Platform Evolution Studies

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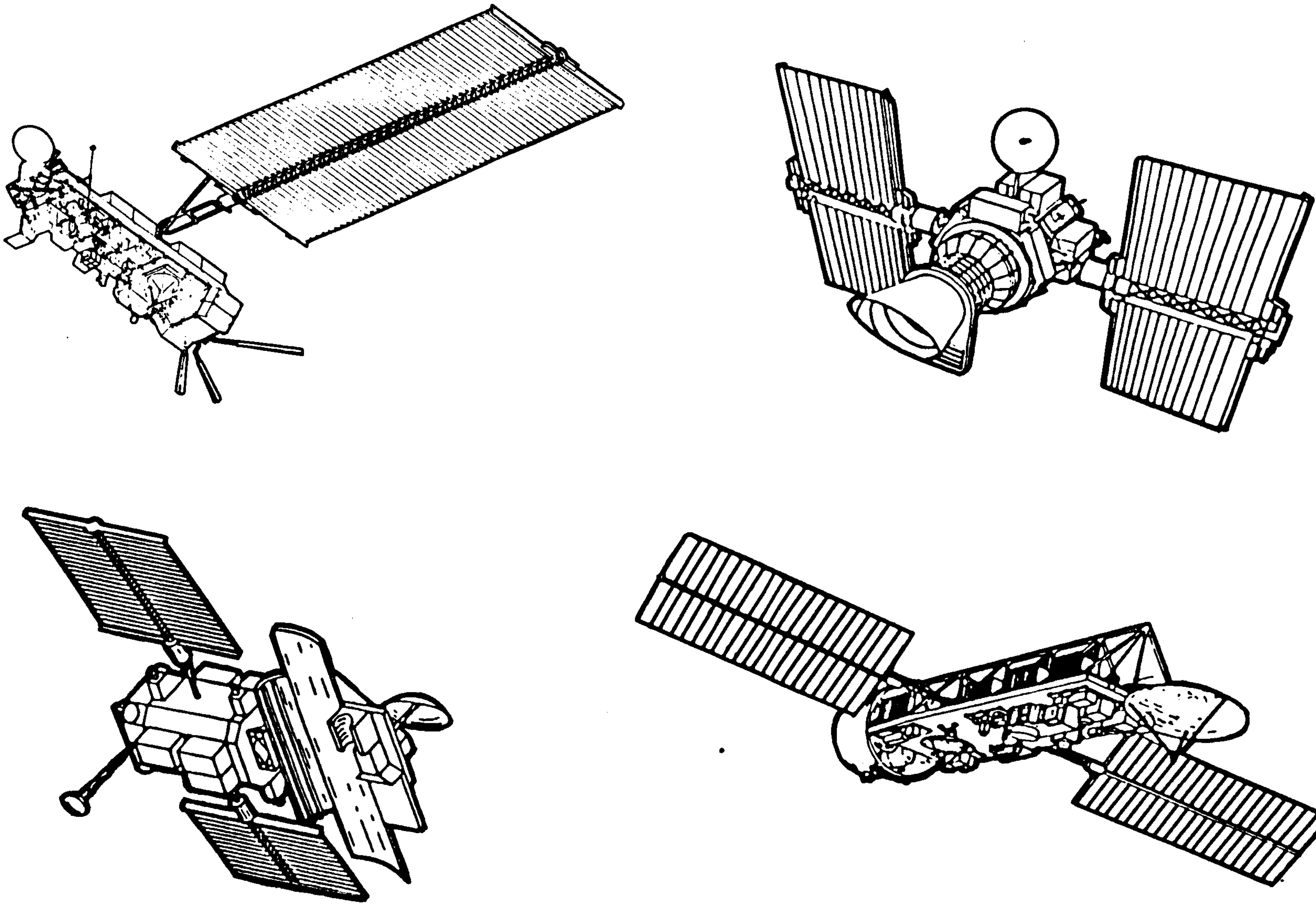
Platform evolution studies have focused on developing two types of platforms: the Geostationary Platform, for use as an observatory in NASA's Mission-to-Planet-Earth (MPE) initiative, and a co-orbiting platform, for use as a branching mechanism for the Space Station Freedom manned base. In 1989, platform evolution efforts also documented existing polar platform scars for servicing and for co-orbiting platform configurations.

Shown on this viewgraph are various platform configurations. An Astrophysics Co-orbiting Platform was studied during Phase B of the Space Station Program. The Stationkeeping Platform was the subject of a Goddard study.

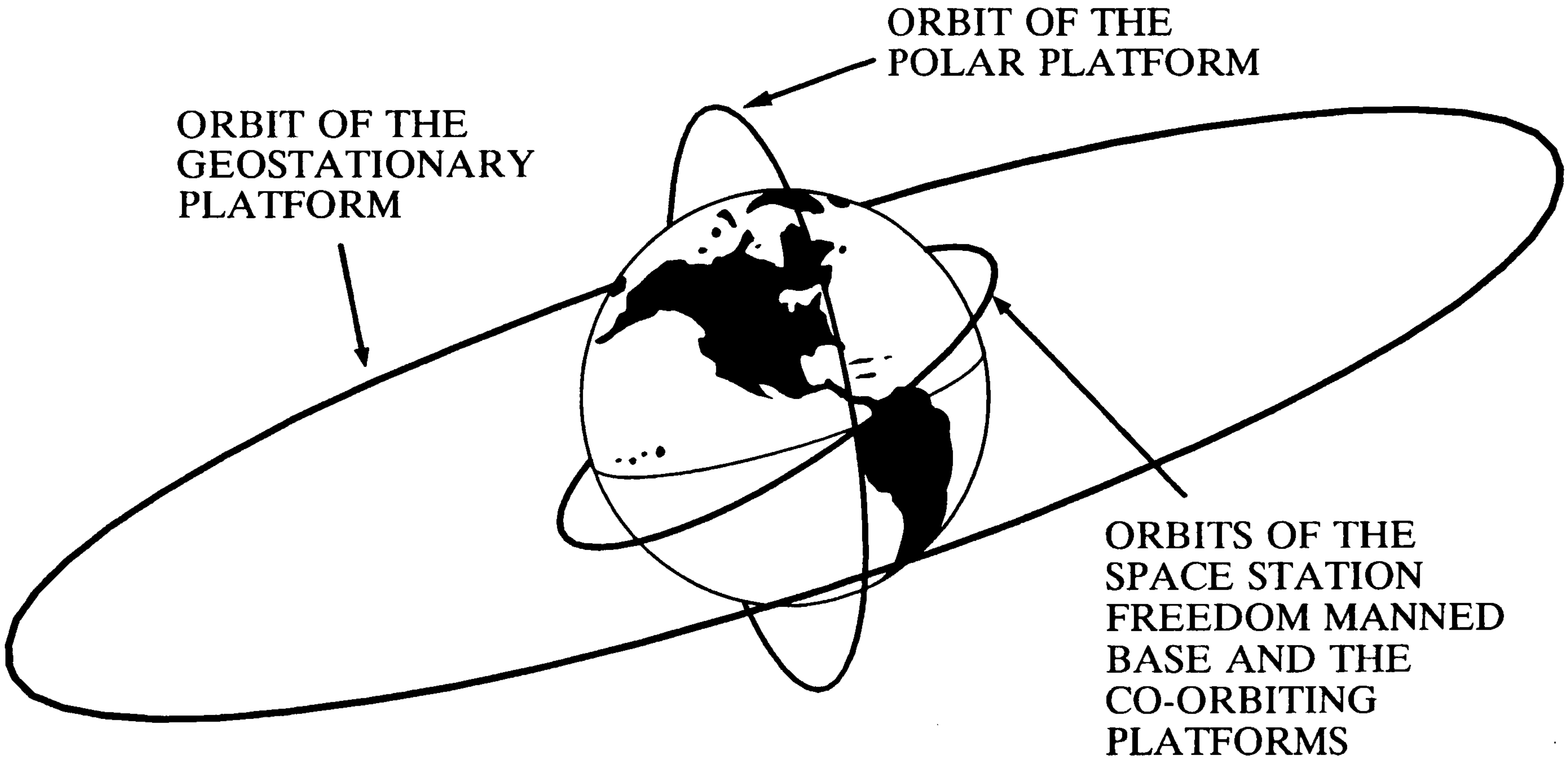
In January, 1990, NASA Administrator, Richard Truly, approved a plan to shift management of the NASA Polar Orbiting Platform Development Program from the Space Station Freedom Office to the Office of Space Science and Applications, which oversees Eos. The platform in combination with Eos payloads will become an Eos observatory. None of the international agreements has been affected.

Today I will briefly describe the NASA Polar Platform and discuss the studies of evolutionary configurations for geostationary and co-orbiting platforms. General Electric Astro-Space Division was selected to perform these studies because of its role as designer of the Polar Platform.



PLATFORM EVOLUTION STUDIES - INTRODUCTION

Space Station Freedom will be in an orbit approximately 333 to 444 km high and inclined at 28.5 degrees. The co-orbiting platforms will be in a similar orbit. The Polar Platform will be in a sun-synchronous orbit, 705 km high at an inclination of approximately 98.2 degrees. The Geostationary Platform will be in a geostationary orbit, 35,754 km high at zero degrees inclination.



PLATFORM ORBITS

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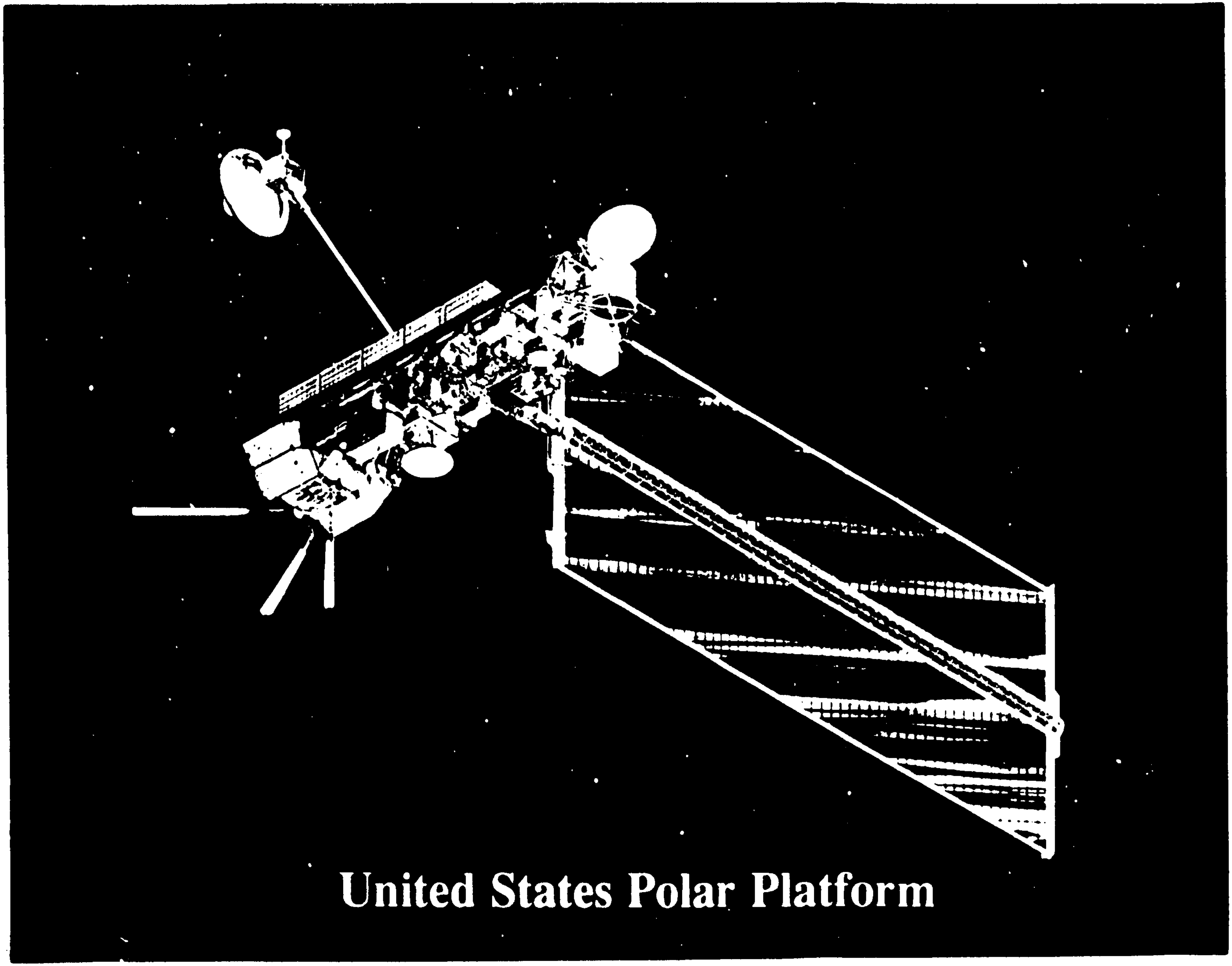
The Polar Platform is a highly modular design with distributed systems packaged in Orbital Replacement Units (ORUs) which facilitates on-orbit servicing. Its design was driven by the Earth Observing System (Eos) instrument complement. It supports a total payload mass of 3500 kg.

During nominal flight, the Polar Platform will maintain its long axis parallel to the velocity vector. A single solar array is mounted on the sun-side of the platform in order to provide a cold field-of-view for payloads. The spinning microwave instrument on the front of the platform requires special accommodation, as shown.

The Polar Platform Payload accommodation features included in the evolution studies are Payload Mounting Plates (2 sizes, one has same footprint as the ORU) attached to the structure using standard interface connectors and payload central thermal bus.


United States Polar Platform

In March 1988, a study was begun to assess the utility of polar platform ORUs and the Space Station Freedom infrastructure for geostationary earth-observing missions. Two test cases, representative of Mission-to-Planet-Earth payloads, were studied. Case A was used to emphasize the Geostationary Platform configuration and design. Case B, considered to be much further in the future, included some assembly at Freedom's manned base. Requirements on the manned base to support such a mission were emphasized. This work was funded by NASA Headquarters Office of Space Station (Code ST) Strategic Plans and Programs Division.

The overall study objectives were to determine the feasibility of using polar platform designs, to identify needed scarring, and to satisfy the test case instrument requirements. All polar platform payload accommodation features, modularity, and serviceability were to be retained.

GEOSTATIONARY PLATFORM STUDY

- March 1988 - April 1989
- Objective

  Determine feasibility of using polar platform designs and identify needed scarring

A reference set of instruments was defined and basic interface requirements established. The total mass and average power for each payload set were overriding criteria. Estimates for the total payload mass, power, and data requirements were less than for the Polar Platform.

GEOSTATIONARY PLATFORM TEST CASES

SENSOR DESCRIPTION	MASS kg	POWER W	DATA Mbps	CASE A	CASE B
MICROWAVE IMAGER/SOUNDER (20m MESH + 10m SOLID)	1,000	300	0.1		X
MICROWAVE IMAGER/SOUNDER (4.4m SOLID)	200	250	0.1	X	
INFRARED SOUNDER (MICHELSON)	165	130	7.4	X	X
LIGHTNING MAPPER	30	100	0.1	X	X
ACTIVE CAVITY RADIOMETER	30	25	<0.1	X	X
SOLAR SPECTROMETER	105	65	<0.1	X	X
CLIMATE RADIATION RADIOMETER	50	30	<0.1	X	X
OZONE MAPPER	20	30	<0.1	X	X
OPERATIONAL IMAGER/SOUNDER (GOES-NEXT ENHANCED)	300	300	3	X	X
SPACE ENVIRONMENT MONITOR	40	25	<0.1	X	X
OPERATIONAL/RESEARCH DATA COLLECTION	25	40	<0.1	X	X
SEARCH AND RESCUE	10	30	<0.1	?	X
OPERATIONAL/RESEARCH DATA DISTRIBUTION	40	?	?	X	X
MODERATE RESOLUTION IMAGING SPECTROMETER	110	100	20	X	
VISIBLE/INFRARED IMAGER (1.5 X 1.5m SEOS)	1,000	150	80		X
PAYLOAD TOTAL - CASE A	1,200	1,200	40		
PAYLOAD TOTAL - CASE B	3,000	1,500	100		

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The Polar Platform design features which enable serviceability, standard interface connectors, orbital replacement units, and payload mounting plates also facilitate ease-of-assembly at the manned base.

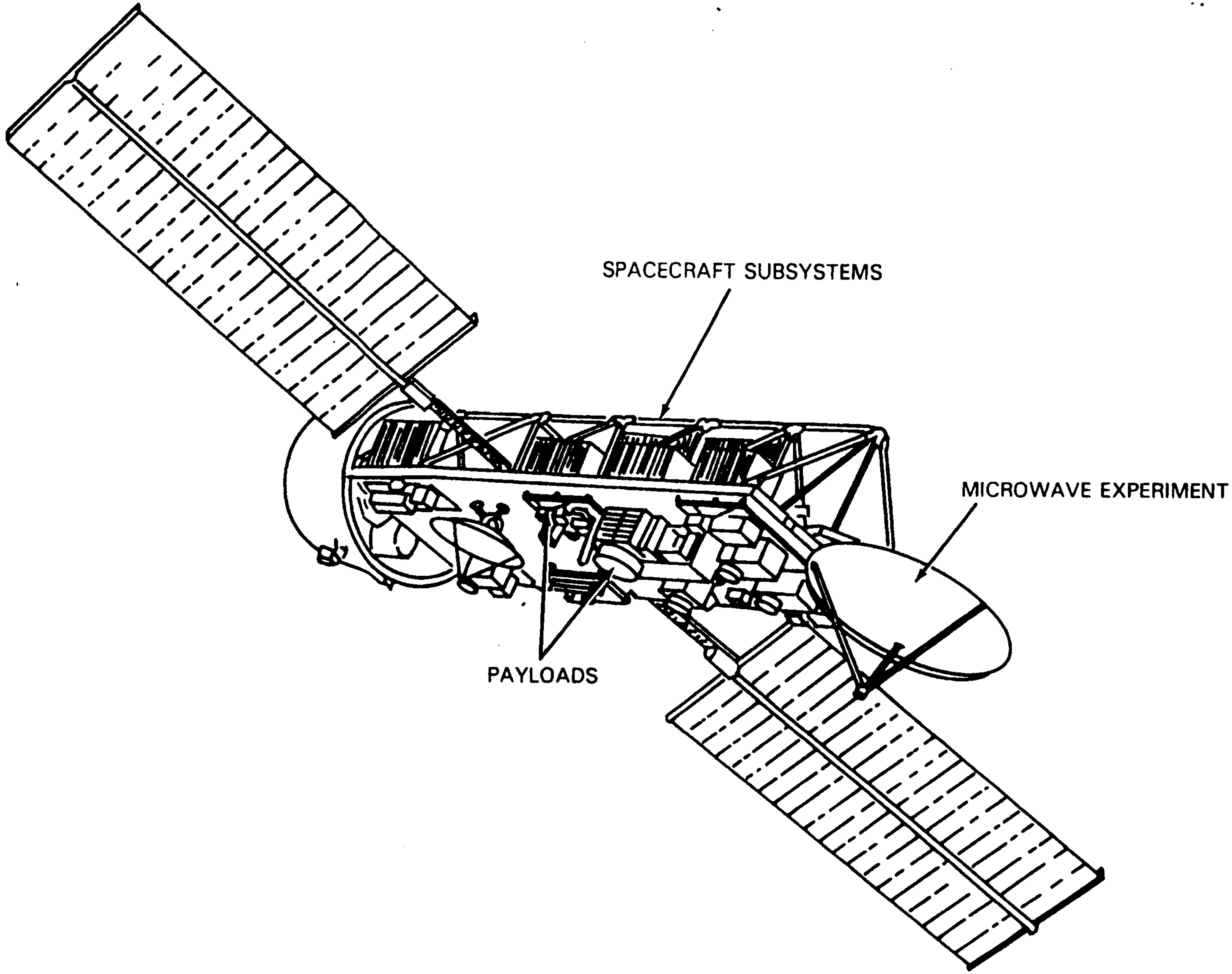
A lifetime of 10 years without servicing for Case A and 20 years with servicing for Case B were design goals. To meet these goals, reliability requirements imposed on the Polar Platform were applied to the geostationary platform design and a replaceable propulsion module, sized for 10 years, was included.

The electrical power subsystem is sized to maximize science operations, including full operations during solar eclipse. Solar eclipse occurs at the vernal equinox and at the autumnal equinox when the Geostationary Platform is opposite the sun.

DESIGN GOALS

- Facilitate ease-of-assembly at the manned base
- Provide long lifetime
- Maximize science operations, including during solar eclipse

The configuration derived for the Case A platform uses composite longerons and a honeycomb core panel with composite skin. The solar arrays, with a total area of 415 square feet, are located with their rotational axis close to the platform's center of gravity to promote control and stability. The propulsion module is attached to the platform with an intermodule connector. The 4.4 meter dish of the microwave image/sounder is deployed on-orbit.



GEOSTATIONARY PLATFORM CONFIGURATION - CASE A

The total estimated launch mass for this platform is 13,175 pounds, which includes fuel for 10 years of operation. This platform can be placed in orbit with a Titan IV Centaur, expected to be capable of placing 15,000 pounds into the required geostationary orbit by the mid 1990s.

GEOSTATIONARY PLATFORM CASE A
WEIGHT SUMMARY

	WEIGHT (LB)	COMMENT
PAYLOAD	2645	CASE A, 1200 kg
SPACECRAFT	6810	STRUCTURE PLUS ORBITAL REPLACEMENT UNITS
TOTAL SPACECRAFT DRY	9455	PAYLOAD PLUS SPACECRAFT
PROPELLANT	3610	MONOPROPELLANT HYDRAZINE
LAUNCH VEHICLE INTERFACE	110	CENTAUR-G
LAUNCH MASS	13175	BEGINNING OF LIFE AT GEOSTATIONARY ORBIT
PLATFORM MARGIN	1825	

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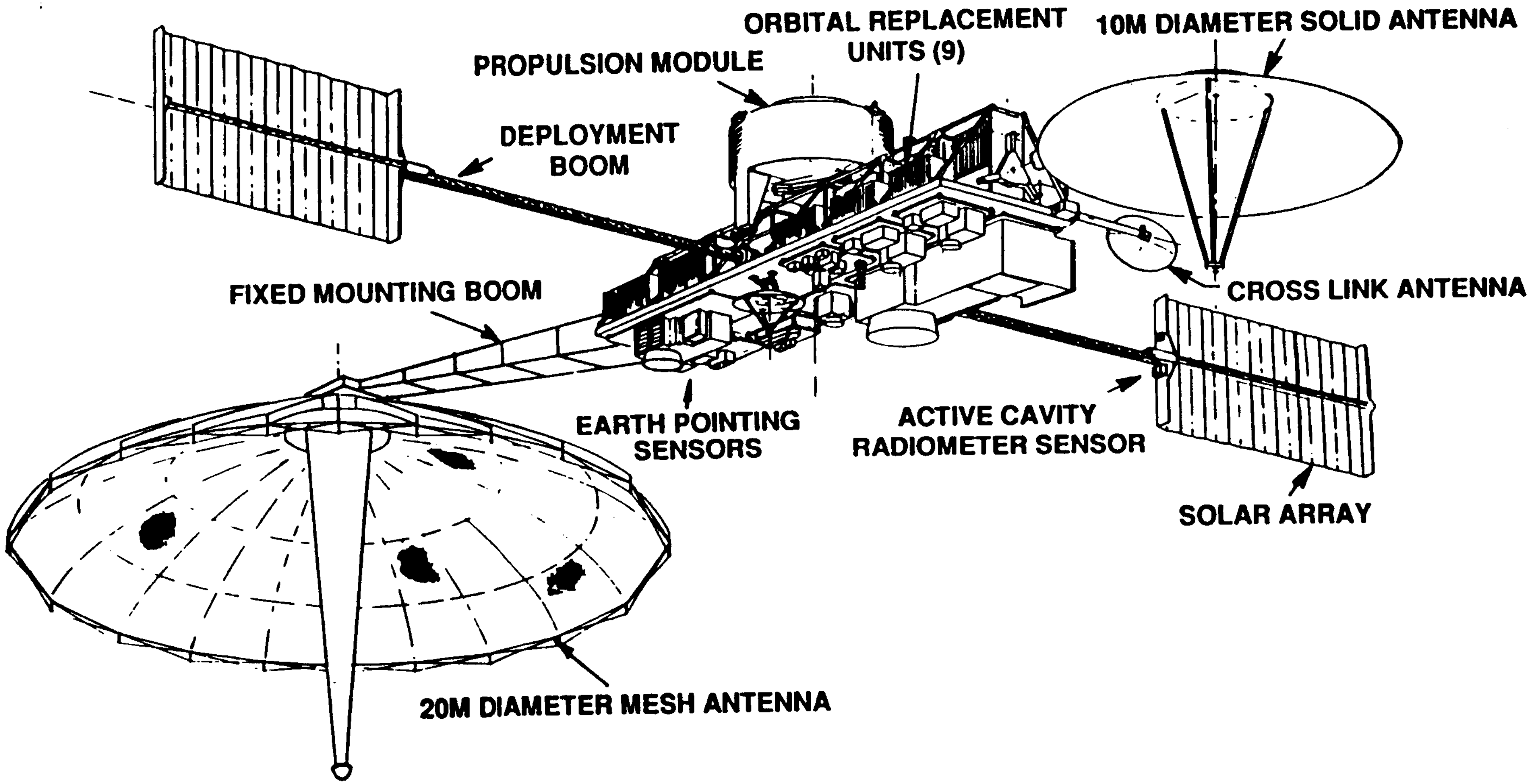
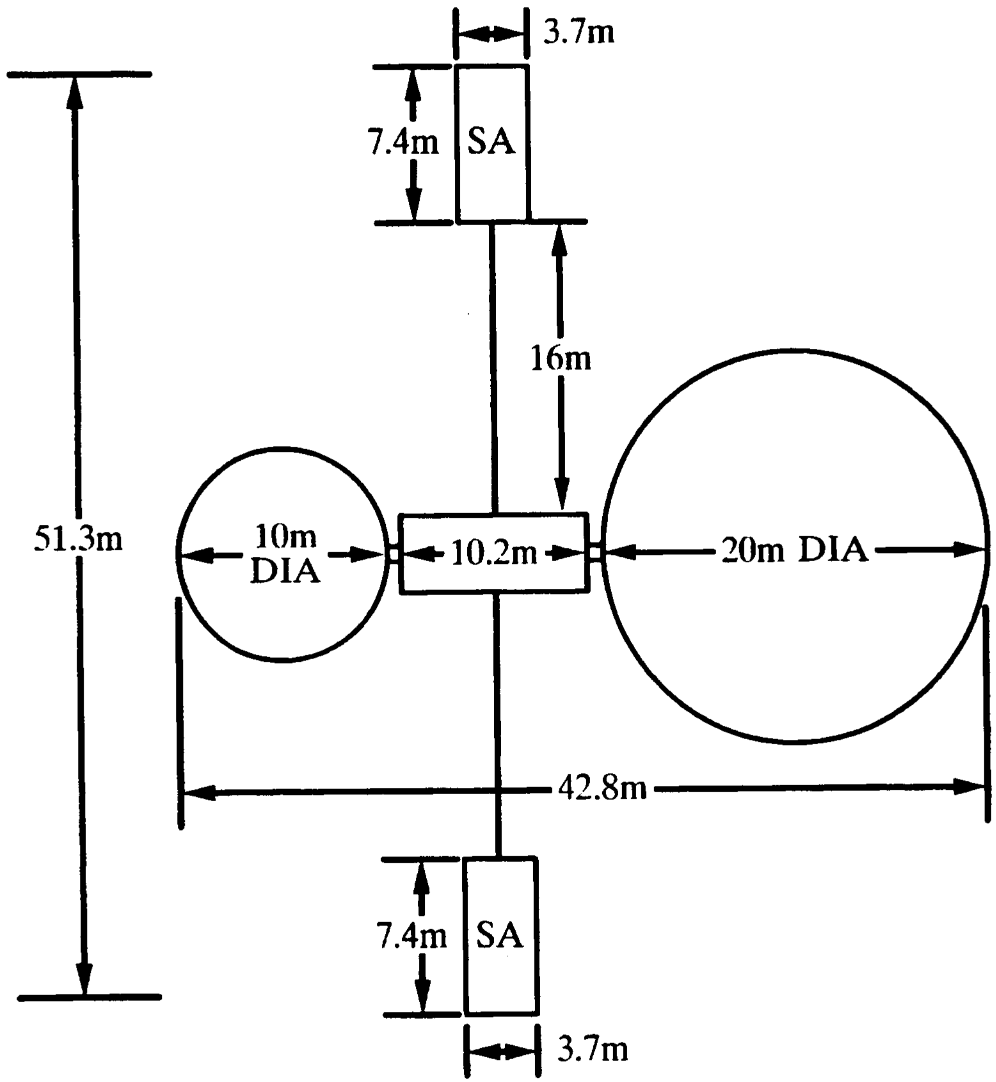
This is a much larger platform than Case A, primarily due to the two large microwave payload antennas, which are mounted at the ends with intermodule connectors. The propulsion module is placed behind the earth-viewing face close to the center of gravity to minimize the center of gravity/center of pressure offset and therefore the frequency of control maneuvers.



GEOSTATIONARY PLATFORM CONFIGURATION - CASE B
ORBITING VIEW

The overall east-west dimension of the on-orbit spacecraft, driven by the length of the platform body and the diameters of the two microwave instruments, is 42.5 m (139.4 ft). The solar arrays have been moved beyond the shadow of the large 20 m diameter antenna. This results in the platform being approximately 51.3 m (168.3 ft) in the north-south dimension.

The platform body is comparable to the baseline Polar Platform, 10.2 m (33.5 ft) long and 3.9 m (12.5 ft) wide. The solar arrays are 3.7 m long by 7.4 m wide—smaller than the polar platform's array.



GEOSTATIONARY PLATFORM DIMENSIONS - CASE B

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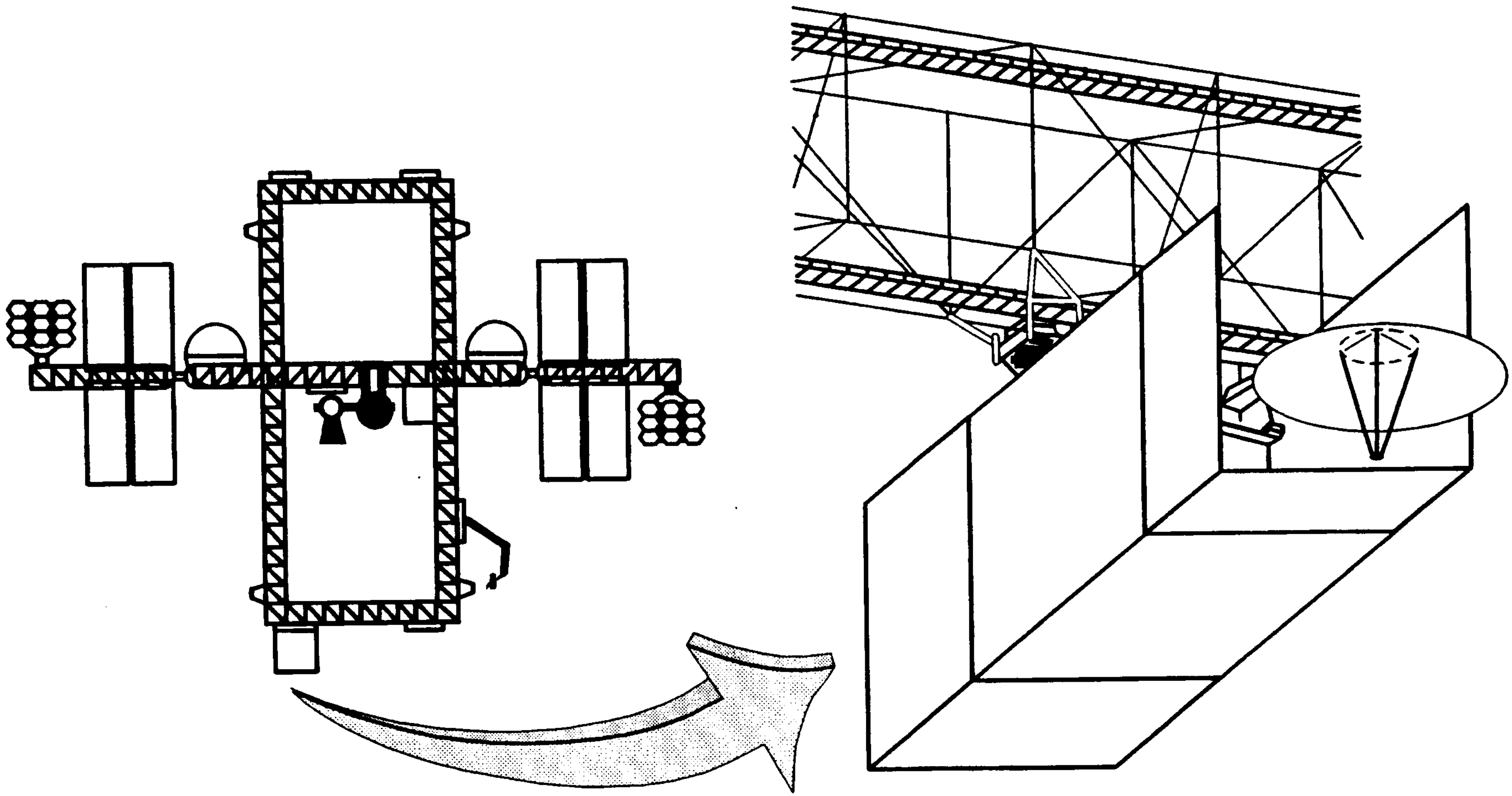
Case B is designed to be assembled at the manned base. Easy assembly requires that platform components be combined into reasonably sized modules. In one scenario, these modules are further combined into three packages for shuttle launch in the logical order of the assembly. The size of these launch packages is constrained by length, not weight, so that the remaining shuttle cargo capacity can be used for other Freedom logistics.

The assembly sequence is described in the Geostationary Platform Study Final Report.

REPRESENTATIVE CASE B LAUNCH MODULES

- Geostationary platform primary carrier structure with smaller payloads
- Visible/infrared imager with carrier
- Microwave imager/sounder, 20m mesh antenna with carrier
- Microwave imager/sounder, 10m solid antenna with carrier
- Monopropellant propulsion module with propellant

The potential location for assembly of the Geostationary Platform is on a nadir-facing side of the truss, such as the lower boom of the dual keel of the evolutionary manned base.



POTENTIAL LOCATION FOR GEOSTATIONARY PLATFORM ASSEMBLY

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In general, the study found it is possible to derive a robust platform for geostationary earth-observing missions from polar platform hardware, with some minor modifications. Two types of changes were required for the ORUs:

Modification to use only one surface for heat rejection. For the battery ORU, this meant 'opening up' the ORU to retain the radiator area with a corresponding decrease in depth.

Deletion of unneeded equipment.

The Case A configuration can be placed in geostationary orbit by a Titan/Centaur.

For Case B, the scars on the manned base are to provide for boost/deboost, storing, assembling, fueling, servicing, and protecting the Geostationary Platform and the Orbital Transfer Vehicle.

The geostationary payload pointing requirements of some of the instruments may be more stringent than polar platform requirements. For example, a few instruments might require special accommodations, such as star trackers, attitude transfer, or ground truth measurements.

In addition, the study showed that the six antennas of the ATDRSS payload conveniently fit on the configuration. Except power which increased from 1200 to 1920 watts, for the payload, the payload mass and resource margins are larger than those for Case A.

The results of this study were published in the final report, dated November 15, 1989.

RESULTS OF GEOSTATIONARY PLATFORM STUDY

- POLAR PLATFORM SUBSYSTEMS MORE THAN ADEQUATE
- MINOR MODIFICATIONS TO ORUs REQUIRED:

  USE ONLY ONE SURFACE FOR HEAT REJECTION

  DELETE UNNEEDED EQUIPMENT
- PLANNED TITAN/CENTAUR CAPABLE OF LAUNCHING CASE A CONFIGURATION TO GEOSTATIONARY ORBIT
- REQUIREMENTS FOR SPACE STATION FREEDOM SUPPORT IDENTIFIED
- PAYLOAD REQUIREMENTS SATISFIED

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A study has recently been completed to test the flexibility of the polar platform design in yet another configuration. This configuration, an Attached Payload Co-orbiting Platform, would serve as a branching mechanism for Space Station Freedom attached payloads. This means that a new concept can be tested as an attached payload on Freedom and if successful, could migrate to the Attached Payload Co-orbiting Platform.

The overall study objectives were to determine the feasibility of using polar platform designs, to identify needed scarring, and to satisfy the test case instrument requirements. All polar platform payload accommodation features, modularity, and serviceability were to be retained.

ATTACHED PAYLOAD CO-ORBITING PLATFORM STUDY

- June 1988 - January 1990
- Objective

  Determine the feasibility of a co-orbiting platform configuration, using polar platform designs, to provide a branching mechanism for Space Station Freedom attached payloads

The selection of attached payloads by NASA's Office of Space Science and Applications (Code E) was announced June 29, 1989. The press release stated that: "Eight of the nine earth science investigations selected as attached payloads involve copies of Eos polar platform instruments." Five of these, also currently planned for flight on the first Polar Platform, were included in the test case used for this effort, in addition to TRAMAR, also selected from the Eos January 1988 Announcement of Opportunity.

ATTACHED PAYLOAD CO-ORBITING PLATFORM TEST CASE

Instrument	Estimated resource requirements		
	Mass (kg)	Power peak (W)	Data peak (Kbps)
CERES	104	138	5
HIMSS	300	115	36
LIS	10	20	4
TRIS-N*	260	390	13000
TRIS-T*	135	270	11475
SAGE III	72	66	84
TRAMAR	740	1594	11700
Totals	1621	2592	36304
Design to value	2000	3000	50000

*MODIS values assumed

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For the test case, the following assumptions were used. The platform would:

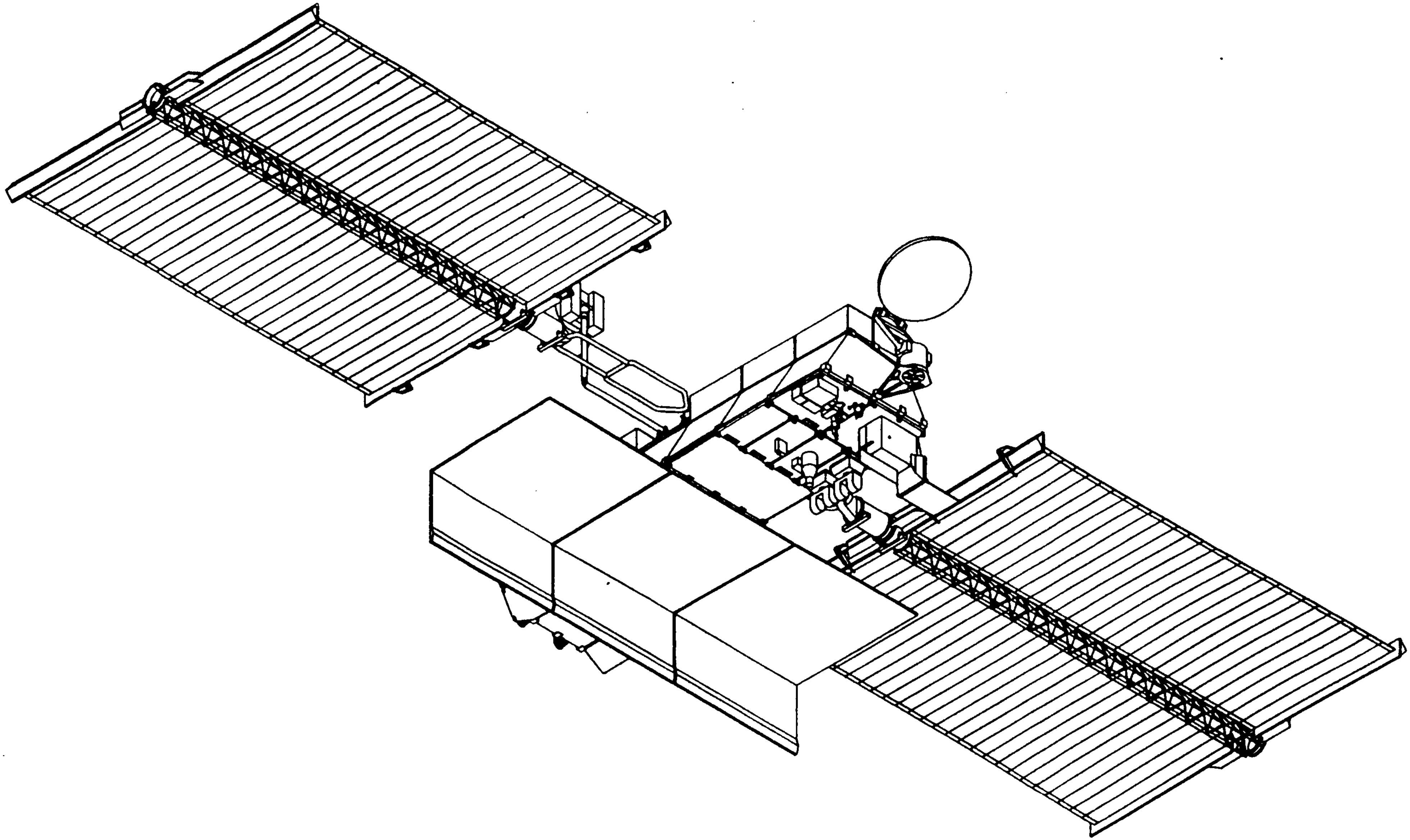
> **Be launched by the shuttle to Space Station Freedom for assembly or direct to orbit by an expendable launch vehicle,**
>
> **Operate in an orbit of between 460 and 600 km at 28.5 degrees of inclination,**
>
> **Be serviced at the manned base by the Mobile Servicing Centre and its dexterous manipulator or by the Flight Telerobotic Servicer, with extravehicular activity as backup,**
>
> **Use the Orbital Maneuvering Vehicle to return to Freedom,**
>
> **Satisfy estimated resource requirements of test case payloads, and**
>
> **Be disposed of safely (including payloads) at end of life by an internal propulsion system or by Freedom logistics.**

ATTACHED PAYLOAD CO-ORBITING PLATFORM STUDY ASSUMPTIONS

- Launch
- Orbit
- Servicing
- Transportation to manned base
- Payloads
- Safe disposal

The structure of the configuration is based on that of the Polar Platform. It has two solar arrays, which are mounted above the TRAMAR near the center of gravity for control purposes.

The major study efforts were in analysis of thermal aspects of ORUs and in control analysis.



ATTACHED PAYLOAD CO-ORBITING PLATFORM
CONFIGURATION

The feasibility of using polar platform designs for a co-orbiting platform was demonstrated. The original plan was to do additional test cases for non-earth observing payloads; however, the funding was not available.

A major benefit of a co-orbiting platform of this type is to free up attached payload accommodations equipment on Space Station Freedom to enable use by a succession of attached payloads.

Benefits to the payloads include:

Operations which are not interrupted as they are expected to be on the manned base,

A cleaner environment,

An altitude which is constant when compared to that of the manned base, and

The capability for a long lived mission.

ATTACHED PAYLOAD CO-ORBITING PLATFORM STUDY

RESULTS

- CONFIGURATION FEASIBLE
- BRANCHING FOR FREEDOM ATTACHED PAYLOADS POSSIBLE

BENEFITS FOR PAYLOADS

- UNINTERRUPTED OPERATIONS
- CLEAN ENVIRONMENT
- CONSTANT ALTITUDE
- LONG LIFE