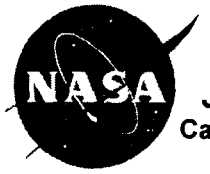


Jet Propulsion Laboratory
California Institute of Technology

JPL

Overview of the DSN Large Array Project

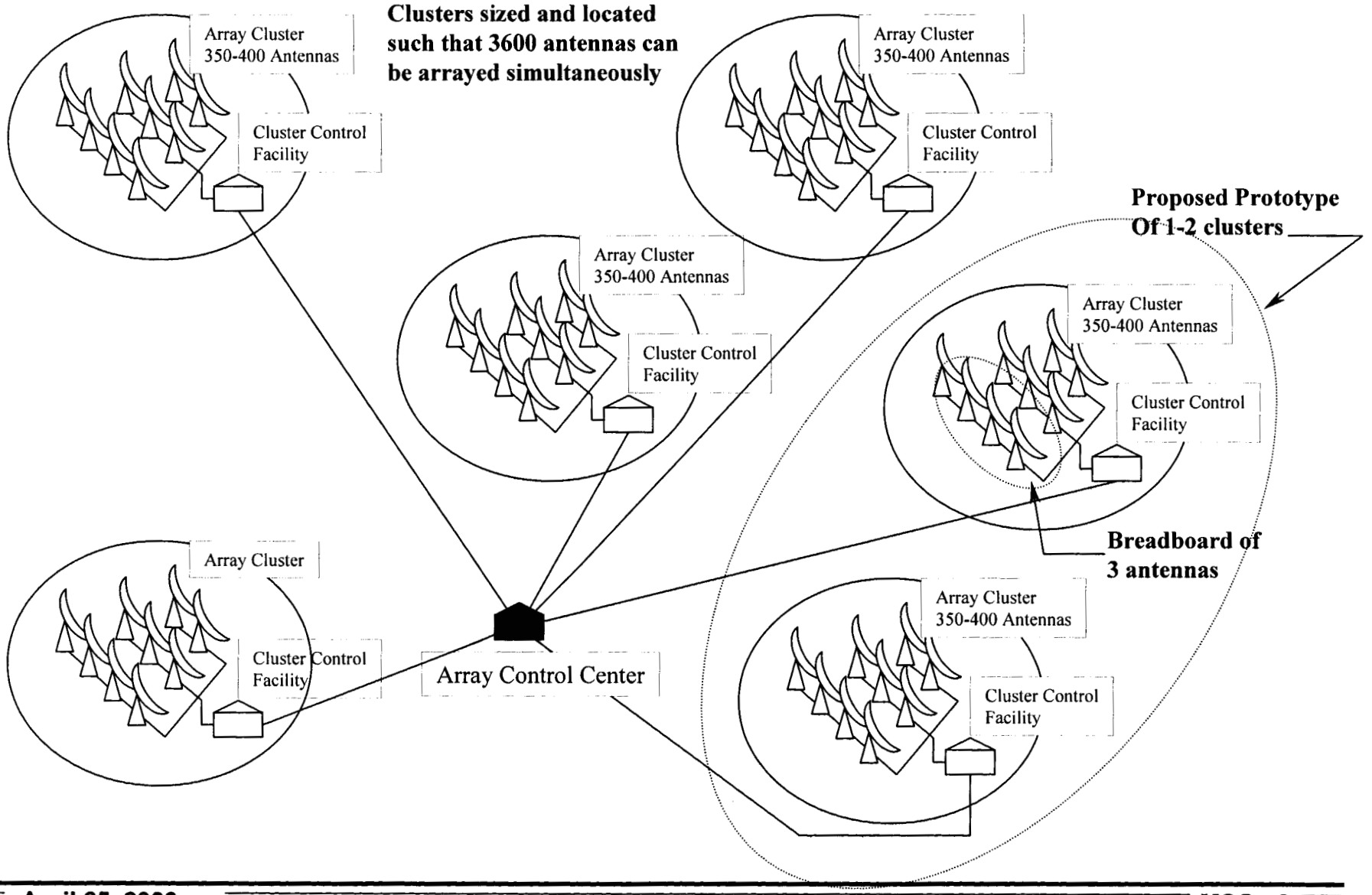
Mark Gatti
DSN Array Project Manager
JPL/Caltech

Overview of the DSN Large Array Project

The need for more ground capability

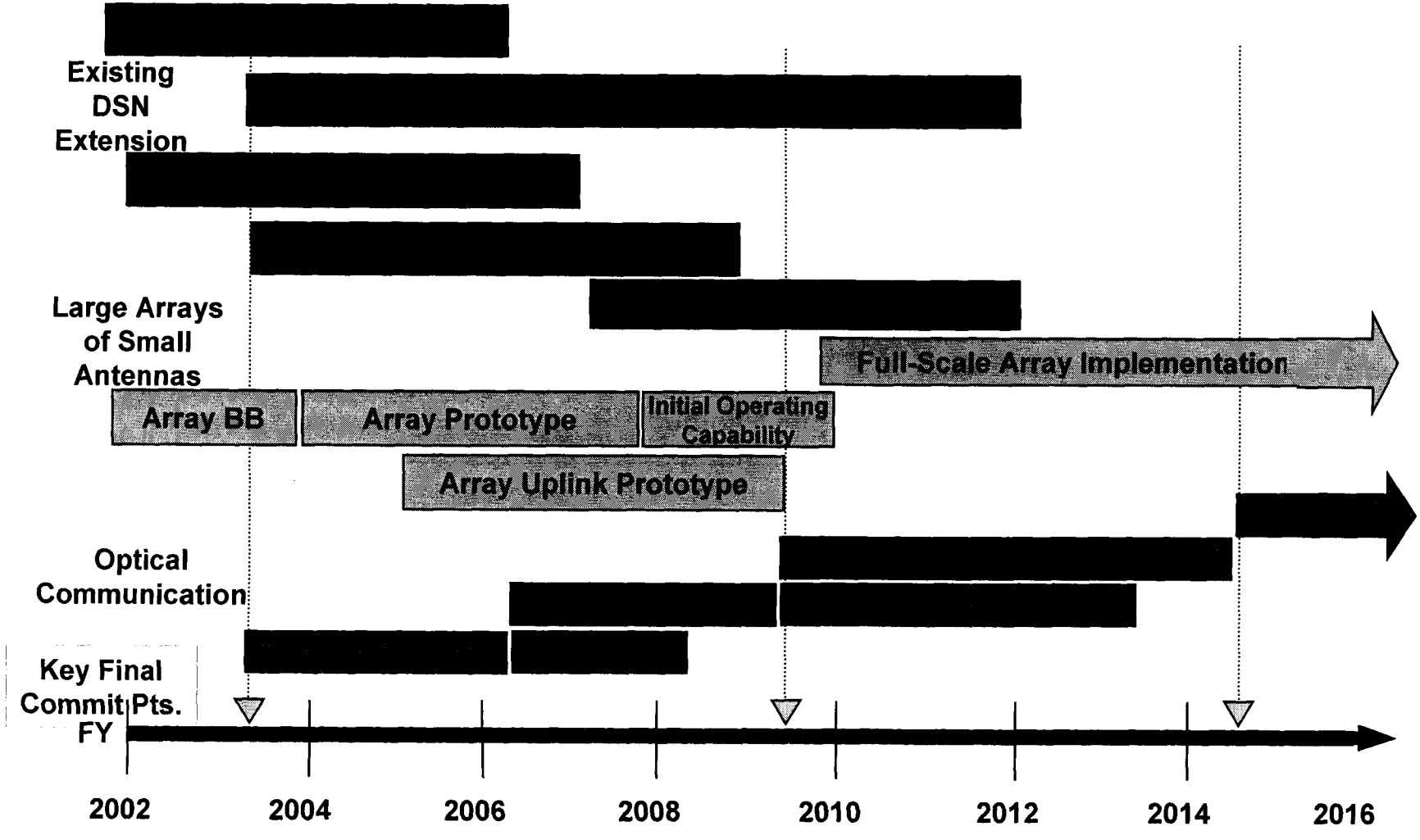
- NASA desires orders of magnitude increased communications capability with its deep space missions.
  - Split between both flight and ground systems.
  - For the DSN it is desirable to attain at least 400x the current X-band capability of the 70m antennas for each longitude
- Recent advances in reflector antenna manufacturing and electronics cost and parametric studies of cost-vs-antenna size suggest that the optimum size for a large array is between 6 to 12 meters.
  - An array of 3600 12m antennas with high aperture efficiency would provide approximately 100 times the effective area of the 70m at X-band
  - Increasing frequency to Ka-band would provide another factor of greater than 4

Overview of the DSN Large Array Project
Cartoon Concept of DSN Array



Overview of the DSN Large Array Project

Large Array in Overall DSN Roadmap

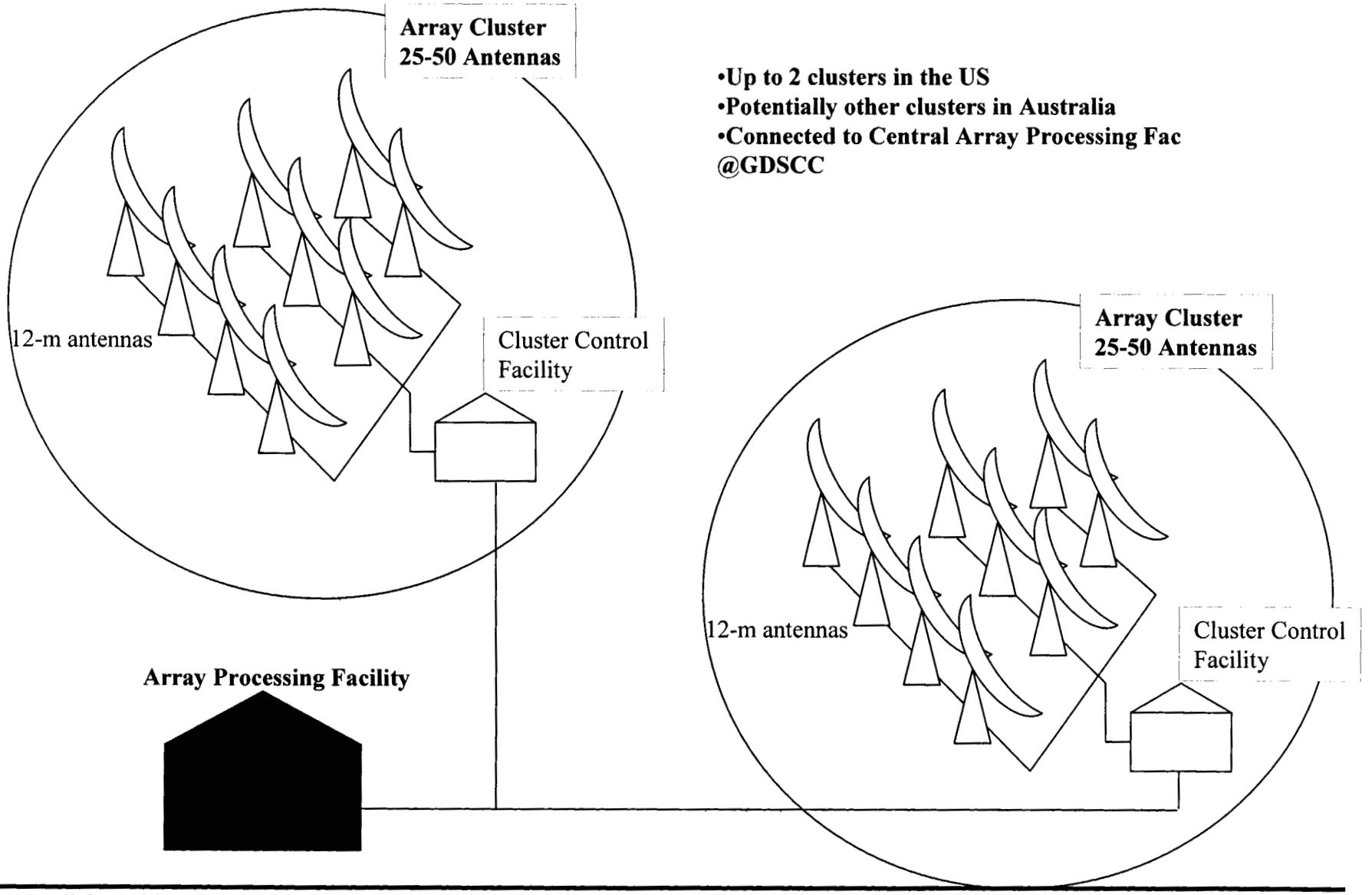


Overview of the DSN Large Array Project Risk Reduction

- An array of approximately 100 antennas has been proposed in order to reduce or eliminate risk to a task of this magnitude
  - A *prototype* of the final DSN Array
  - Will demonstrate management, cost, technology, operations, and maintenance of a large array
- Current budget estimate for this prototype array was made in February 2002
  - $87 million
  - 100 antennas
  - All located at the Goldstone Deep Space Communications Complex
  - 12-m antenna, aluminum hydroformed antenna

Overview of the DSN Large Array Project

Cartoon Concept of Prototype Array



- **Up to 2 clusters in the US**
- **Potentially other clusters in Australia**
- **Connected to Central Array Processing Fac @GDSCC**

Overview of the DSN Large Array Project

What Leads to the Development of the Prototype Array?

Mission Drivers:
- **Increase science data return**
- **Reduce DSN service unit costs**

Spacecraft Design Solutions:
-Increase transmission power
-Higher bandwidth

DSN Architecture Solutions:
- **Increase DSN apertures**
- Higher bandwidth
- Efficient utilization of apertures

DSN Design Options:
- Build more monolithic large antennas
- **Build large array of small RF antennas**
- Build optical communication telescopes

Validation Approaches for Cost Effectiveness:
- Validation via breadboard
- **Validation via prototype array**

Overview of the DSN Large Array Project

Programmatic Objectives for Prototype Array

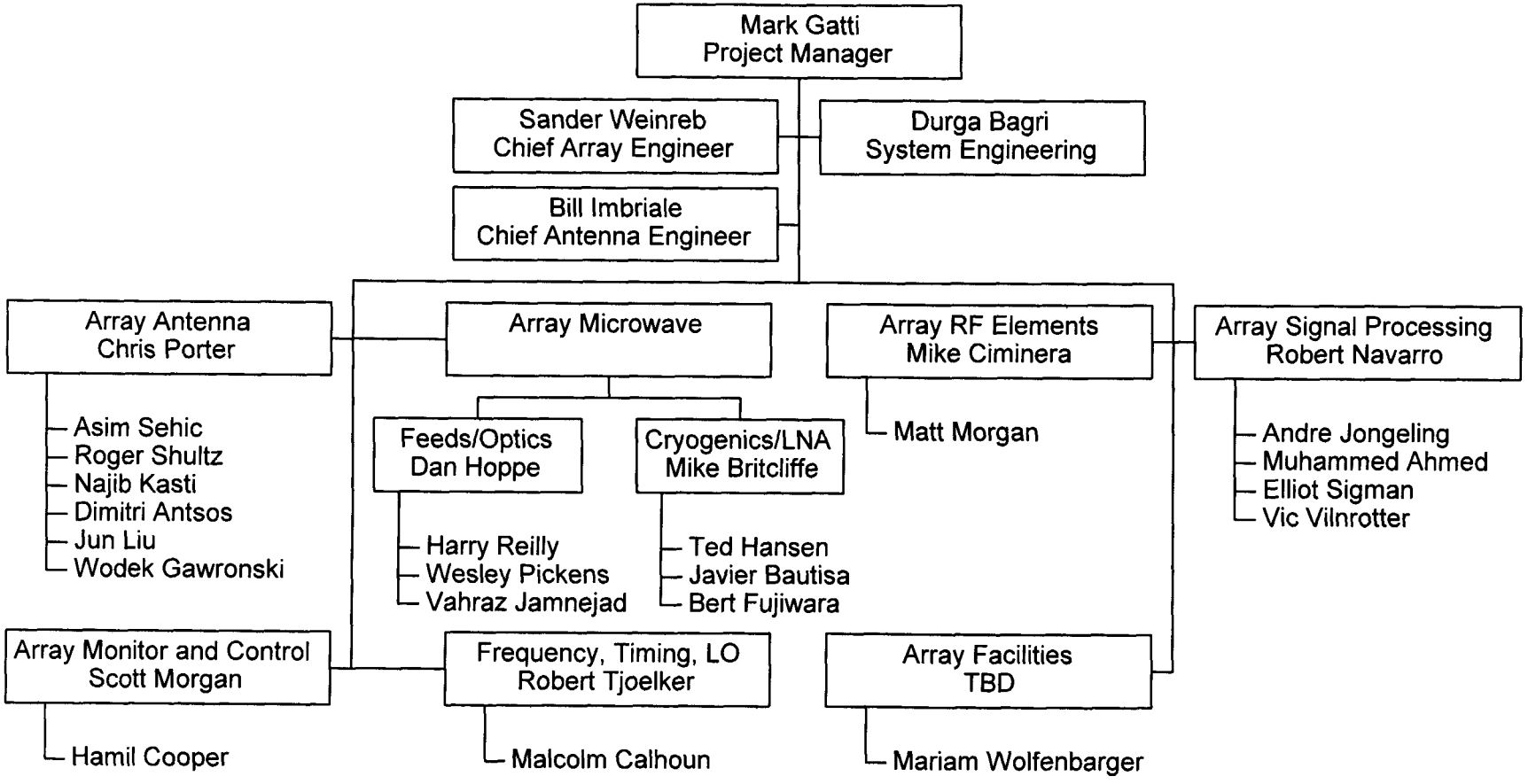
- Demonstrate by December 31, 2008 the technical, cost and operational feasibility of large arrays of small antennas to provide greatly increased downlink capability. Required to meet minimum success criteria.
  - Demonstrate all DSN X- and Ka-band downlink services now provided using 34-m and 70-m antennas, and additional capabilities unique to arrays.
  - Demonstrate cost-effective manufacture of the prototype array system.
  - Demonstrate cost-effective operations and maintenance of the prototype system.
  - Accurately predict the life-cycle cost for a full-scale Array System.
  - Provide signal reception capability at least equivalent to two 34-m antennas.
- Provide by September 30, 2010 an Initial Operational Capability for mission support. Fulfills full success criteria.
  - Two array sites, operating in conjunction with GDSCC. Capability equivalent to two-to-four 34-m antennas at each site. Dual functions: Operations and R&D.

Overview of the DSN Large Array Project

Paradigm Shift

- Currently activities are being managed by the Technical Divisions within the Engineering and Science Directorate .
  - DSN Communications Ground Systems Section leading the effort with support from others
  - Undertaking simultaneous technology development efforts and planning for implementation of the prototype array
  - Fast Paced Team making use of expert contractors/consultants and students
  - Contacts with SKA, ATA, ALMA, and other array efforts
  - Future funding being developed

Overview of the DSN Large Array Project
Organization



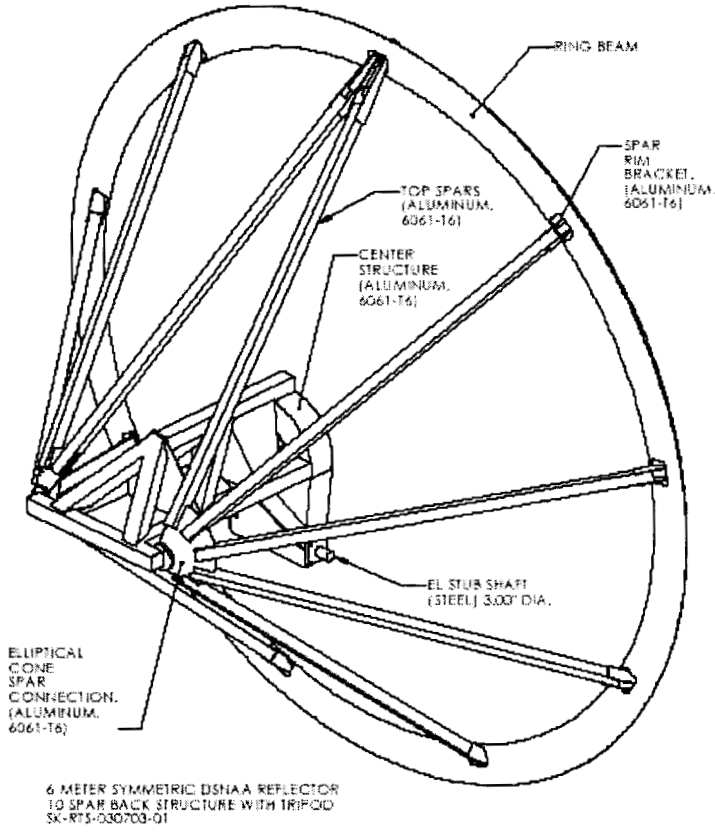
Overview of the DSN Large Array Project

Breadboard Array

- As part of the immediate future, and in preparation to construct the prototype array, a breadboard array will be constructed at JPL/Caltech
  - Three antennas
  - 6m size, inherited from the ATA with the possibility of using an alternate antenna reflector. Modified feed to operate at DSN bands
  - Electronics, signal processing, local oscillators, monitor and control
  - Will be used as technology development test bed
  - Located at JPL (2) and Caltech (1)

Overview of the DSN Large Array Project

6-m Breadboard Antenna



6 METER SYMMETRIC DSNAA REFLECTOR
10 SPAR BACK STRUCTURE WITH TRIPOD
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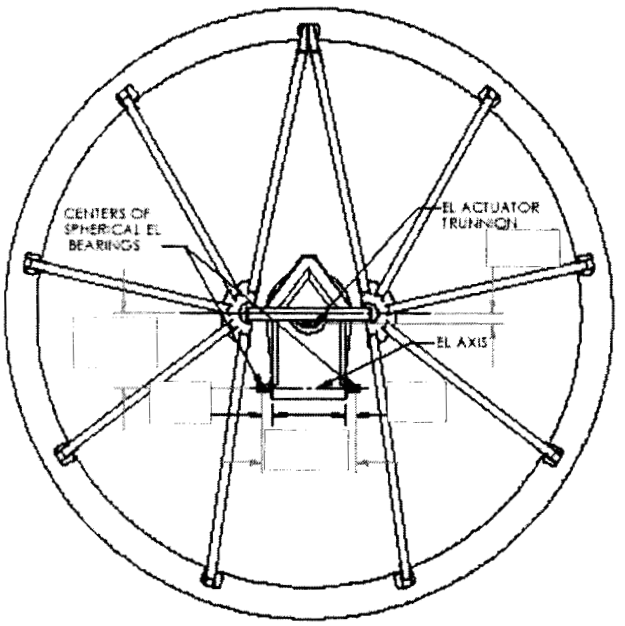
Overview of the DSN Large Array Project



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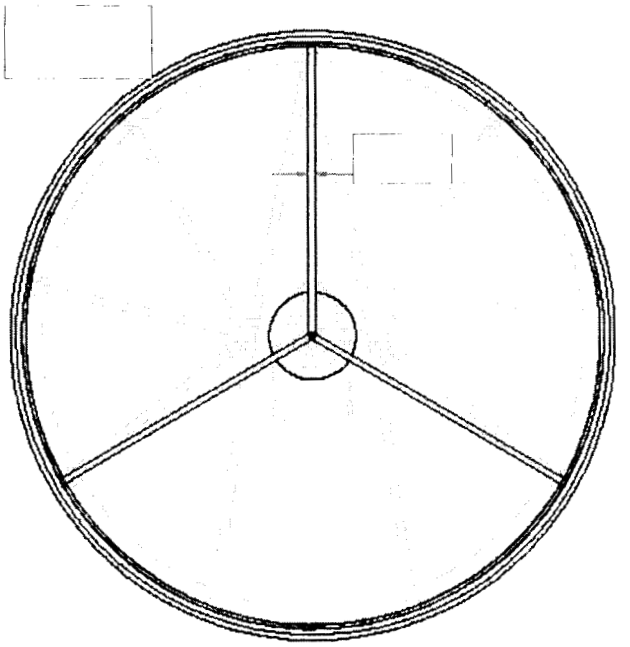
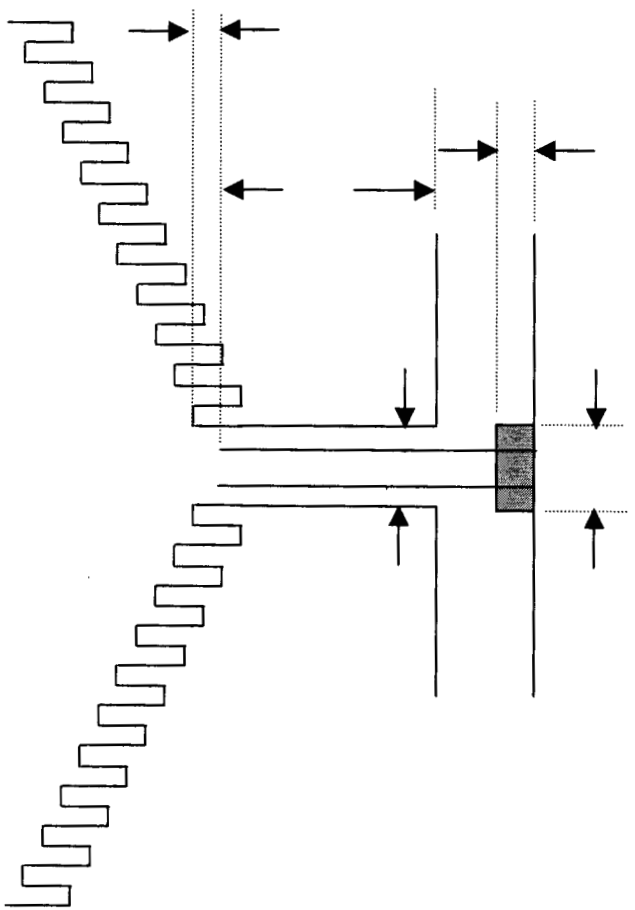
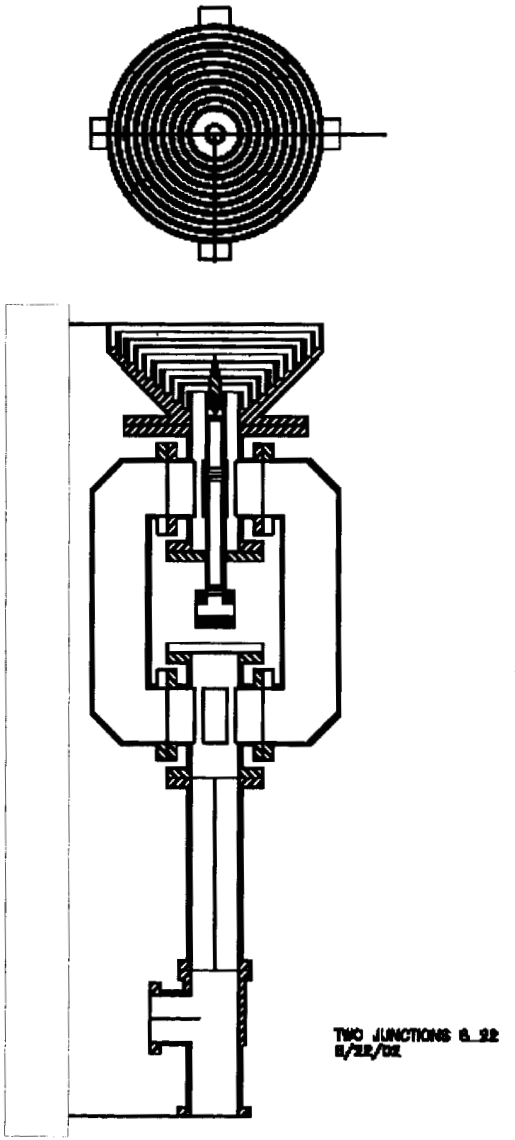


6 METER SYMMETRIC DSNAA REFLECTOR
10 SPAR BACK STRUCTURE WITH TRIPOD

Overview of the DSN Large Array Project

Narrow-Band Match Design





Overview of the DSN Large Array Project Summary

- Synergy with activities of the US SKA
  - Technologies
    - Antennas
    - Feeds
    - LNA/Cryogenic
    - Correlators (for array calibration)
    - High bandwidth real-time data transport
    - Monitor and Control
  - Operations
  - Location, Land Acquisition, Site Studies/RFI
- Relative time Scales of other similar activities
  - ATA
  - LOFAR
  - DSN Array
  - SKA
- Where Requirements Diverge
  - Narrowband, modulated, weak, high data rate spacecraft signals
  - Imaging -vs- maximum A/T
  - Site diversity
  - Navigation