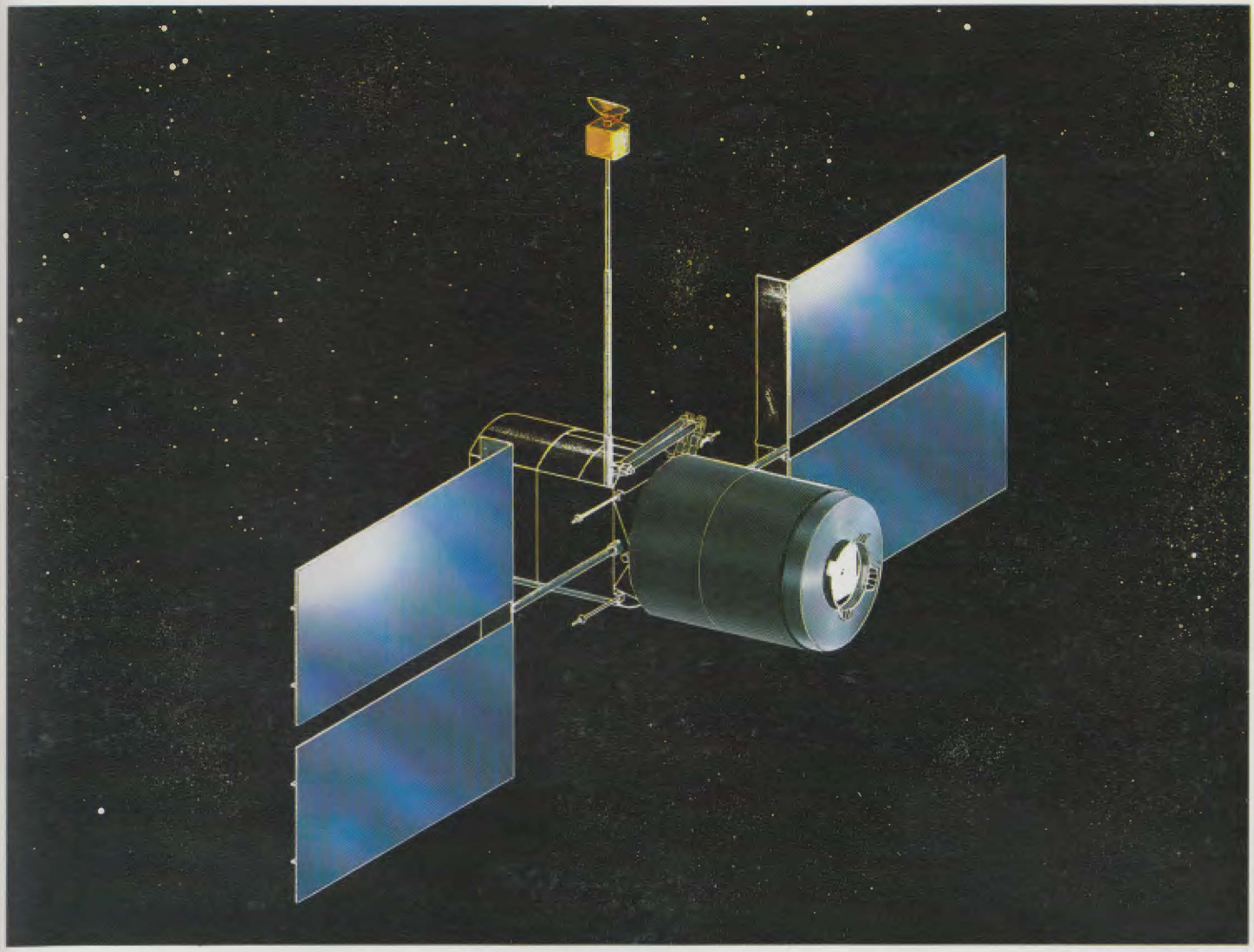


Key Requirements and Objectives

- Very low gravity environment for long-term experiments in the fields of:
  - Material Science
  - Fluid Physics
  - Life Science
- Optimum commonality with other COLUMBUS elements, especially the Attached Laboratory.
- 30 years operational life time by on-orbit servicing by manned intervention, replacement of ORU's.
- Coherence with other ESA space programme elements, mainly HERMES and DRS.
- Enhancement of space technology, especially Rendezvous and Docking and external serving including Robotics.

Figure: 1.1.–1.

Main Design and Performance Features

- **CONFIGURATION:**
  - Pressurized Module for payload
  - Resource Module for orbit and attitude control, power generation / storage, communications etc.
  - Pressurized Module commonality with Attached Laboratory configuration
  - Working space for 2 astronauts during servicing.

- **DIMENSIONS:**
  - 12 m length x 4.5 m diameter
  - 38 m solar array extended

- **ELECTRICAL POWER:**
  - 120 VDC regulated.
  - 18 kW total solar array output power (End of Life), 4.0 kW average for payload.
  - Dedicated power distribution for subsystems and payload.
  - 6 Nickel Hydrogen batteries for energy storage.

- **GUIDANCE, NAVIGATION AND CONTROL:**
  - Real-time bus (1553 B).
  - Fine attitude control with reaction wheels and magnetorquers.
  - Sun pointing.

- **PROPULSION:**
  - Bi-propellant / cold gas assembly
  - 400 Newton main engine
  - Tank sized for 2700 kg fuel
  - Replenishment by tank replacement on-orbit (Super ORU).

- **DATA MANAGEMENT:**
  - Resource Module dedicated computer / data bus.
  - Minimum Telemetry / Telecommand for initialization and safe mode.
  - Independent data acquisition and processing for subsystems and payload.
  - Transparent data communication, ISO Layer Model.
  - Scientific data multiplexing and transmission to ground.
  - Automated system operation incl. failure detection, isolation and recovery.
  - Data storage: 3 Mbps and 10 Mbps recording; 50 Mbps playback; 30 Gigabits storage.

- **COMMUNICATION:**
  - Direct and via DRS to / from ground: S-band (omni-directional).
  - Via DRS: Ka-band, 1.2 m steerable antenna on boom.
  - GPS L-Band receivers for on-orbit state vector determination.

- **MICROGRAVITY:**
  - Better than 10^{-5} m / sec^2

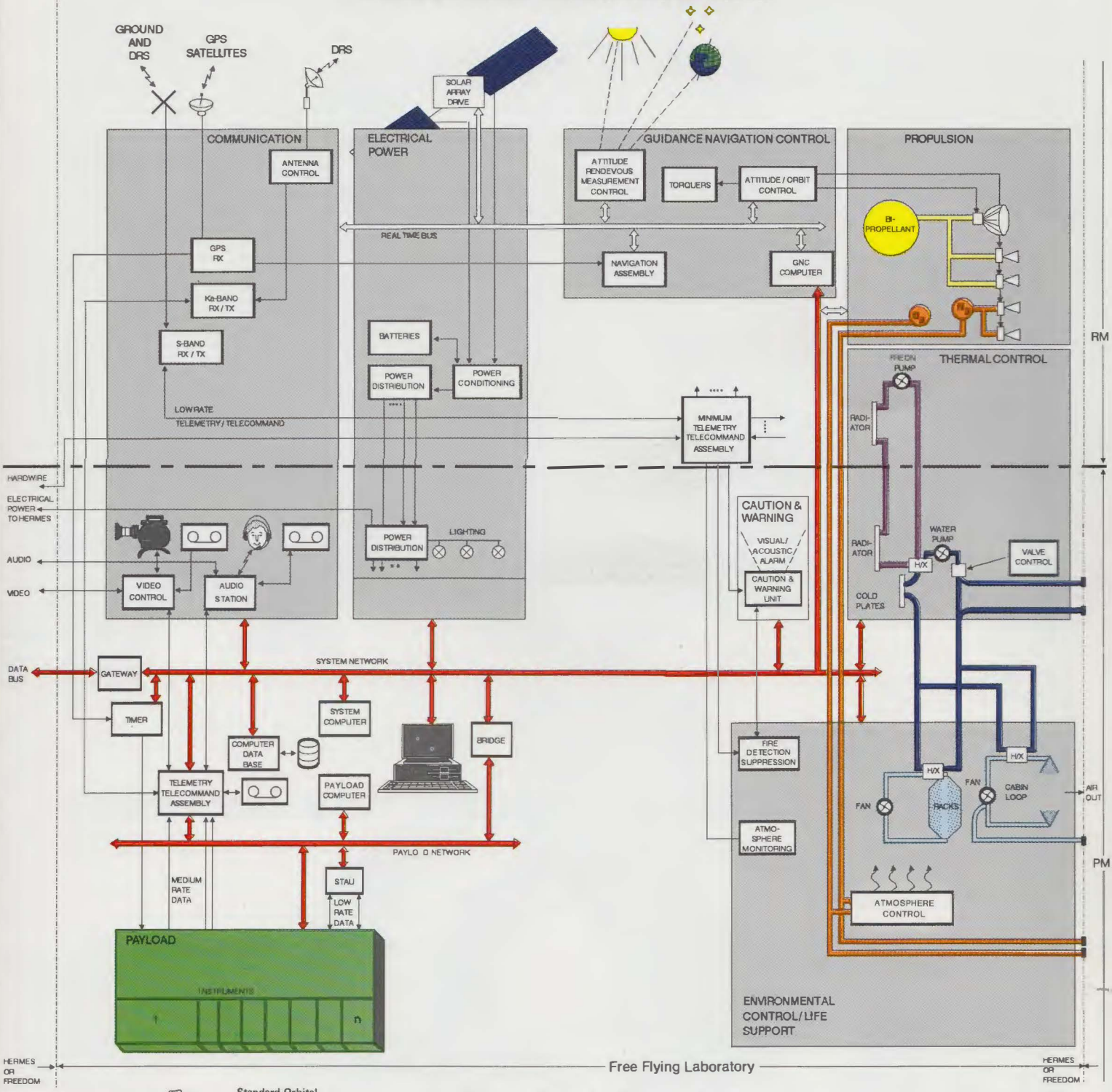
- **MISSION ORBIT:**
  - Co-orbiting with S.S. Freedom (335 to 460 km varying with solar activity).
  - 28.5^0 inclination.

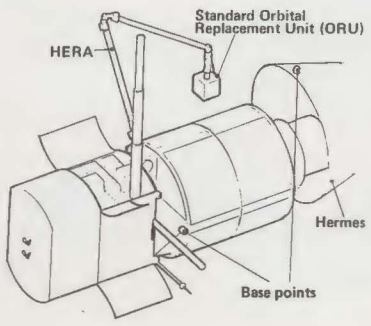
- **LAUNCH:**
  - Dedicated ARIANE 5 launch
  - Launch Mass:

Dry mass	15.690 kg
Fuel (for 180 days first mission)	1.010 kg
Scientific payloads	1.200 kg
ESA margin	500 kg
Total mass	18.400 kg

  - Super ORU for servicing, launched by NSTS

Functional Architecture





External Servicing

- Hermes Robotics Arm (HERA) launched by Hermes flight to Free Flying Laboratory.
- HERA transfer to Free Flying Laboratory via Base points for ORU transfer and on-orbit stowage.
- Accommodation of HERA on Free Flying Laboratory until next usage.

Key Free Flying Laboratory Interfaces

With S.S. Freedom

- Electrical Power: 6.0 KW (during full servicing)
- Life Support:
  - Air exchange
  - Atmosphere pressure and composition control by S.S. Freedom.
- Data Management and Communication:
  - Low rate telemetry / telecommand (incl. differential GPS) during rendezvous manoeuvre
  - Video.
  - Voice communication.
- Docking / Berthing Adapter with separation safety hatch.
- Station manipulator for Free Flying Laboratory and Super ORU handling.

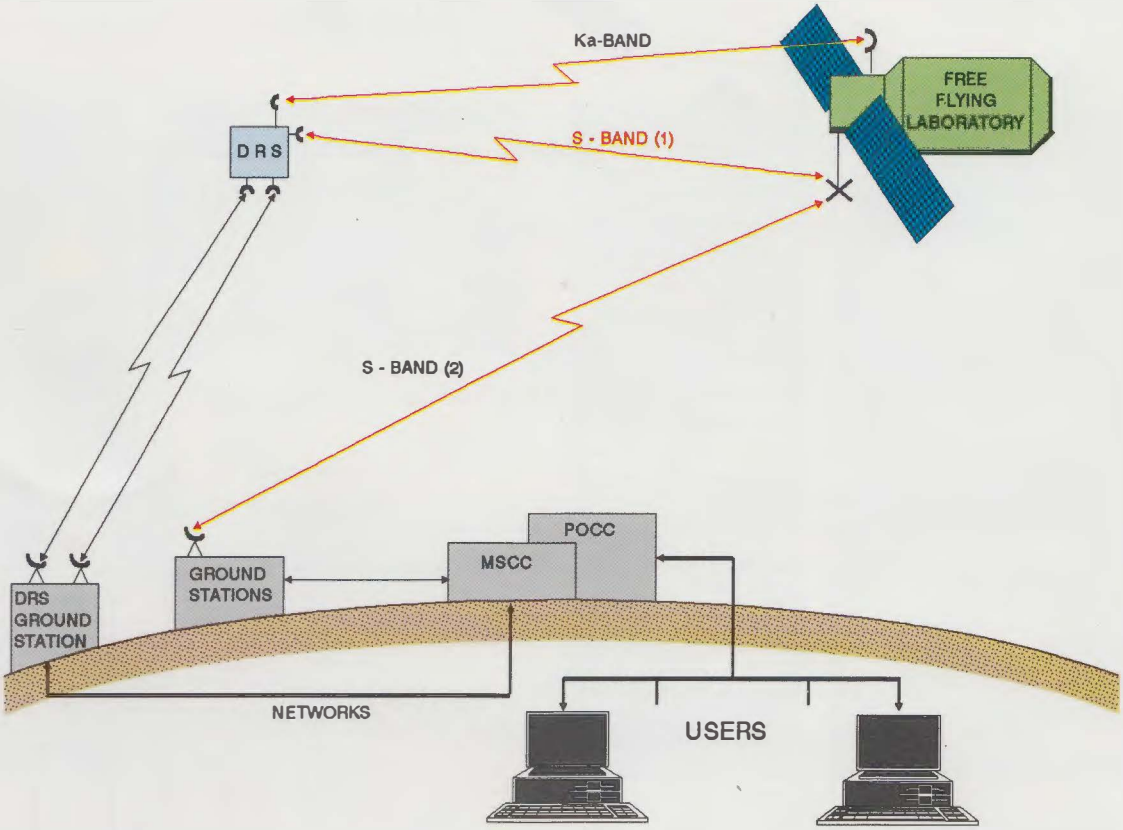
With Hermes

- Data Management and Communication:
  - Low rate telemetry / telecommand.
  - Voice communication.
- Power to Hermes: 2.0 KW (For Hermes contingency support).
- Docking / Berthing Adapter.
- Monitoring and Control of Hermes Robotics Arm.

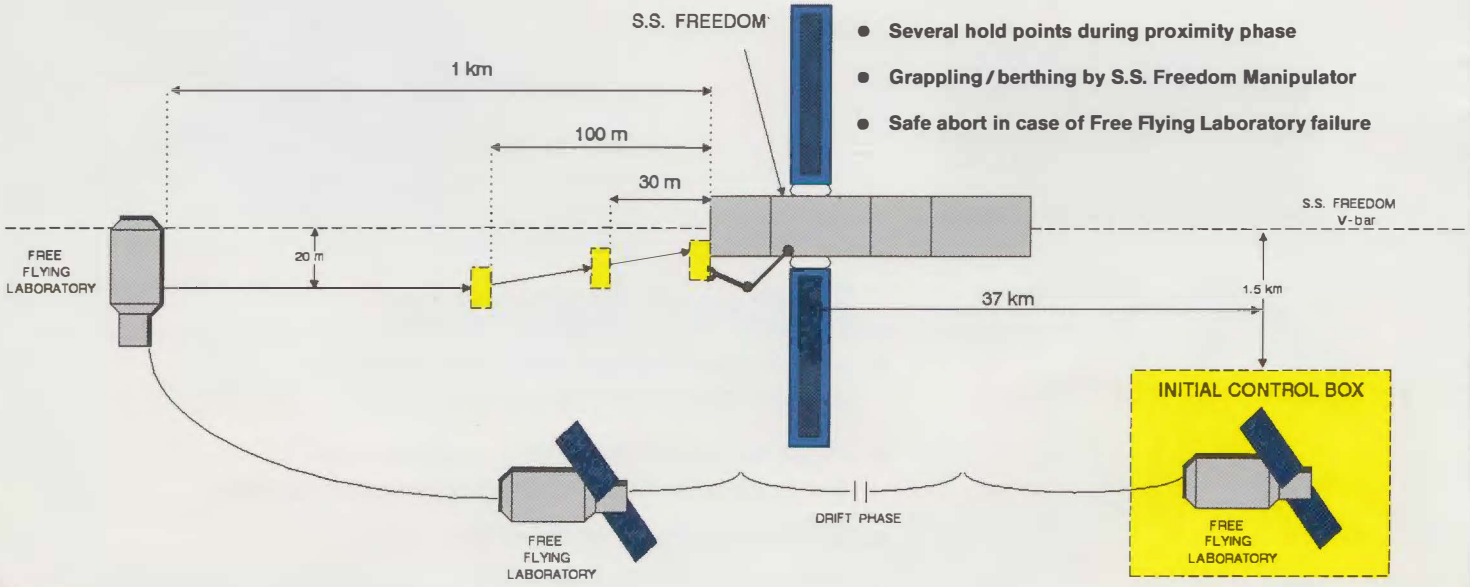
Payload Accommodation

- Physical accommodation in single and / or double racks (12.0 m^3 total volume).
- Available utilites / interfaces:
  - Electrical power: 120 VDC + 1% / -3.5%
  - Data acquisition (bus, discrete, analog).
  - Data distribution to instruments.
  - Data processing and bulk software storage.
  - Multiple low, medium, and high rate data inputs (up to 32 Mbps per channel).
  - Video signal distribution and display: RGB colour signal.
  - Air and water cooling.
  - Vacuum / venting.
- Racks and drawers are Orbit Replaceable Units for payload reconfiguration.

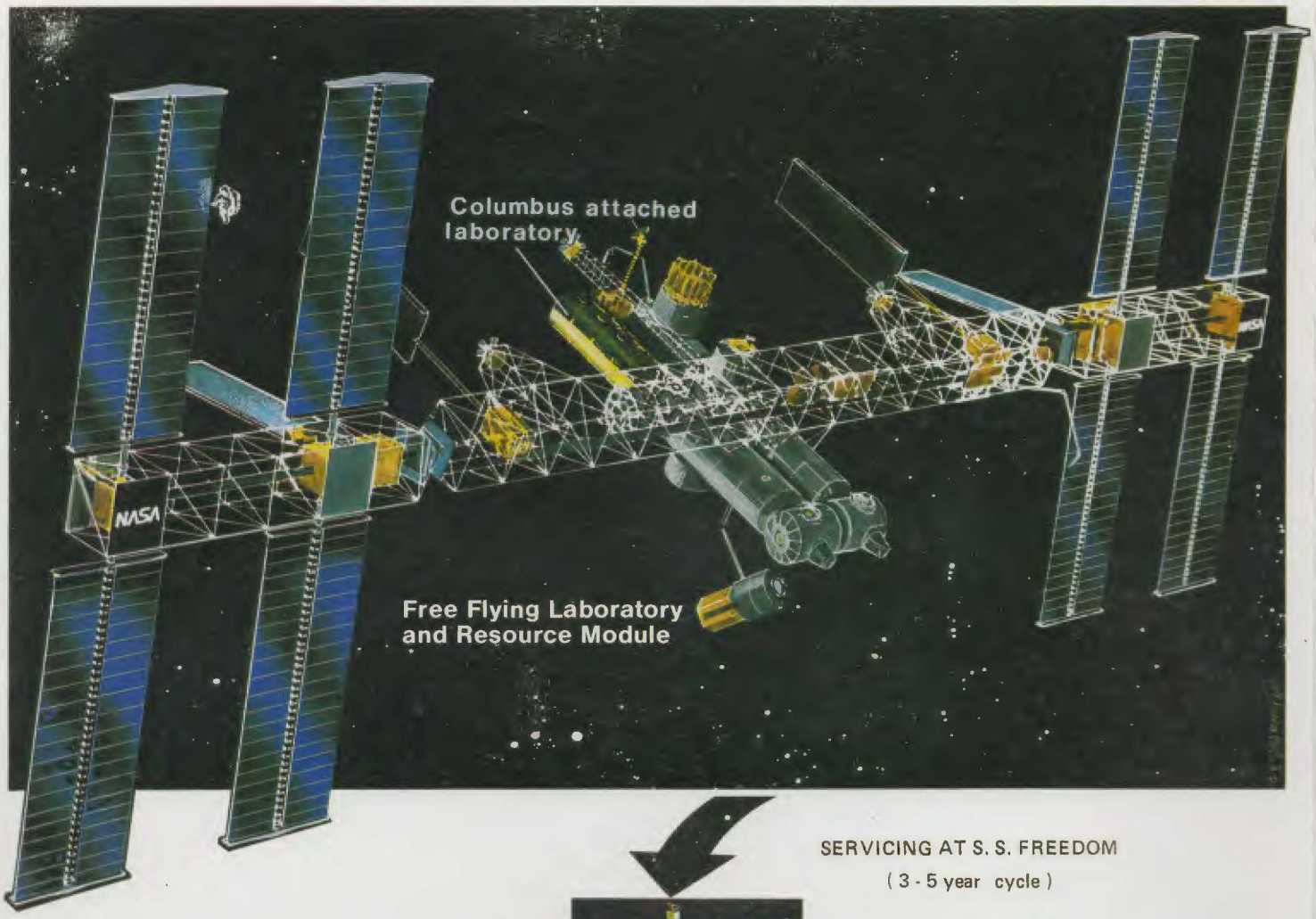
Operations Scenario



S.S. Freedom / Free Flying Laboratory Rendezvous



- Several hold points during proximity phase
- Grappling / berthing by S.S. Freedom Manipulator
- Safe abort in case of Free Flying Laboratory failure


Columbus attached laboratory
NASA
Free Flying Laboratory and Resource Module


SERVICING AT S. S. FREEDOM
(3 - 5 year cycle)
SERVICING BY HERMES
(180 day cycle)
ARIANE 5 LAUNCHES

Figure: 1.1.–2.