MSFC PRESENTATION CHARTS

ON

GEOSTATIONARY PLATFORM

PRESENTED AT THE

GOVERNMENT/INDUSTRY SEMINAR ON LARGE SPACE SYSTEMS TECHNOLOGY

BY

WILLIAM T. CAREY, JR.

JANUARY 1978

GEOSTATIONARY PLATFORM (Figure 1)

(BACKGROUND)

The Geostationary Platform has been shown to be a more cost effective way of accomplishing a wide variety of geosynchronous missions in lieu of the traditional specialized satellite approach. The platform (which will be assembled in low earth orbit from elements supplied by multiple Shuttle launches for subsequent transfer to geostationary orbit), could fly as soon as 1986.

The idea of a Geostationary Platform is not new for it has been the topic of speculation and study for several years. However, now that people throughout NASA, the Aerospace Community and the potential user community have seen the Shuttle in flight, they are beginning to realize that the capability to build such large structures in space is upon us.

The concept as presented herein has been built on a set of missions provided to us by the Office of Space and Terrestrial Applications. We have also worked with them in developing the concept. Many of you have seen some of the Advanced Concepts developed by various NASA groups and their contractors. They are frequently called Public Service Platforms. Most of these concepts are extremely large and special purpose, and thus are candidates for the decade of the 90's. The platform I am talking about would be much earlier and would be multipurpose. In many ways, the Geostationary Platform can be viewed as a precursor to these large special purpose satellites.

We believe that in configuring a Geostationary Platform institutional considerations are very important. As you will see, we have maintained a clean interface between what the users would provide and the platform. Some of the benefits that a platform could offer in comparison to conducting the same missions via the traditional specialized satellite mode are shown on Figure 1.

PROGRAM DEVELOPMENT	GEOSTATIONARY PLATFORM (BACKGROUND)	CAREY DATE: JANUARY 1978

- IDEA OF A GEOSTATIONARY PLATFORM IS NOT NEW: HOWEVER, THE UTILITY AND POTENTIAL OF THE STS (INCLUDING LARGE SPACE STRUCTURES, MAN-IN-SPACE AND GEOSTATIONARY CAPABILITIES) SEEMS TO BE MORE RECOGNIZED NOW.

- WORKING WITH THE OFFICE OF SPACE AND TERRESTRIAL APPLICATIONS (OSTA) IN DEFINING CONCEPT.

- CONCEPT WHICH SEEMS TO MAKE THE MOST SENSE FOR EARLY (1986-1988) APPLICATION TAKES FORM OF A STRONGBACK STRUCTURE WITH ANTENNAS AND OTHER PAYLOADS MOUNTED THEREON.

  - VERY LARGE ANTENNAS TO FOLLOW LATER
  - INITIAL PLATFORM OVER CONUS - OTHERS FOLLOW LATER

- INSTITUTIONAL CONSIDERATIONS ARE VERY IMPORTANT

- SOME OF THE BENEFITS ARE:

  - ECONOMIES THAT CAN BE PASSED ON TO USERS
  - ON-BOARD SWITCHING BETWEEN ANTENNAS-FLEXIBILITY
  - LARGER APERTURE ANTENNAS PERMITTING LOWER COST GROUND TERMINALS
  - MORE EFFICIENT USE OF ALREADY OVERCROWDED SPECTRUM
  - OPPORTUNITY FOR NEW MISSIONS NOT OTHERWISE AVAILABLE

Figure 1

GEOSTATIONARY PLATFORM (Figure 2)
(POTENTIAL LONGITUDINAL LOCATIONS)

Figure 2 shows the longitudinal location of the operational geostationary satellites currently in orbit. The satellites tend to group in four longitudinal positions: the United States, Western Europe, India and the Pacific. Furthermore, within each of these positions, the satellites generally prefer the central longitudinal position of the geophysical area they serve so that they can communicate with any ground station with elevation angles of greater than 5°.

In order to avoid interference, satellites must have a separation distance of at least 4° if they operate in the same frequency band. We are simply beginning to run out of parking spaces. As one looks to the decade of the 1980's, the problem will become much worse. The Geostationary Platform with its inherent capability to provide large aperture antennas with multiple, narrow beams and the ability to switch signals from beam-to-beam and antenna-to-antenna provides an answer to this dilemma. Furthermore, we believe that by taking the Geostationary Platform approach instead of the traditional individual satellite approach, cost savings can be realized and passed on to users.

The missions and the concept that I will be showing today are for the platform over the United States. Platforms over the other high density traffic areas would probably look much the same.

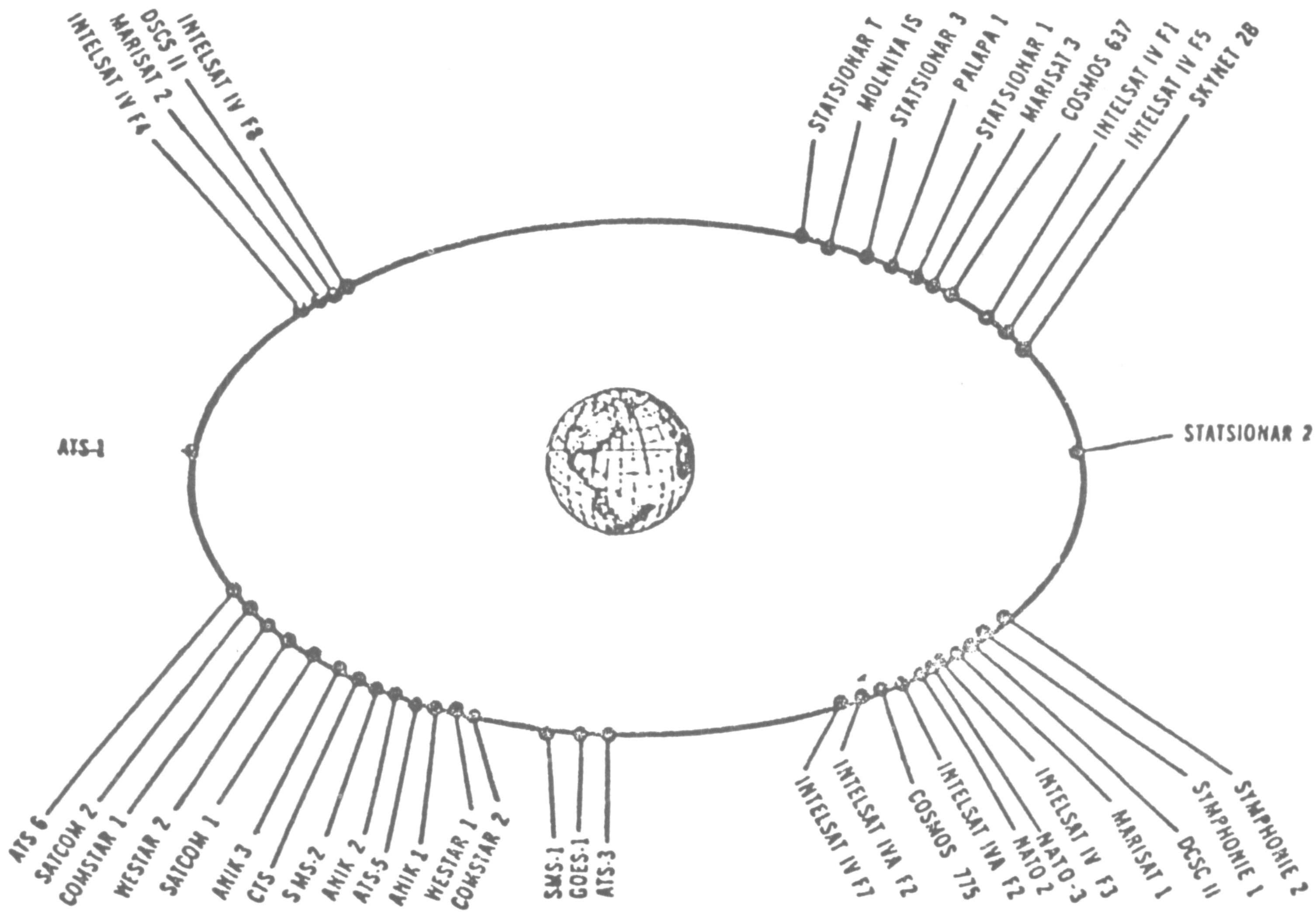
INTELSAT IV F8
DSCS II
MARISAT 2
INTELSAT IV F4
STATSIONAR 7
MOLNIYA 1S
STATSIONAR 3
PALAPA 1
STATSIONAR 1
MARISAT 3
COSMOS 637
INTELSAT IV F1
INTELSAT IV F5
SKYNET 2B
ATS-1
STATSIONAR 2
ATS 6
SATCOM 2
COMSTAR 1
WESTAR 2
SATCOM 1
ANIK 3
CTS
SMS-2
ANIK 2
ATS-5
ANIK 1
WESTAR 1
COMSTAR 2
SMS-1
GOES-1
ATS-3
INTELSAT IV F7
INTELSAT IVA F2
COSMOS 775
INTELSAT IVA F2
NATO 2
NATO-3
INTELSAT IV F3
MARISAT 1
DSCS II
SYMPHONIE 1
SYMPHONIE 2

FIGURE 2

GEOSTATIONARY PLATFORM (Figure 3)
(DESIRED MISSION CAPABILITIES)

The next several charts show the candidate missions, which were identified by the Office of Space and Terrestrial Applications (OSTA). which we have used to derive the design of the Geostationary Platform. The four mission categories are shown on Figure 3.

GEOSTATIONARY PLATFORM
DESIRED MISSION CAPABILITIES

- FIXED POINT (POINT-TO-POINT) COMMUNICATIONS
- MOBILE SATELLITE COMMUNICATIONS SERVICE
- BROADCAST SATELLITE SERVICES
- SPACE RESEARCH, METEOROLOGY AND EARTH OBSERVATION SATELLITES

FIGURE 3

GEOSTATIONARY PLATFORM
DESIRED MISSION CAPABILITIES (Figure 4)

FIXED (POINT-TO-POINT) COMMUNICATIONS

Missions in the area of fixed (point-to-point) communications which could be accommodated on the platform are shown on Figure 4. The two C-Band services shown at the top of the page would accomplish the next generation function now being provided by the current domestic communications satellites (COMSTAR, WESTAR, SATCOM), the Canadian ANIK, and ATS-6. New services and capabilities are also provided at S-Band, Ku-Band, and K-Band.

DESIRED MISSION CAPABILITIES

FIXED POINT (POINT–TO–POINT) COMMUNICATIONS

TWO C–BAND BROAD BEAM ANTENNAS FORMED BY A 0.7M X 2.0M ELLIPSOIDAL REFLECTOR COVERING ALL CONUS TO ALLOW ANY EARTH STATION TO COMMUNICATE WITH ANY OTHER EARTH STATION (4.5M DIAMETER TRUNKLINE GROUND RECEIVERS).

ONE 30M C–BAND ANTENNA WITH MULTIPLE FEEDS PROVIDING 37 SPOT BEAMS TO CONUS METRO AREAS AND 3 SPOT BEAMS TO HAWAII, ALASKA, AND PUERTO RICO. (4.5M DIAMETER TRUNK LINE RECEIVERS).

THESE SERVICES CURRENTLY PROVIDED VIA 10 INDIVIDUAL DOMESTIC SATELLITES IN GEOSTATIONARY ORBIT WHICH MUST MAINTAIN $\gtrsim 4^\circ$ SEPARATION TO AVOID MUTUAL JAMMING.

ONE 12M DIAMETER KU–BAND ANTENNA WITH MULTIPLE FEEDS PROVIDING BROADCAST TO THE 20 LARGEST METRO AREAS ANYWHERE WITHIN CONUS (1.5M ROOFTOP RECEIVER ANTENNAS).

FOUR INDEPENDENTLY GIMBALLED 4.5M DIAMETER Ku–BAND ANTENNAS COVERING FOUR SEPARATE GEOGRAPHIC AREAS WITH NEWS OR SPORTING EVENTS.

ONE 1M X 3M S–BAND ANTENNA TO PROVIDE CONUS COVERAGE FOR "THIN ROUTE" POINT–TO–POINT COMMUNICATIONS. (3M DIAMETER GROUND RECEIVER).

SMALL HORN ANTENNA (CONUS COVERAGE) AND A 2M DIAMETER ANTENNA WITH MULTIPLE FEEDS (10 BEAMS) TO PROVIDE K–BAND TO MAJOR METROPOLITAN AREAS TO SUPPORT EXPERIMENTS IN ELECTRONIC MAIL, DATA TRANSFER AND PERSONAL COMMUNICATIONS.

ELECTROMAGNETIC SPECTRUM (REF)

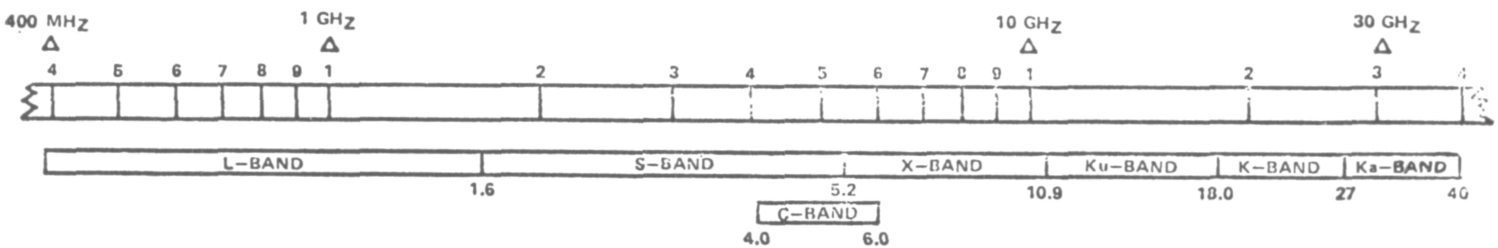

Figure 4

GEOSTATIONARY PLATFORM
DESIRED MISSION CAPABILITIES (Figure 5)
(MOBILE SATELLITE COMMUNICATIONS SERVICE)

The mobile satellite communications services are to be accommodated on the platform are shown on Figure 5.

GEOSTATIONARY PLATFORM
DESIRED MISSION CAPABILITIES

(MOBILE SATELLITE COMMUNICATIONS SERVICE)

FOUR 3M DIAMETER L–BAND ANTENNAS PROVIDING DIRECT LINK BETWEEN SHIPS AND LAND BASED TERMINAL (IMPROVED SERVICE COMPARED TO CURRENT MARISAT AND PLANNED MAROTS).

ONE 10M (UHF) ANTENNA AND ONE 1M (L–BAND) ANTENNA PROVIDING COMMUNICATIONS BETWEEN AIRCRAFT AND LAND BASED TERMINAL AS PREVIOUSLY CONSIDERED FOR AEROSAT.

ONE 12M DIAMETER L–BAND ANTENNA WITH 4 FEEDS PROVIDING CONUS COVERAGE FOR COMMUNICATIONS BETWEEN TRUCKS, CARS, ETC.

ELECTROMAGNETIC SPECTRUM (REF)

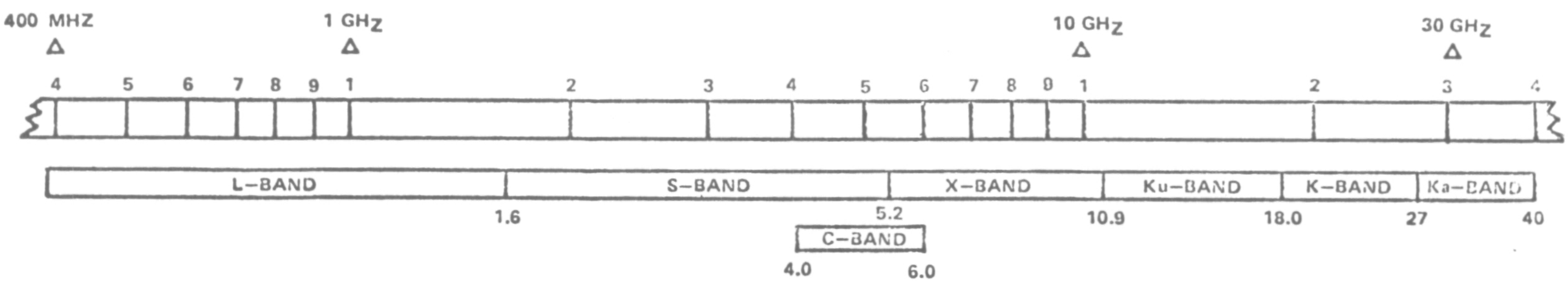

Figure 5

GEOSTATIONARY PLATFORM (Figure 6)
(TYPICAL EXAMPLE OF IMPROVED SERVICE)

The MARISAT, which is currently in operation; provides communication links between ships and land terminals. The current system, and that planned for the next generation (MAROTS) requires that the link pass through both the satellite and a large earth station. The switching function to assure the right ship is connected to the right land terminal is done in the earth station.

In the Geostationary Satellite Mode the switching function would be done in the satellite, and thereby eliminates the need for the earth station. The land terminal would link directly with the Platform through the appropriate narrow beam antenna. On board the platform the signal would be routed to the proper antenna and beam which covers the region in which the ship is located.

The resulting cost savings made possible by eliminating earth stations would enable the user to provide the service at a much lower cost.

This example is but one of many that a Geostationary Platform with on-board-switching could make possible.

GEOSTATIONARY PLATFORM
TYPICAL EXAMPLE OF IMPROVED SERVICE

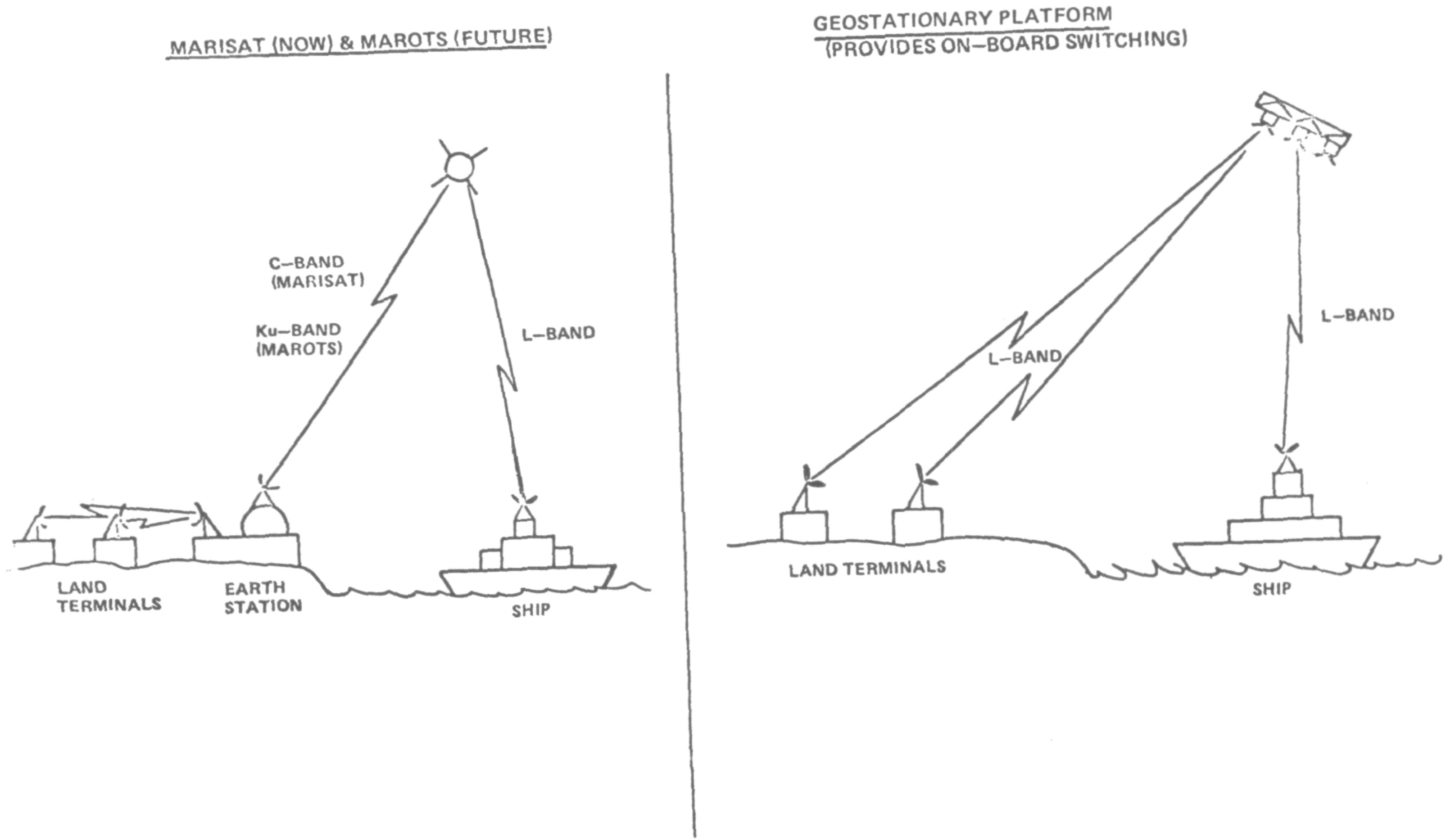

Figure 6

GEOSTATIONARY PLATFORM
LAUNCH AND ASSEMBLY SEQUENCE
(Figure 7, Figure 8, and Figure 9)

The Platform would be assembled in low earth orbit from elements supplied by multiple Shuttle launches. The first launch (Figure 7) carries the 30 meter parabolic antenna and other supplies to low altitude earth orbit. During the seven day mission, the 30-meter parabolic antenna is assembled. The second (Figure 8) launch carries the remaining parts to build-up the platform. The platform is assembled and checked out during the second flight. The third launch (Figure 9) provides the Geosynchronous Transfer Stage. After assembly of the basic platform and support systems and the attachment of mission payloads, the platform is transferred to geosynchronous orbit to a longitudinal position to serve missions over the United States. The platform would have an open ended lifetime with periodic visits by either manned or automated vehicles to carry out periodic or emergency repair and refurbishment and to bring on board new mission payloads.

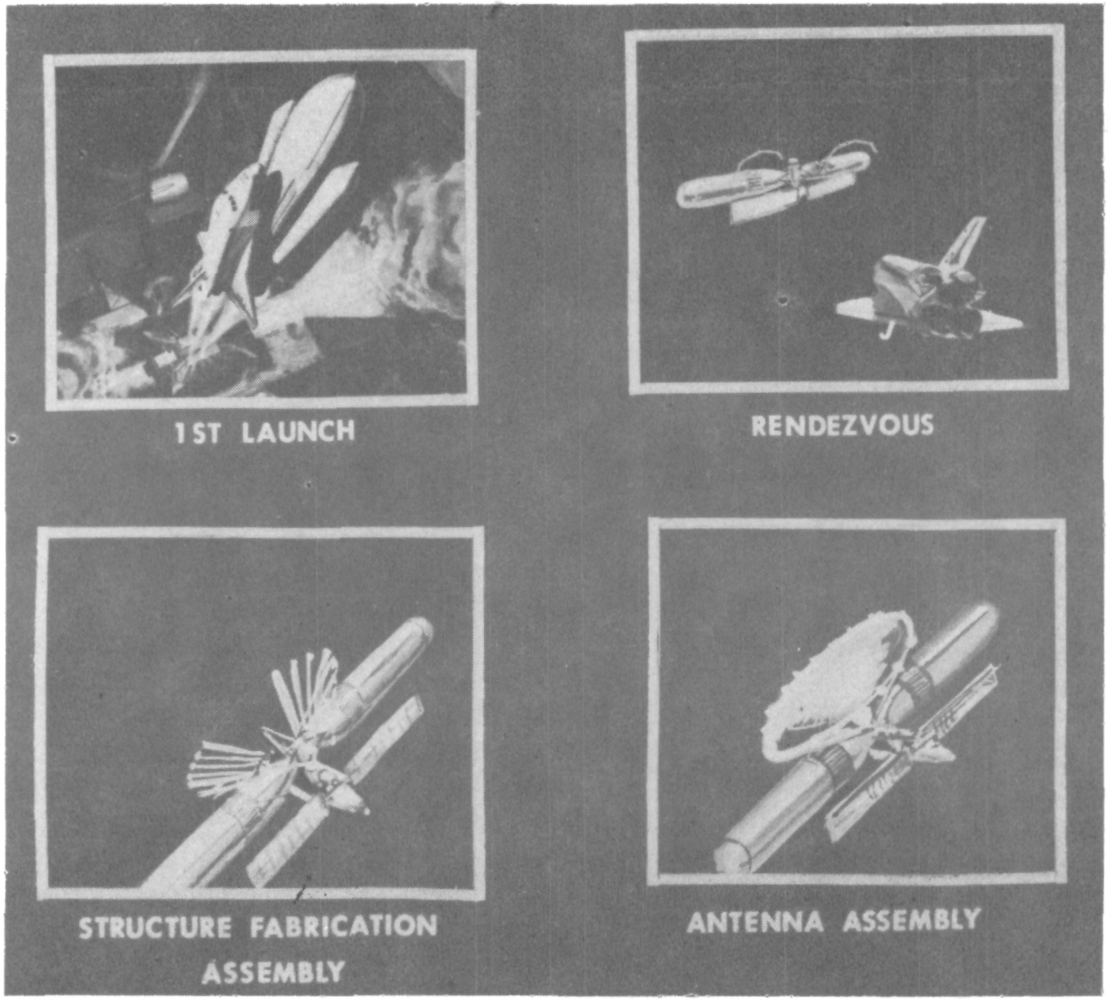
1ST LAUNCH
RENDEZVOUS
STRUCTURE FABRICATION ASSEMBLY
ANTENNA ASSEMBLY

Figure 7

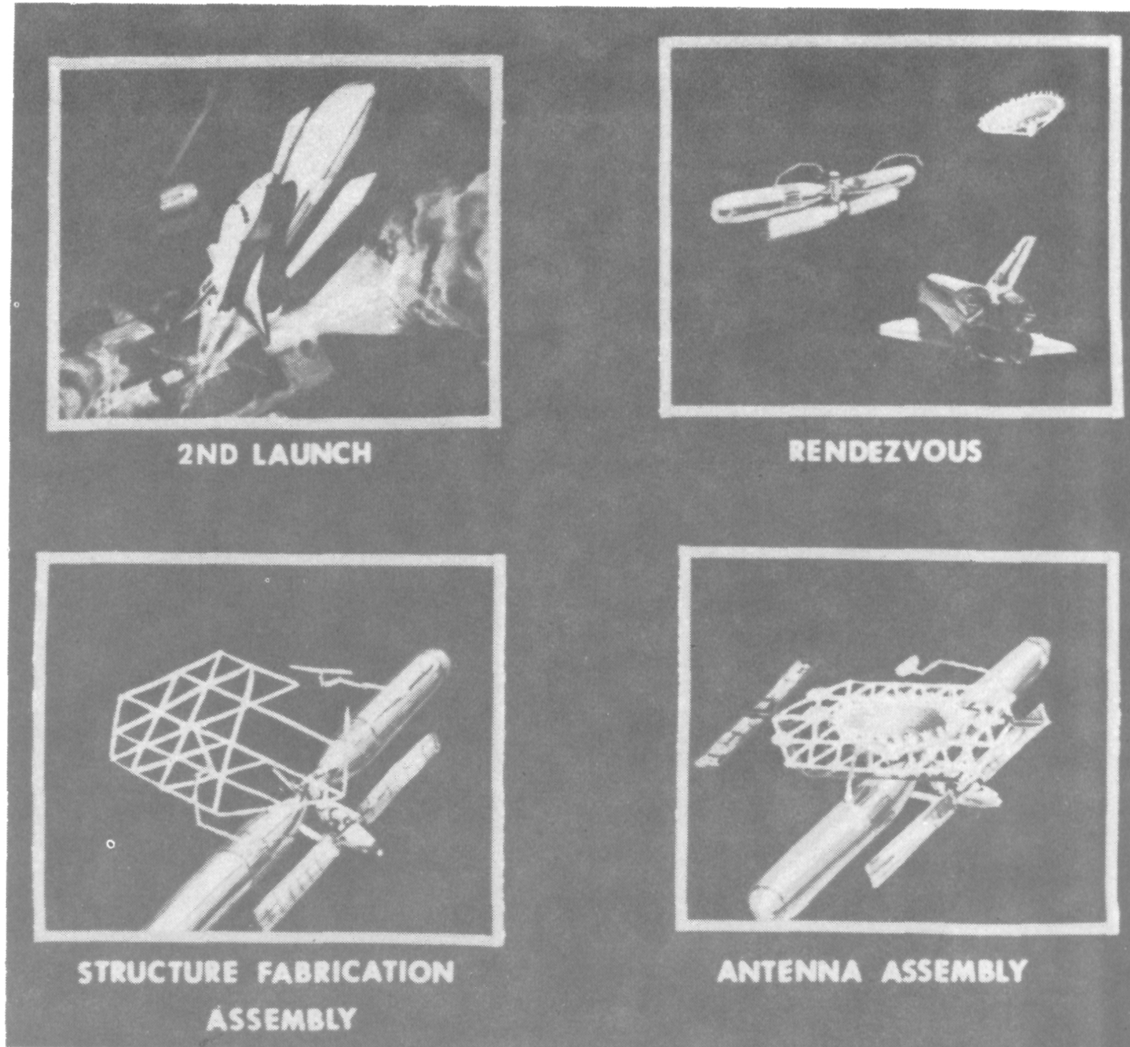
2ND LAUNCH
RENDEZVOUS
STRUCTURE FABRICATION ASSEMBLY
ANTENNA ASSEMBLY

Figure 8

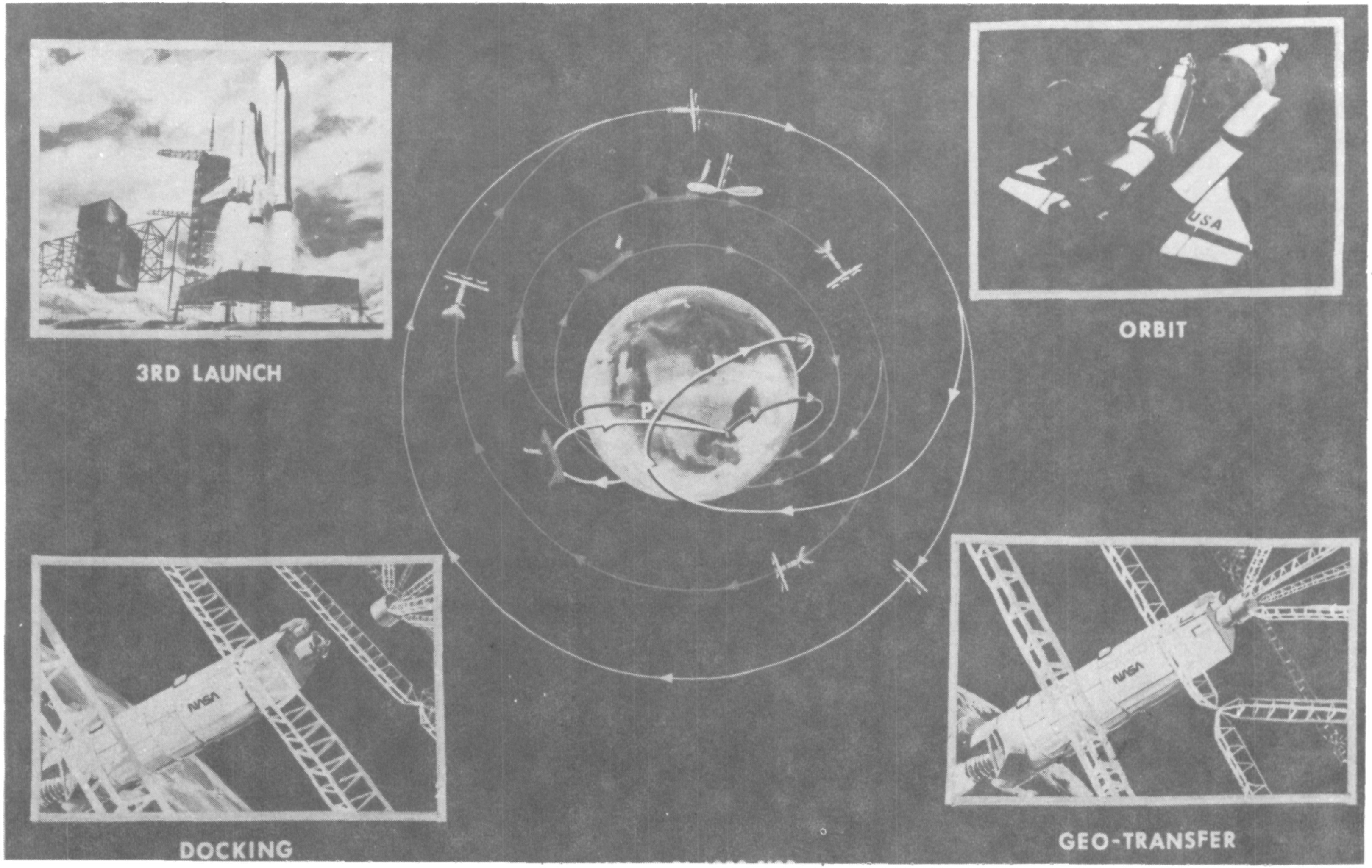

Figure 9

GEOSTATIONARY PLATFORM (Figure 10)
(CONCEPT)

The Geostationary Platform as it would look while operating at its geostationary position is shown on Figure 10. The dimension of the platform are 82 meters by 31 meters and it will weigh around 18,000 pounds. Power modules with roll up solar arrays are shown at each end. A support module would be located on the back of the platform immediately behind the 30-meter antenna. This module would house switching equipment required to interconnect each antenna to the other and to other platform support equipment. Attitude control is maintained using 4 reaction wheels with periodic momentum dumping provided by the propulsion modules shown at 4 locations on the platform. Platform pointing would be provided at $\pm 0.5^{\circ}$ with fine pointing provided by each payload as required. Interface between the platform and the user-provided payloads has been kept simple with only structural attach points and electrical interface for power transfer and payload housekeeping functions. Thermal control is provided by each payload.

Most of the mission packages would be provided by the users who would pay a transportation fee for delivery to the platform and a "use" fee for drawing support (electrical power, coarse pointing, housekeeping functions, etc.) from the platform.

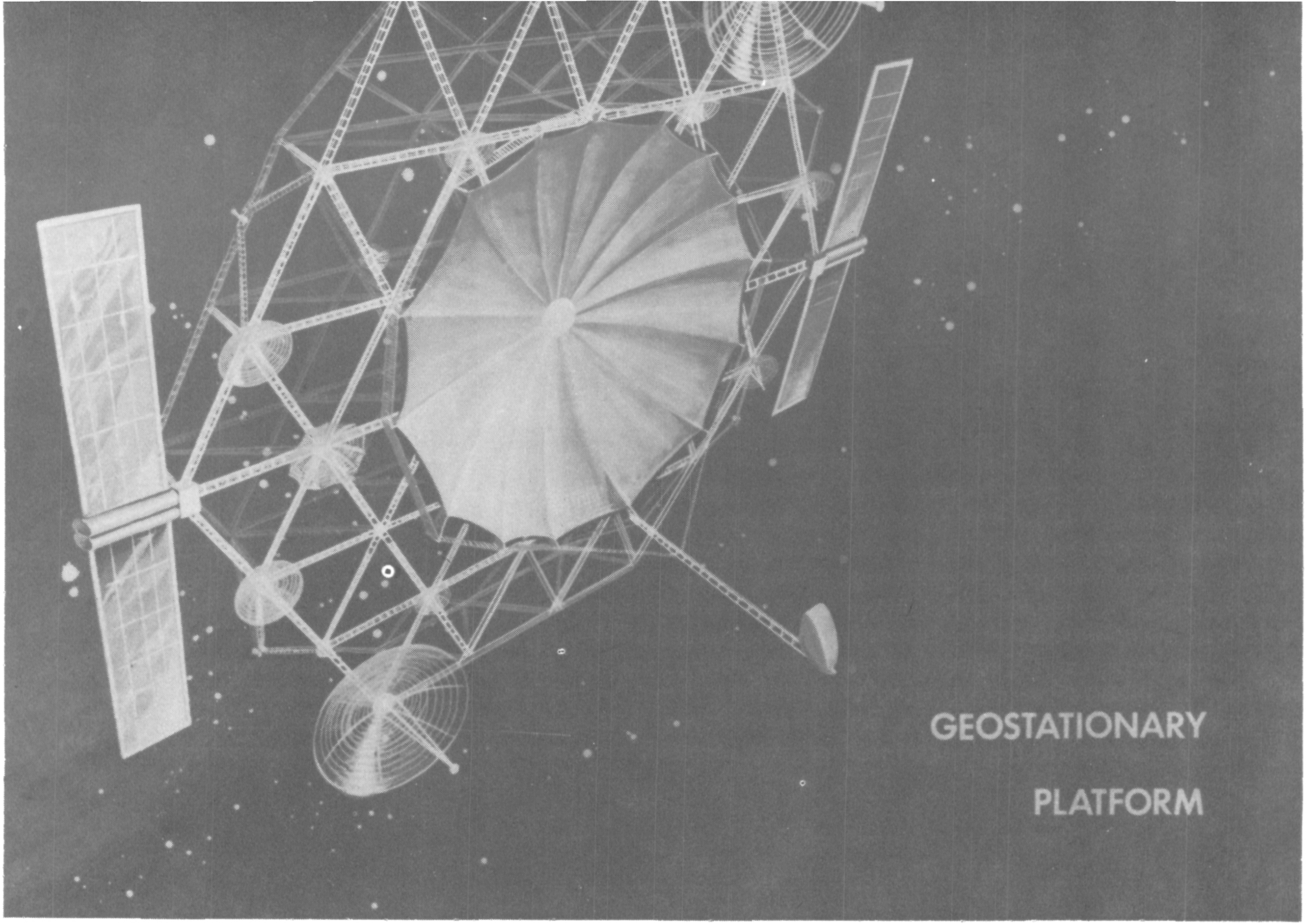

Figure 10

GEOSTATIONARY PLATFORM (Figure 11)

30-METER ANTENNA

One of the key features of the platform is a 30-meter parabolic antenna which would operate at C-Band and provide 40 spot beams to earth, each of which would be approximately 70 miles diameter. These beams would be made possible by providing an offset feed with 40 feed horns as depicted in Figure 11. These 40 spot beams would provide coverage to the major metropolitan areas of the United States. The preferred assembly or deployment approach for this antenna is currently under study.

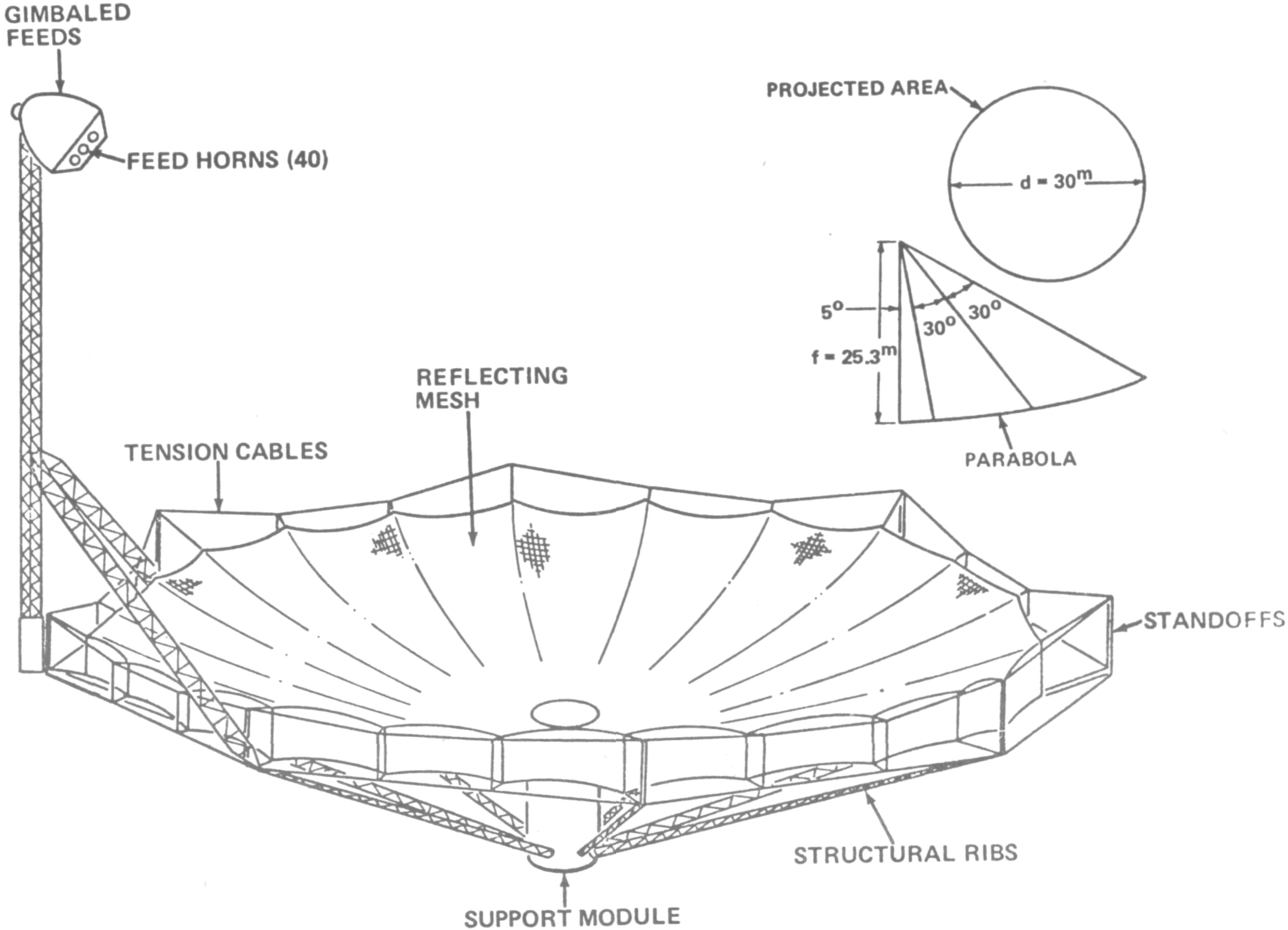
GIMBALED FEEDS
FEED HORNS (40)
PROJECTED AREA
d = 30m
5°
30°
30°
f = 25.3m
PARABOLA
REFLECTING MESH
TENSION CABLES
STANDOFFS
STRUCTURAL RIBS
SUPPORT MODULE

FIGURE 11

GEOSTATIONARY PLATFORM (Figure 12)

(CONCLUSIONS)

In summary, we believe the Geostationary Platform has great promise. Although we are now only in the preliminary definition phase we believe that we have penetrated to sufficient depth to say that there are no showstoppers. Our plans are to continue our definition and analysis activity embracing those activities shown on the chart.

We support the objectives of the Large Space Systems Technology Program and look forward to working with any of you, either individually or collectively, in making this Platform become a reality.

CONCLUSIONS

- O GEOSTATIONARY PLATFORM HAS STRONG MISSION JUSTIFICATION, IS TECHNICALLY FEASIBLE, AND OFFERS MANY BENEFITS OVER THE TRADITIONAL SPECIALIZED SATELLITE APPROACH
- O TECHNICAL CHALLENGES EXIST BUT NO SHOWSTOPPERS
- O MSFC ACTIVITIES WILL CONTINUE:
  - FURTHER DEFINITION OF BASELINE AND ALTERNATIVES
  - BROADER USER BASE
  - FURTHER ESTABLISH SUPPORT REQUIREMENTS
  - COST AND COST COMPARISON
  - IDENTIFY SRT REQUIREMENTS AND INITIATE KEY ACTIVITIES
- O CLOSE LIAISON REQUIRED WITH OAST LARGE SPACE SYSTEMS TECHNOLOGY PROGRAM

Figure 12