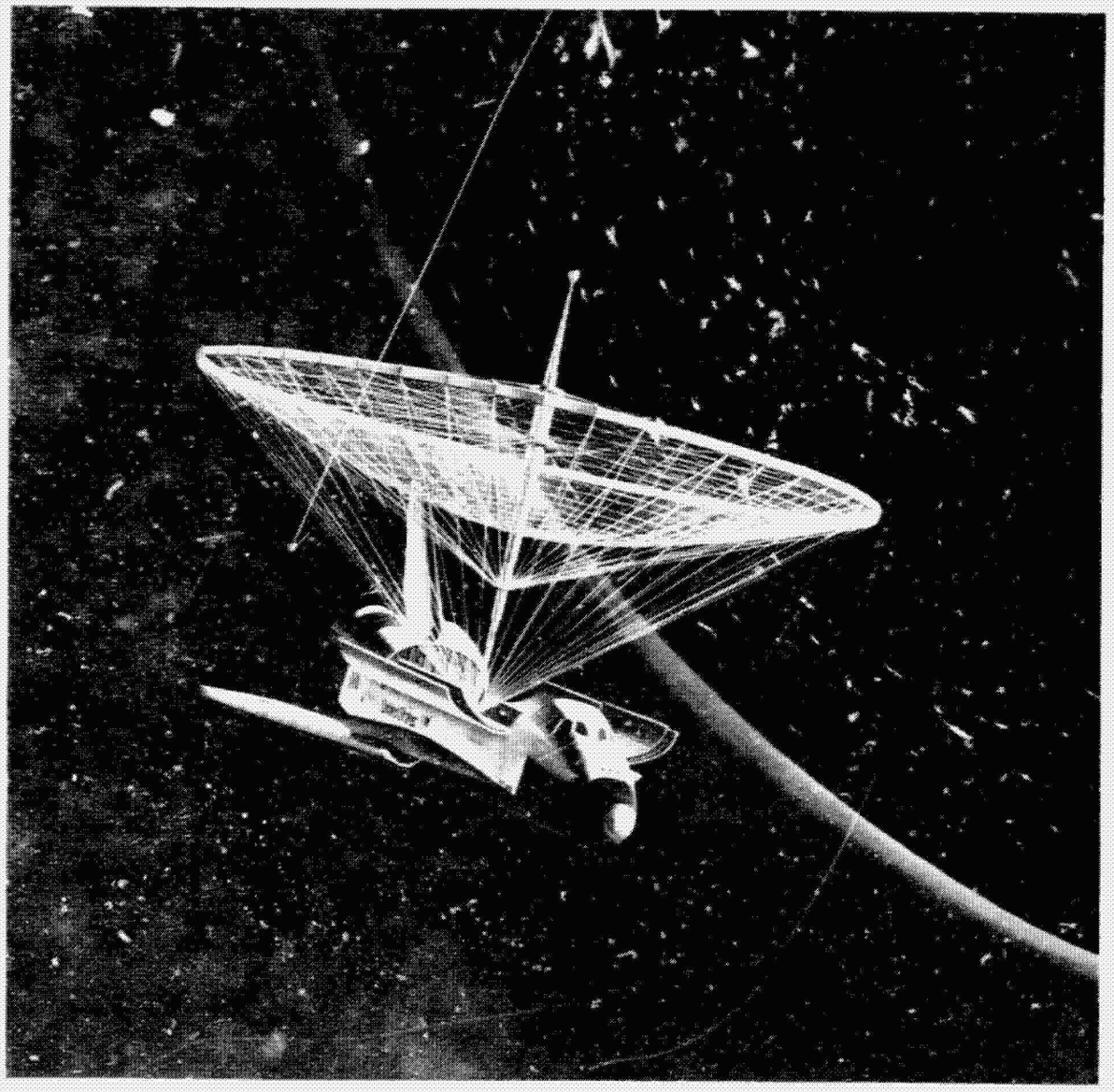
MODULAR REFLECTOR CONCEPTS STUDY

NAS1-15753
GENERAL DYNAMICS

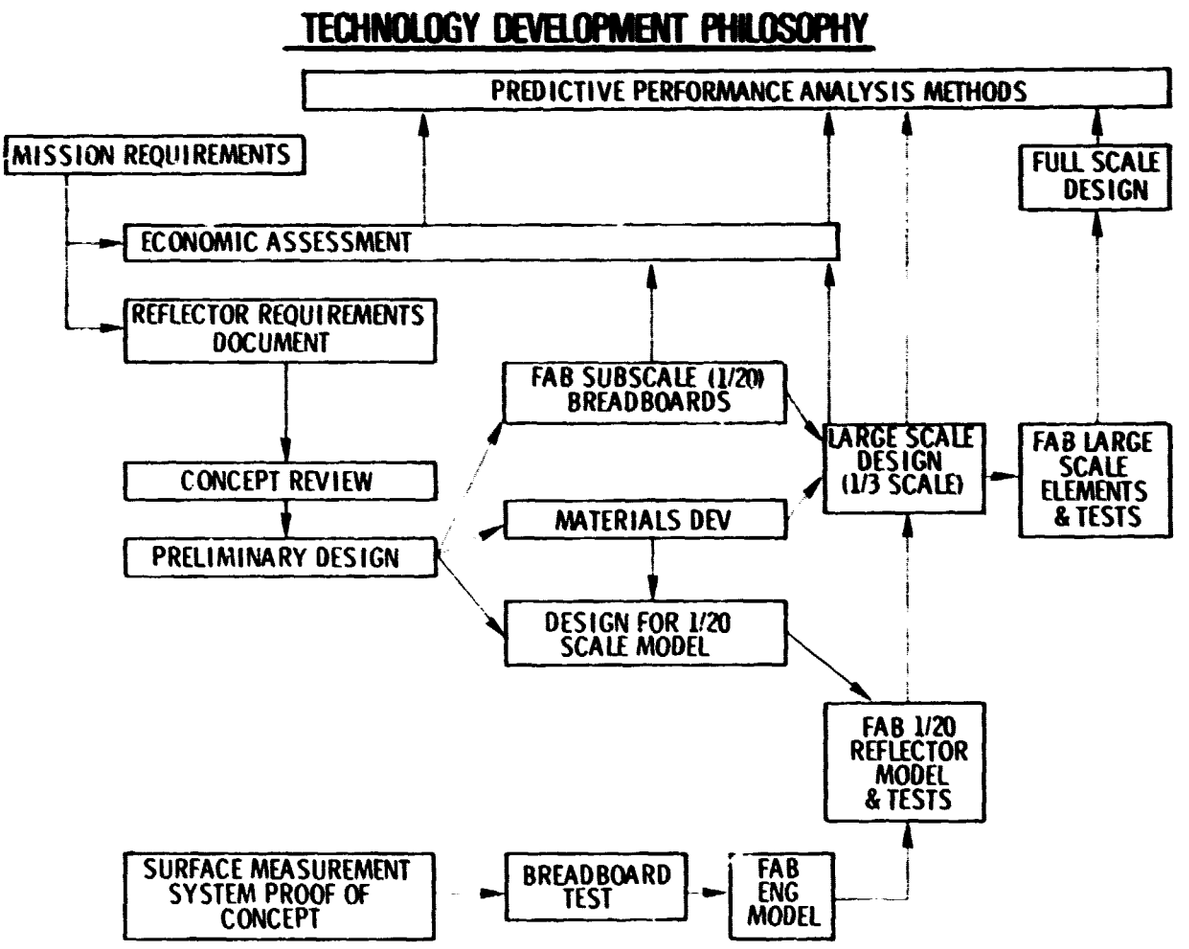
ACCOMPLISHMENTS

- PARAMETRIC CURVES HAVE BEEN DEVELOPED TO SIZE FACETTED ANTENNA SURFACES
- PACKAGING AND DISPENSING ARRANGEMENTS HAVE BEEN DEVELOPED FOR DCM AND PETA CONCEPTS
- PRELIMINARY ASSEMBLY STUDIES OF PETA ASSEMBLY TECHNIQUE COMPLETED
- PRELIMINARY DESIGNS FOR 100 METER REFLECTORS BEING ESTABLISHED

In the deployable reflector area for near term mission applications, a Maypole (Hoop/Column) concept is being developed by the Langley Research Center for LSST. Shown below is an artist's view of the antenna as deployed from shuttle.

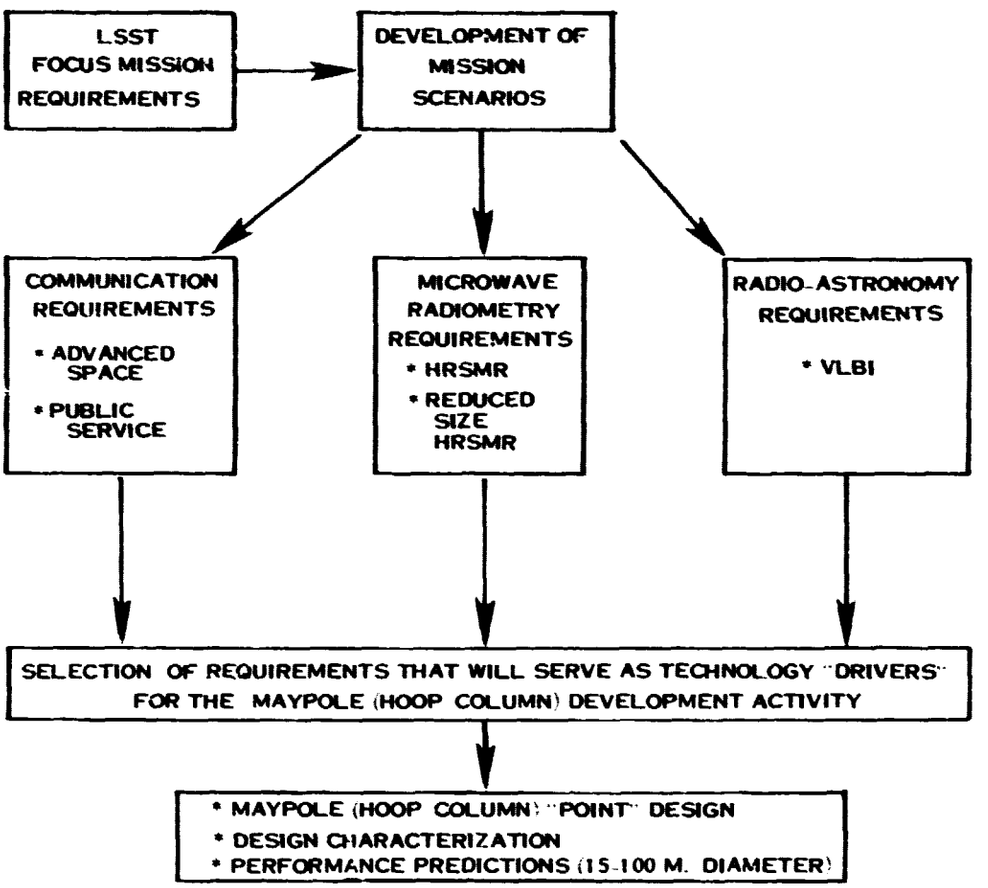


Shown below is the technology development philosophy that is underway for the Maypole (Hoop/Column) development effort. Included in this plan shall be: (1) a review of the mission requirements; (2) an economic assessment of the reflector technology; (3) concept review; (4) preliminary design using subscale and intermediate scaled elements; and (5) the integration of the surface measurement system with the reflector. Throughout this technology development activity, confidence in the design of critical items shall be obtained through the fabrication and test of subscale, intermediate, and full scale components. All of these outputs shall input the development and verification of the predictive analysis methods.



One of the first activities associated with the Maypole development effort is to develop possible mission scenarios (using the LSST near term focus mission) so that the reflector configuration and requirements could be determined. The following view graph presents the approach used in defining the technology drivers and the subsequent "point" design for the reflector activity.

LSST CONFIGURATION/REQUIREMENT DEFINITION APPROACH FOR THE MAYPOLE (HOOP/COLUMN) DEVELOPMENT ACTIVITY



In developing the scenario for the communications mission, the recent results of a Langley contract with TRW are prevalent and shall influence the LSST activity. The TRW multiple beam antenna study represents the only known multiple beam work that has been undertaken by NASA during the past several years. Therefore, it was believed to be important to briefly report on the results of this work during this RTR review. The following view graph presents the objectives of the multiple beam study.

KU-BAND MULTIPLE BEAM ANTENNA PROGRAM OBJECTIVES

CONUS SPOT BEAM ANTENNA

- DEVELOP A 12/14 GHz MULTIPLE BEAM ANTENNA FOR CONTIGUOUS SPOT BEAM COVERAGE OF CONUS PLUS ALASKA AND HAWAII
- FREQUENCY REUSE ACHIEVED THROUGH A COMBINATION OF FREQUENCY PLAN, POLARIZATION ORTHOGONALITY, LOW SIDELOBE BEAMS
- APPLICATION IS HIGH CAPACITY POINT-TO-POINT COMMUNICATIONS AND DIRECT BROADCAST SERVICE
- BUILD AND TEST A BRASSBOARD MODEL ANTENNA TO:
  - EVALUATE THE MULTIPLE BEAM ANTENNA DESIGN CONCEPT
  - ESTABLISH ACHIEVABLE BEAM ISOLATION AND GAIN
  - DETERMINE PERFORMANCE CHARACTERISTICS OF KEY ELEMENTS OF ANTENNA HARDWARE
  - PROVE FEASIBILITY OF A FLIGHT MODEL ANTENNA

CONUS SPOT BEAM ANTENNA

DESIGN SPECIFICATIONS AND MEASURED CAPABILITIES

	SPECIFICATIONS	MEASURED CAPABILITIES
DOWNLINK FREQUENCY	11.7 TO 12.2 GHz	11.7 TO 12.2 GHz
UPLINK FREQUENCY	14.0 TO 14.5 GHz	14.0 TO 14.5 GHz
POLARIZATION	ORTHOGONAL LINEAR	ORTHOGONAL LINEAR
COVERAGE	CONTIGUOUS CONUS, ALASKA AND HAWAII	CONTIGUOUS CONUS, ALASKA AND HAWAII
NUMBER OF BEAMS	ABOUT 25 BEAMS	17 BEAMS
SIDELOBE LEVEL	-32 dB	-36 dB AT BORESIGHT -32 dB OFF BORESIGHT
CROSS POLARIZATION	-28 dB	-32 dB
BEAM CROSSOVER LEVEL	-7 dB FOR DOWNLINK -9 dB FOR UPLINK	-6 dB FOR DOWNLINK -8 dB FOR UPLINK
BEAM ISOLATION	28 dB	TBD
FEED CIRCUIT LOSS	<0.30 dB	<0.20 dB
INPUT VSWR	<1.4:1	<1.2:1
REFLECTOR DIAMETER	200 CM APPROXIMATELY	200 CM
POWER HANDLING CAPACITY	100 WATTS AVERAGE POWER	100 WATTS

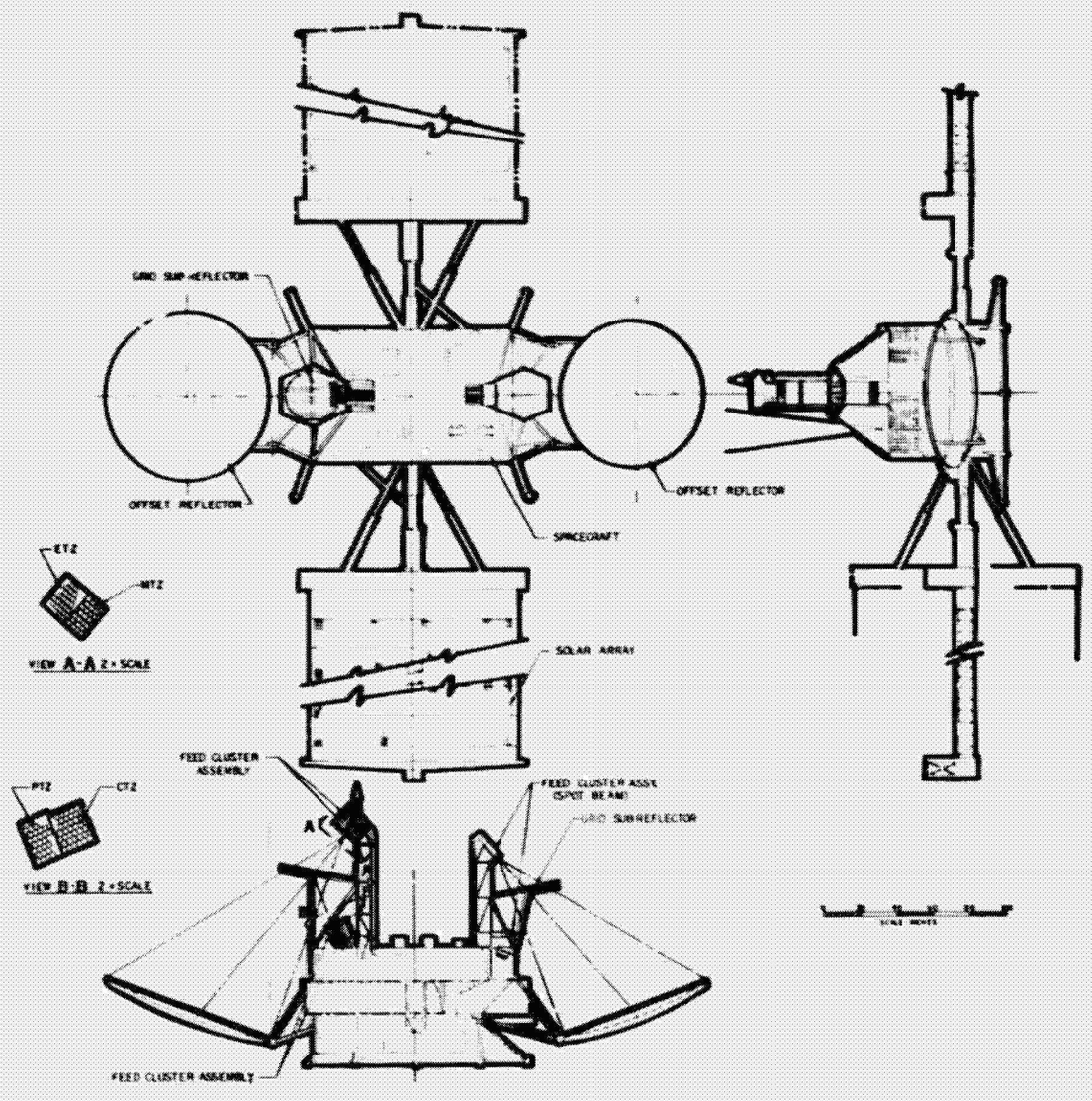
CONUS SPOT BEAM ANTENNA

KEY DESIGN FEATURES

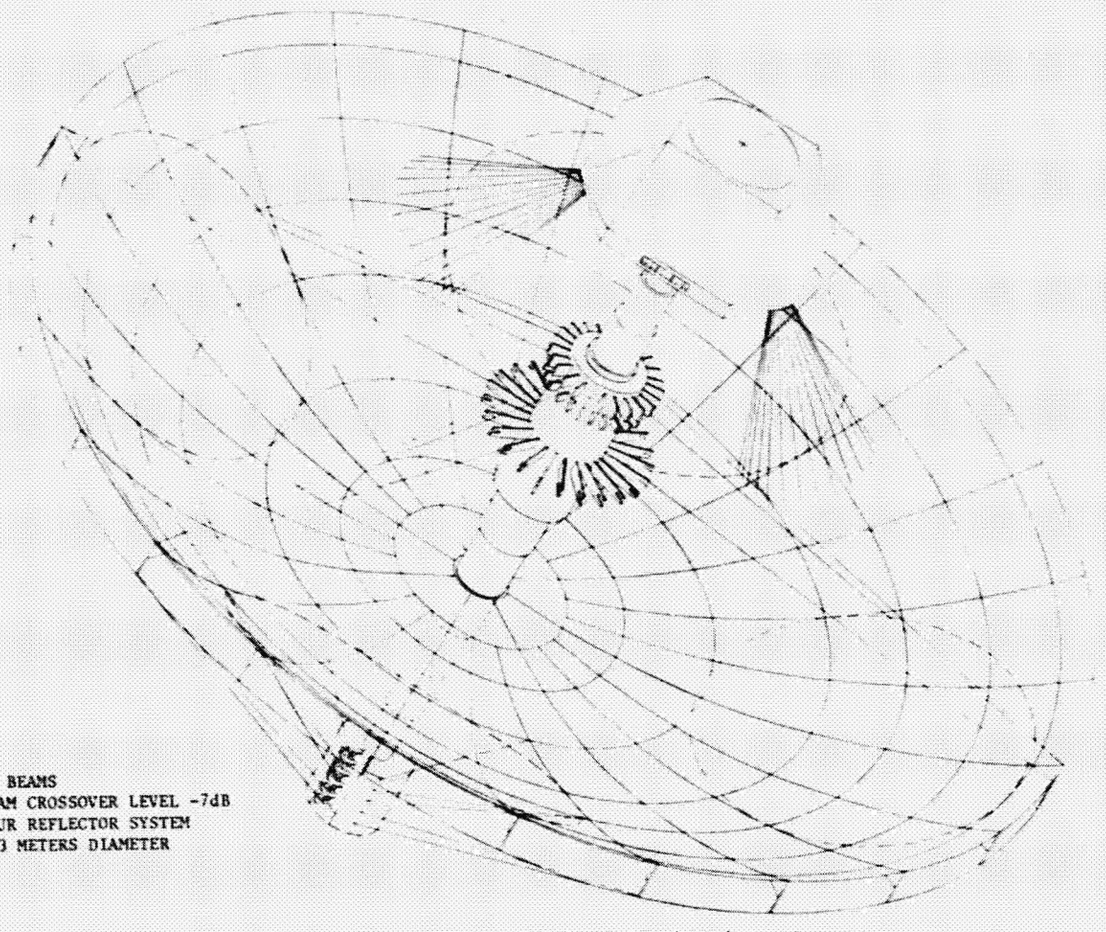
- 15-BEAM COVER CONUS PLUS TWO SEPARATE BEAMS FOR ALASKA AND HAWAII
- EACH BEAM UTILIZES ONE-HALF OF THE 500 MHz BANDWIDTH AVAILABLE FOR BOTH UPLINK AND DOWNLINK COMMUNICATIONS
- BEAMS OF THE SAME COLOR ARE COPOLARIZED AND IN THE SAME FREQUENCY BAND
- BEAMS IN ADJACENT ROWS ARE ISOLATED BY FREQUENCY SEPARATION
- ADJACENT BEAMS IN A ROW ARE ORTHOGONALLY POLARIZED
- 17-BEAM SYSTEM REQUIRES TWO 2-METER OFFSET REFLECTORS WITH 17 FEEDS
- EACH FEED CONSISTS OF A 9-HORN CLUSTER TO PRODUCE ONE SPOT BEAM
- EACH OFFSET REFLECTOR IS CONFIGURED WITH A WIRE GRID SUBREFLECTOR TO DIPLEX ORTHOGONALLY POLARIZED FEEDS (BEAMS)
- EACH FEED IS LINEARLY POLARIZED AND OPERATES BOTH DOWNLINK (11.7 - 12.2 GHz) AND UPLINK (14.0 - 14.5 GHz)

A conceptual satellite configuration using the multiple beam design is shown below. In order to meet the requirements, two offset fed reflectors are needed for beam interleaving.

CONCEPTUAL SATELLITE CONFIGURATION



Shown below is how the Maypole (Hoop/Column) could be used to produce the 17-beam CONUS coverage as described in the TRW study. This configuration is for an F/D <1.0.

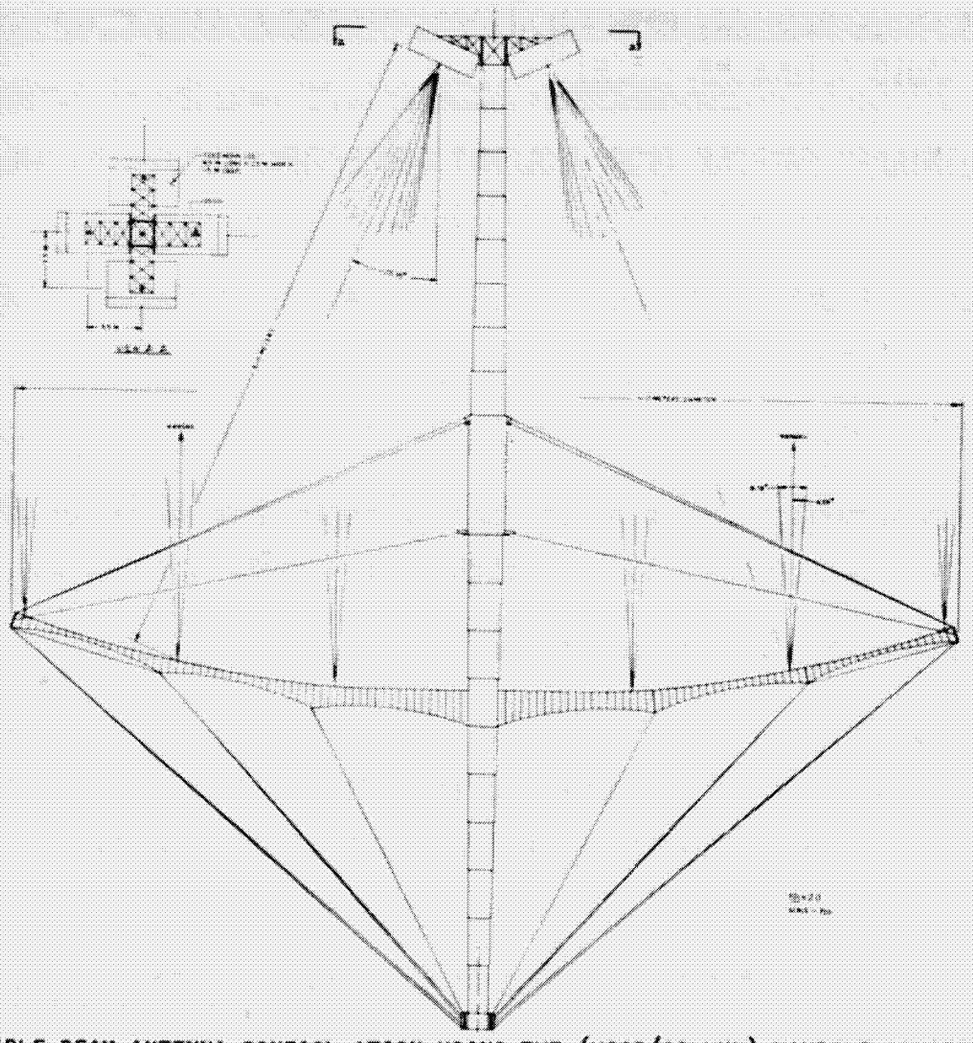


17 BEAMS
BEAM CROSSOVER LEVEL -7dB
FOUR REFLECTOR SYSTEM
7.3 METERS DIAMETER

MULTIPLE BEAM ANTENNA CONFIGURATION USING THE (HOOP/COLUMN) MAYPOLE CONCEPT FOR PROVIDING CONUS COVERAGE AT KU-BAND (ISOMETRIC VIEW).

Shown below is how the Maypole (Hoop/Column) could be used to produce 308 beams for CONUS coverage. A longer F/D = 2.0 would be required. This is basically the QUAD Aperture approach that will be discussed in the next paper by D. C. Montgomery and L. D. Sikes.

HIGH PERFORMANCE FEED CLUSTER
308 BEAMS
BEAM CROSSOVER LEVEL -3.75dB
FOUR REFLECTOR SYSTEM
CORRUGATED HORN FEED ELEMENTS (5.75λD)
61.0 METERS DIAMETER



MULTIPLE BEAM ANTENNA CONFIGU ATION USING THE (HOOP/COLUMN) MAYPOLE CONCEPT FOR PROVIDING SUBCONTINENT, C INENT, CONTIGUOUS BEAM COVERAGE (SECTION VIEW).

SUMMARY OF ACCOMPLISHMENTS

I. REFLECTOR DEVELOPMENT

- REQUIREMENTS DEFINITION: DEVELOPED SCENARIOS FOR LSST NEAR TERM FOCUS MISSION; COMMUNICATIONS, MICROWAVE RADIOMETRY, AND RADIO ASTRONOMY - VLBI.

- PRELIMINARY MAYPOLE (HOOP/COLUMN) CONCEPTUAL DESIGN OBTAINED FOR THE COMMUNICATIONS FOCUS MISSION.

- CONCEPTUAL DESIGNS OBTAINED FOR CRITICAL COMPONENTS OF HOOP/COLUMN REFLECTOR.

- PUBLICATIONS:

  A. "DEPLOYABLE REFLECTOR ANTENNA TECHNOLOGY DEVELOPMENT FOR THE LARGE SPACE SYSTEMS TECHNOLOGY PROGRAM", BY R. E. FREELAND, AND T. G. CAMPBELL. PRESENTED AT AIAA CONFERENCE MAY 1979 HAMPTON, VA.

  B. "DEVELOPMENT OF MAYPOLE (HOOP/COLUMN) DEPLOYABLE REFLECTOR CONCEPT FOR 30 TO 100 METER APPLICATIONS", BY DR. B. C. TANKERSLY, HARRIS CORPORATION. PRESENTED AT AIAA CONFERENCE MAY 1979.

  C. "NASA TECHNOLOGY FOR LARGE SPACE ANTENNAS", BY R. A. RUSSELL, T. G. CAMPBELL, AND R. E. FREELAND. PRESENTED AT 49TH STRUCTURES AND MATERIALS PANEL MEETING, OCTOBER 7-12, 1979, COLOGNE, WEST GERMANY.

Included in FY 79 was the development of Electromagnetic Analysis methods for large aperture antennas. Shown below are a few of the accomplishments.

SUMMARY OF ACCOMPLISHMENTS CONT'D.

II. ELECTROMAGNETIC ANALYSIS

° PUBLICATIONS:

A. "A PRELIMINARY STUDY OF A VERY LARGE SPACE RADIOMETRIC ANTENNA", NASA TM 80047/P.K. AGRAWAL.

B. "A METHOD FOR PATTERN CALCULATION FOR REFLECTOR ANTENNAS WHOSE GEOMETRY IS DESCRIBED BY A FINITE NUMBER OF DISCRETE SURFACE POINTS", IEEE SYMPOSIUM, JUNE 1979, P. K. AGRAWAL, AND W. F. CROSWELL.

The final activity conducted during FY 79 was the development of a Surface Accuracy Measurement Sensor for Large space systems. These accomplishments are listed below.

SUMMARY OF ACCOMPLISHMENTS CONT'D.

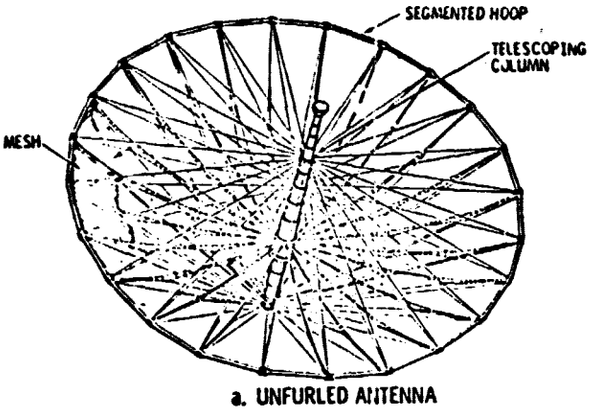
III. SURFACE ACCURACY MEASUREMENT SYSTEM

- SUCCESSFUL PROOF OF CONCEPT DEMONSTRATION AT TRW, SEPT 1979.
- PUBLICATIONS:

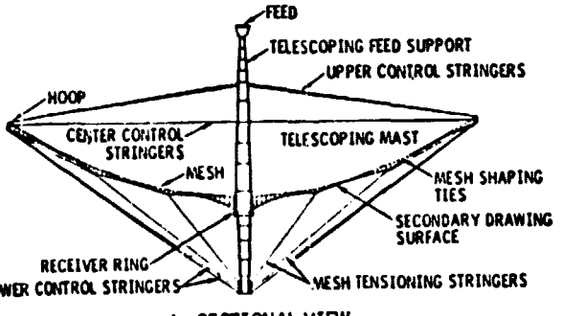
  "SURFACE ACCURACY MEASUREMENT SENSOR FOR DEPLOYABLE REFLECTOR ANTENNAS", R. S. NEISWANDER, TRW. PRESENTED AT AIAA CONFERENCE, HAMPTON, VA. MAY 1, 1979.

This view graph shows how the TRW system would be implemented using the Maypole (Hoop/Column) reflector.

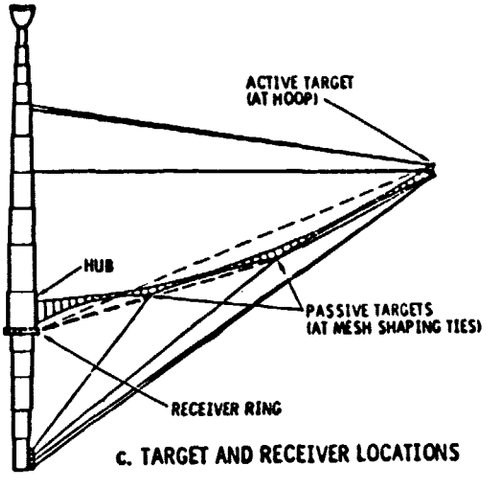
HARRIS MAYPOLE (HOOP-AND-COLUMN) MESH DEPLOYABLE ANTENNA



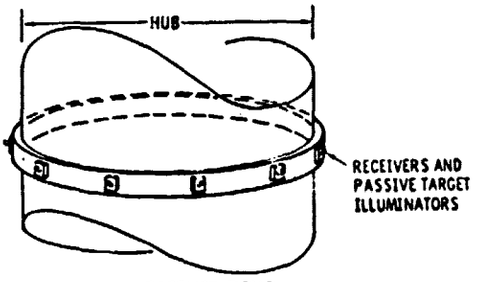
a. UNFURLED ANTENNA



b. SECTIONAL VIEW



c. TARGET AND RECEIVER LOCATIONS



d. RECEIVER RING

This photograph shows the set-up for the proof of concept demonstration of the SAMS at TRW. This set-up is basically a 1/10-scale configuration of the 100-meter reflector application.