LDR SYSTEM CONCEPTS AND TECHNOLOGY

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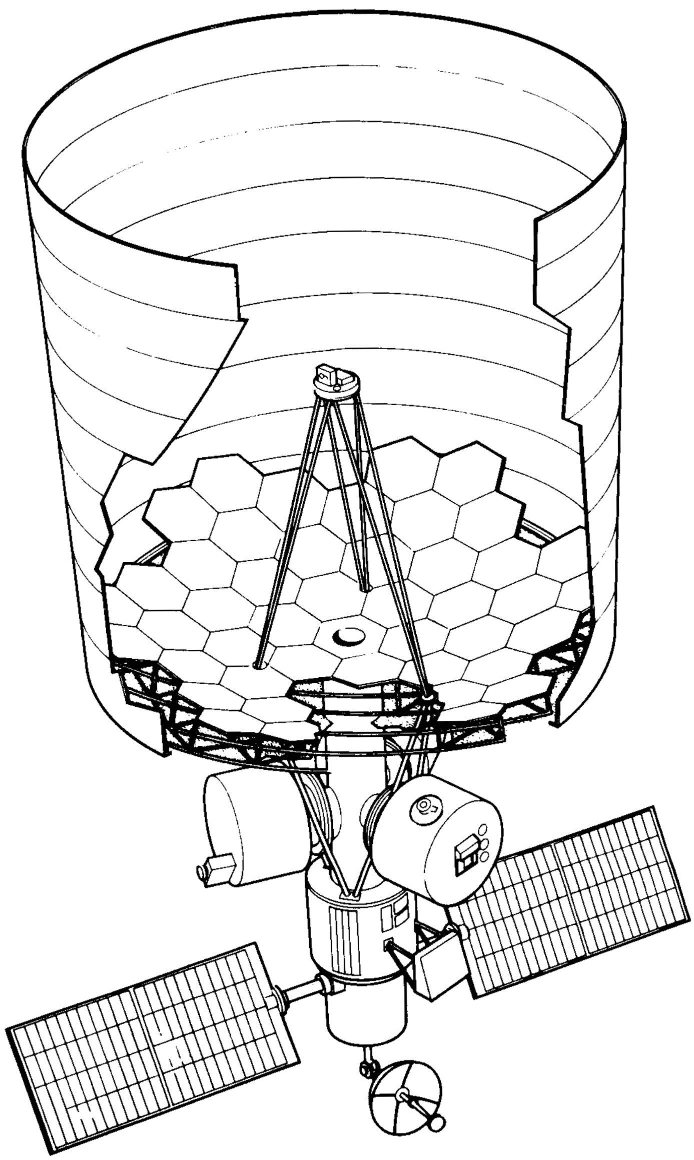
The Large Deployable Reflector is a 20-meter-diameter infrared/submillimeter telescope planned for the late 1990's. The Astronomy Survey Committee of the National Academy of Sciences (Field Committee) recommended LDR as one of the two space-based observatories that should start development in the 80's. LDR's large aperture will give it unequaled resolution in the wavelength range from 30 - 1000 microns.

To meet LDR performance goals will call for advances in several technology disciplines including: optics, controls, thermal control, detectors, cryogenic cooling, and large space structures.

KEY LDR TECHNOLOGY DRIVERS

* 20-METER-DIAMETER PRIMARY MIRROR
* 2-4 MICRON RMS WAVEFRONT ERROR BUDGET
* 0.06 ARC SEC POINTING ACCURACY
* 1K THERMAL GRADIENT ACROSS THE PRIMARY
* LARGE, COMPLEX INSTRUMENTS
* 1-2 WATTS OF COOLING AT 4K
* 10-YEAR LIFETIME

This is a view of LDR showing the thermal shade, primary and secondary mirrors, backup structures, instrument modules, spacecraft, and solar panels.



One of the key challenges in the development of LDR is to understand the interdependence of all of the various systems. A major change in one system will almost certainly have a pronounced impact on several other systems. For example, a change in the thermal expansion of the support structure for the primary mirror will not only affect the primary optics, but will also affect the actuator system that positions the optics. The impact and interaction of the LDR systems must be clearly understood prior to Phase B.

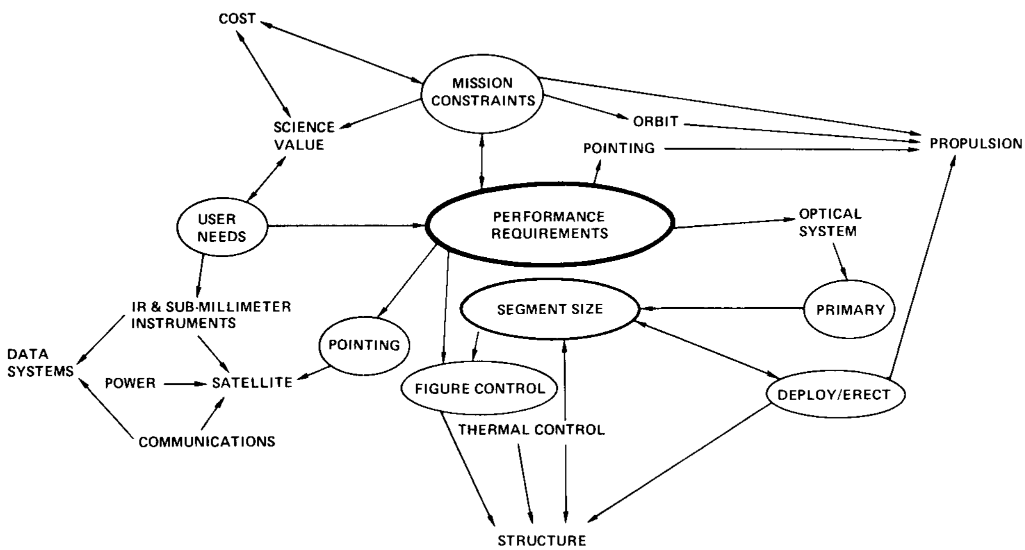
There are several key "system issues" or questions that have an impact on several LDR systems. The impact of these issues on the various LDR systems must be well understood before the proper decision can be made on how to implement LDR. Single or multiple Shuttle launches, polar or equatorial orbits, deployed or assembled construction, these are only a few of the systems issues that must be addressed prior to developing a comprehensive technology development plan.

LDR SYSTEM ISSUES

* SEVERAL KEY "SYSTEM ISSUES" HAVE BEEN DEVELOPED; THE INTERRELATION MUST BE STUDIED

* TRANSPORTATION TO ORBIT
* ORBIT PARAMETERS
* ORBITAL ENVIRONMENT
* DEPLOYED OR ASSEMBLED CONSTRUCTION
* OPTICAL CONFIGURATION
* APERTURE SIZE
* MIRROR SURFACE ACCURACY
* CONTAMINATION CONTROL

The principal LDR system relationships must be well understood before a technology development plan can be developed. This task was added at the beginning of the Technology Definition Plan Studies.



To produce a technology development plan for LDR, it was decided to undertake the System Concept and Technology Definition Studies. The purpose of the studies is to understand the interaction of the various systems of LDR and to understand the impact of the systems issues on the total system.

Two contractor teams were selected, each undertaking parallel $450,000 studies; one team was headed by Eastman Kodak and the other by Lockheed.

The output of these studies will be two concepts for LDR, each of which could meet the LDR system requirements. A technology development plan will also be produced that will identify the augmentations that must be made in the OAST technology program if LDR is to be undertaken in the early 1990's without undue technological uncertainty.

SYSTEM CONCEPT AND TECHNOLOGY DEFINITION STUDIES

* TWO INDEPENDENT STUDIES OF LDR SYSTEM CONSIDERATIONS AND TECHNOLOGY REQUIREMENTS

* EACH CONTRACTOR WILL DEVELOP TWO CONCEPTS FOR LDR AND A TECHNOLOGY DEVELOPMENT PLAN

* THE PLAN WILL:
  - BE TIME PHASED
  - BE RANKED BY PRIORITY
  - HAVE INTERMEDIATE MILESTONES
  - HAVE REQUIRED TECHNOLOGY LEVELS
  - HAVE PRELIMINARY COST DATA

The LDR technology development plan will include several key technologies that have already been identified as key candidates.

KEY LDR TECHNOLOGIES

* OPTICS
* STRUCTURES AND MATERIALS
* POINTING AND CONTROLS
* INSTRUMENTS AND CRYOGENICS
* SYSTEMS ANALYSIS

LDR represents one of the most challenging astronomy projects ever undertaken by NASA. Due to this challenging nature there are several key decisions that must be made concerning how the program will be implemented. These decisions will have a substantial impact on the resulting technology development program. Until sufficient study has been made to allow these key questions to be answered, parallel technologies may have to be pursued in some areas.

TECHNOLOGY DEVELOPMENT PLANNING

* THE LDR TECHNOLOGY PROGRAM IS " PATH DEPENDENT"

* THE TECHNOLOGY PATH TAKEN DEPENDS ON THE SYSTEMS APPROACH TAKEN:

    * SINGLE OR MULTIPLE SHUTTLE LAUNCHES

    * POLAR OR EQUATORIAL ORBITS

    * DEPLOYED OR ASSEMBLED CONSTRUCTION

    * SPACE STATION UTILIZATION

The early LDR feasibility studies made the assumption that LDR will be automatically deployed from a single Shuttle launch. This caused severe weight and packaging constraints. Ultra-lightweight optics and structures were required to meet severe Shuttle weight constraints. In addition, deployment schemes with both high packaging efficiency and extreme deployed accuracy were needed.

One possible concept for reducing the volume constraint is the use of an Aft Cargo Carrier. This proposed device would fit on the end of the Shuttle External Tank and provide an additional 10,000 cubic feet of storage space with a diameter of 25 feet.

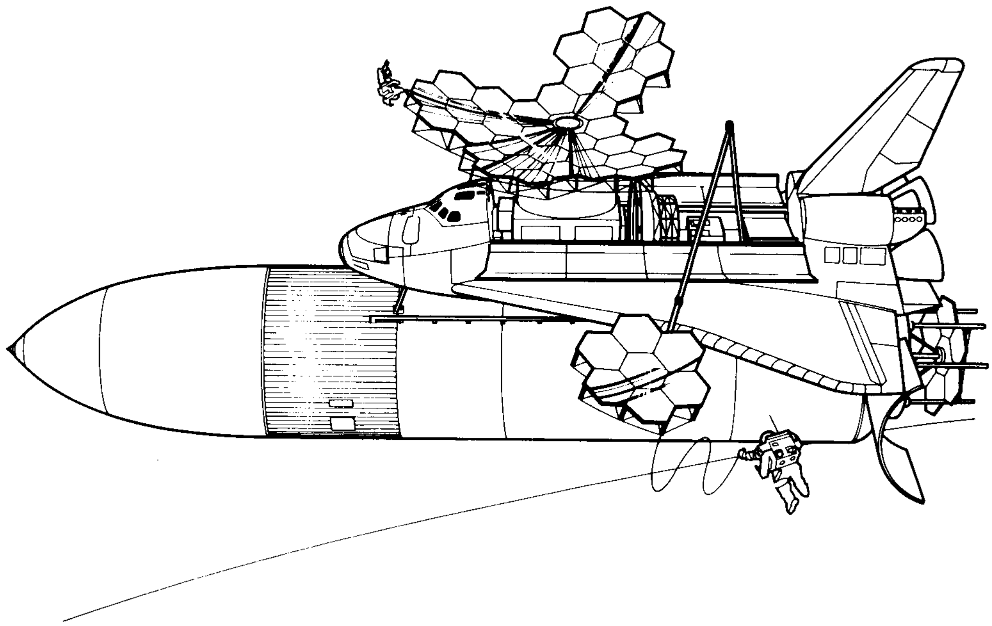
LDR CONCEPT #1

* SINGLE SHUTTLE LAUNCH OPTION
* SEMI-AUTOMATIC DEPLOYMENT
* SHUTTLE AFT CARGO CARRIER

KEY TECHNOLOGIES

* LIGHTWEIGHT OPTICS & STRUCTURES
* DEPLOYABLE STRUCTURES
* SOPHISTICATED DEPLOYMENT MECHANISMS

The picture shows LDR being assembled in orbit using the Aft Cargo Carrier to store the segments of the primary mirror. The other portions of the LDR system are carried in the Cargo Bay.



With the decision to deploy a manned space station within a decade, the possibility of assembling LDR in space using this facility became a serious consideration. Assembly in space has several advantages including using multiple Shuttle launches to eliminate both weight and volume constraints. If this path is pursued, then the technology program will focus on assembly of percision structures in space. It is important that this possibility be studied in the near term prior to the start of the detailed design of the station.

LDR CONCEPT #2

* MULTIPLE SHUTTLE LAUNCHES
* SPACE STATION ASSEMBLY

<u>KEY TECHNOLOGIES</u>

* ASSEMBLY OF LARGE SPACE STRUCTURES
* ADVANCED REMOTE MANIPULATOR TECHNOLOGY
* ROBOTICS
* ADVANCED EVA

The picture shows LDR attached to the Space Station. The Station could be useful not only for initial assembly of LDR but also for initial alignment, refurbishment, and resupply.