LSS CONTROL TECHNOLOGY

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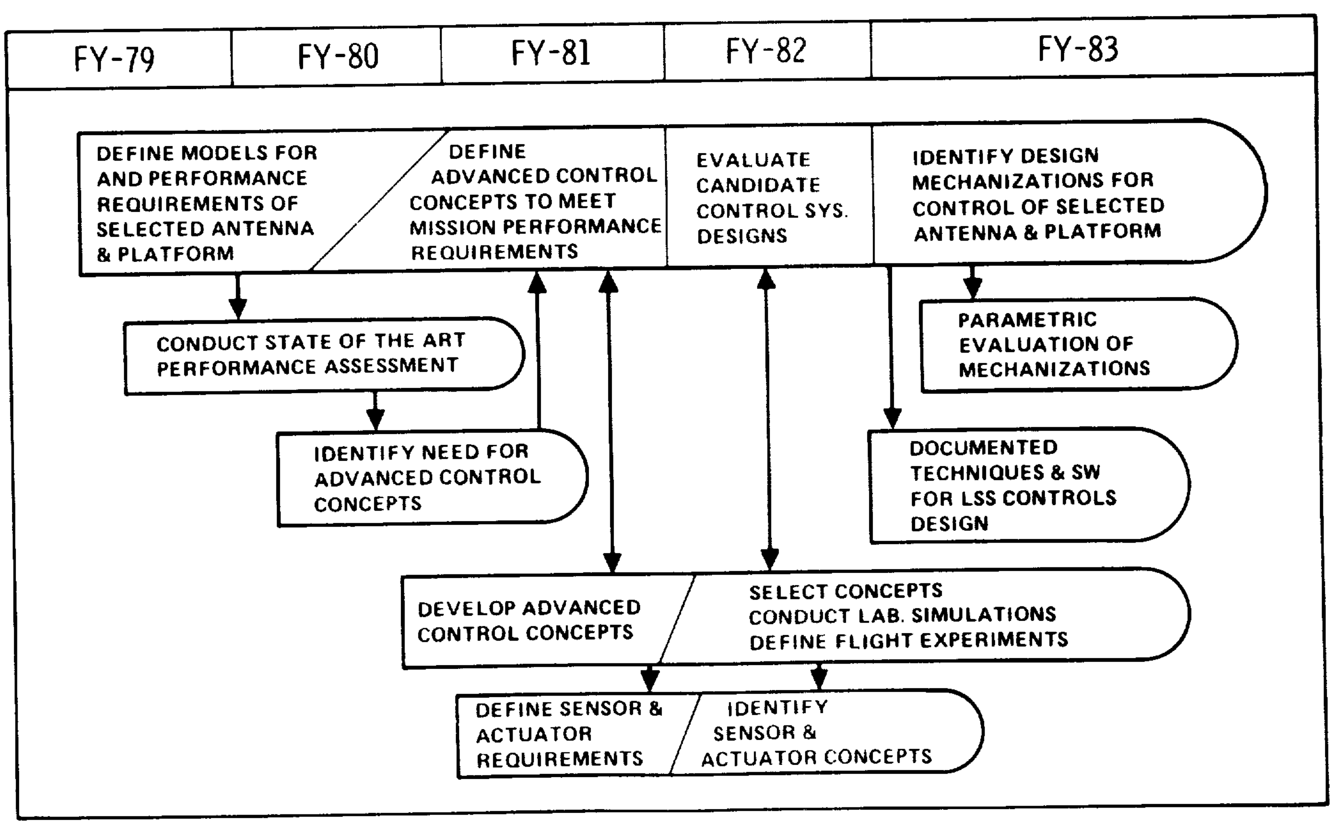
LSST CONTROLS TECHNOLOGY DEVELOPMENT

The objective of LSS Controls is to define and develop the necessary control technologies required by a variety of future large platform and antenna missions.

The plan shows technology developments in three main areas. The top part of chart shows the SYNTHESIS tasks which support the definition, development and evaluation of control systems for classes of platform and antenna applications, leading to the selection and evaluation of preferred mechanization.

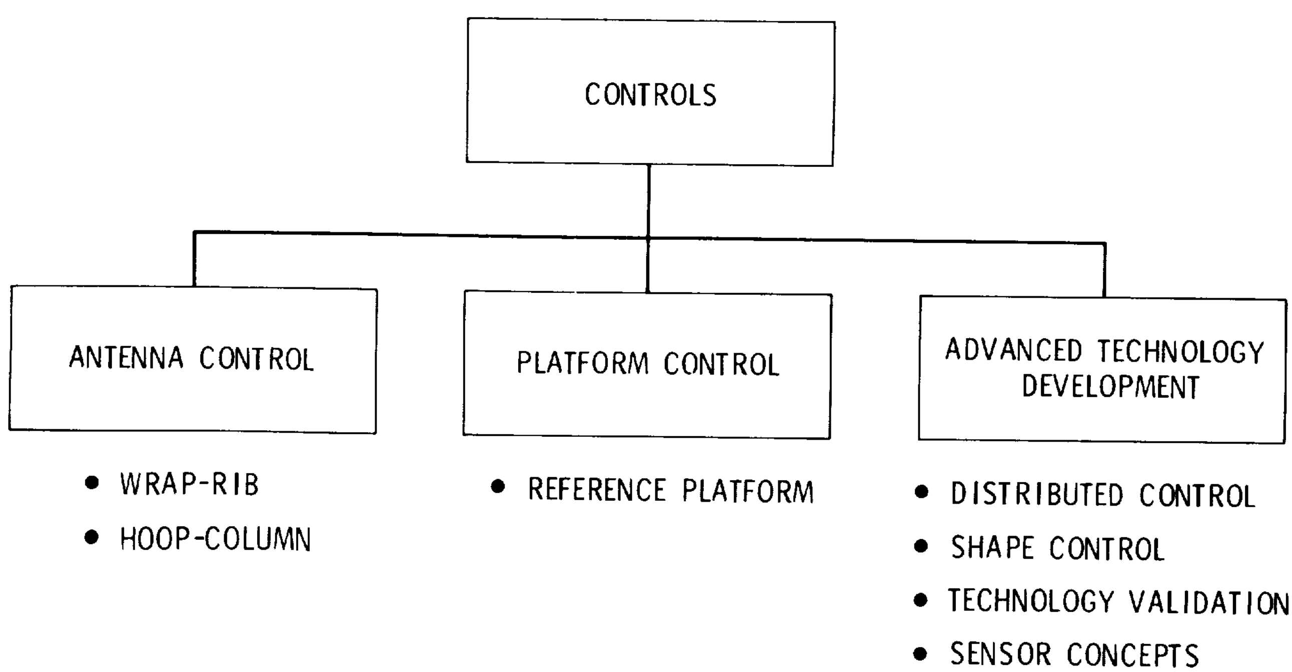
The center of the chart shows the ADVANCED TECHNOLOGY DEVELOPMENT tasks which develop the fundamental technology needed to achieve precise attitude, pointing, and shape control required by LSS, as well as the associated hardware concepts.

The TECHNOLOGY VALIDATION tasks address the verification of control technology through ground demonstrations of control technology and the definition of flight experiments required for verification and for establishing technology readiness.



JPL LSS CONTROLS PROGRAM ELEMENTS

The LSS Controls program at JPL addresses the synthesis tasks for large antennas and platforms, as well as the Technology Development and Validation areas. In this presentation I will summarize briefly the overall LSS Controls program at JPL. The following four speakers, Y.H. Lin, J.M. McLauchlan, R.S. Edmunds, and D.B. Schaechter, will follow with detailed reports on Antenna Control, Shape and Vibration Sensors, Platform Control, and Advanced Control Technology and Validation, respectively.



FY'81 ACCOMPLISHMENTS - ANTENNA AND PLATFORM CONTROL

(1) Updated control requirements and dynamic models to reflect the latest configurations for platforms and antennas (3-dimensional platform models with 4 payloads, 64m Hoop-Column antenna, and a 55m Wrap-Rib antenna).

(2) Defined and developed a hierarchy of control systems needed to meet the performance requirements of various classes of missions. This hierarchy constitutes an inventory of control technology which provides specific control solutions of varying complexity depending upon the specific mission requirements.

(3) A study was completed to define the control subsystem for the Land Mobile Satellite Service (LMSS) mission. The specific LMSS disturbance environment and control requirements were defined and preliminary control subsystems were developed for both the single-aperture offset-fed wrap rib and the quad-aperture hoop column implementations. The subsystems defined included control concepts as well as detailed equipment lists (type, dimensions, weight, power, etc.). This study is covered in detail in a separate paper (also included in these proceedings in the section on antennas) entitled "Attitude Control Subsystem Study for the LMSS Spacecraft".

(4) A key accomplishment in the platform and antenna control area has been the quantitative assessment and identification of sensor and actuator requirements, performance regime achievable, the sensitivity of that performance to system (structure/control) uncertainties, and the identification of key technology drivers.

- UPDATED DYNAMIC MODELS AND CONTROL REQUIREMENTS
- DEFINED AND DEVELOPED ADVANCED CONTROL CONCEPTS TO MEET MISSION PERFORMANCE REQUIREMENTS
- DEFINED CONTROL SUBSYSTEM MECHANIZATION FOR THE LMSS COMMUNICATIONS MISSION
- QUANTITATIVE ASSESSMENT OF
  - SENSOR AND ACTUATOR REQUIREMENTS
  - PERFORMANCE REGIME
  - SENSITIVITY TO CONTROL/STRUCTURAL UNCERTAINTIES
  - TECHNOLOGY DRIVERS

FY'81 ACCOMPLISHMENTS - CONTROL TECHNOLOGY

(1) Techniques have been developed for computing the sensitivity matrix of the far-field electric fields of antennas with respect to feed displacements. This sensitivity matrix is being used to account for RF considerations in the design of RF-performance-optimum control systems.

(2) Continued development of the experimental facility has resulted in a detailed finite-element model of the flexible beam and in accurate calibration of the sensor and actuator scale factors. Interactive software has been developed and added to the facility, thus allowing very fast implementation of control laws. A laser/retroreflector system has been incorporated to visualize the motion of the beam.

(3) Static shape estimation and control has been demonstrated experimentally on the beam facility. The method has been also demonstrated through computer simulation of a 55-meter wrap-rib reflector using 18 sensors and 18 actuators distributed circularly around the reflector.

(4) An active distributed control approach has been developed which exhibits reduced sensitivity to model errors. The concept has been demonstrated experimentally.

- DEVELOPED ANALYSIS KNOW-HOW TO DETERMINE ANTENNA CONTROLLER DESIGNS BASED ON RF PERFORMANCE
- EXPERIMENTAL FACILITY DEVELOPMENT
- STATIC SHAPE ESTIMATION AND CONTROL
  - LABORATORY DEMONSTRATION
  - APPLICATION TO 55M REFLECTOR
- ACTIVE DISTRIBUTED CONTROL ANALYSIS AND LABORATORY DEMONSTRATION

FY'82 TASK SUMMARY - CONTROL TECHNOLOGY

A major theme of the FY'82 work will be the development of control systems which can either adapt to changing or uncertain models or be insensitive to the model errors. Specific tasks are:

(1) Develop expanded algorithms for distributed control and for system identification required for off-line and real-time knowledge of the flexible spacecraft dynamics.

(2) Investigate the sensitivity of the shape determination and control system to actuator/sensor type, number and location.

(3) Compute the sensitivity of the far field of an antenna to reflector shape deformations. Develop control-design approach to optimize RF performance.

(4) Experimental verification of precise shape control with poorly known dynamics and application to multidimensional plate-like structures.

- DEVELOP EXPANDED IDENTIFICATION ALGORITHMS FOR MODAL DETERMINATION AND DISTRIBUTED CONTROL
- ESTABLISH SHAPE DETERMINATION AND CONTROL PERFORMANCE SENSITIVITY TO ACTUATOR/SENSOR TYPE, NUMBER AND LOCATION
- COMPUTE RF SENSITIVITY TO DISH DISTORTION AND DEVELOP CONTROL DESIGNS TO OPTIMIZE RF PERFORMANCE
- EXPERIMENTAL VALIDATION OF PRECISE SHAPE CONTROL WITH POORLY KNOWN DYNAMICS

FY'82 TASK SUMMARY - ANTENNA AND PLATFORM CONTROL

(1) A variety of platform and payload configurations will be examined covering both manned and unmanned applications. Study will include the effects of platform and pointing mount stiffness on payload controller performance as well as the effects of man/shuttle disturbances.

(2) The large antenna control task will complete the evaluation of additional system drivers and establish performance levels and sensitivity to truncation errors as well as software and hardware constraints, nonlinearities, etc.

(3) A task will be initiated to define a control flight experiment. This task will address the definition of control experiment goals and requirements, the development of mechanization approaches and the identification of instrumentation requirements.

- EXAMINE SENSITIVITY OF CONTROLLER PERFORMANCE TO DISTURBANCES CAUSED BY MAN/SHUTTLE INTERFACE

- COMPLETE EVALUATION OF SYSTEM DRIVERS AND ESTABLISH PERFORMANCE OF ADVANCED CONTROL SYSTEMS FOR LARGE ANTENNA MISSION CONCEPTS

- DEFINE FLIGHT EXPERIMENT CONTROL GOALS AND REQUIREMENTS, DEVELOP MECHANIZATION APPROACHES AND INSTRUMENTATION REQUIREMENTS